KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF HUMANITIES AND SOCIAL SCIENCES

FACULTY OF SOCIAL SCIENCES

DEPARTMENT OF ECONOMICS

TRADE OPENNESS, POPULATION HEALTH STATUS AND HEALTH FINANCING IN SUB-SAHARAN AFRICA

A THESIS SUBMITTED TO THE DEPARTMENT OF ECONOMICS, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF A MASTER OF PHILOSOPHY DEGREE IN ECONOMICS

BY

YAW BOATENG ATAKORAH

MAY, 2016

DECLARATION

I hereby declare that this submission is my own work towards the degree of Master of Philosophy (Economics) and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

YAW BOATENG ATAKORAH ……….......………...… ……………….………
(PG1906614) Signature Date

Certified by:

DR. JACOB NOVIGNON ……………………… ……………………
(Supervisor) Signature Date

Certified by:

DR. DANIEL SAKYI ……………………… ……………………
(Internal Examiner) Signature Date

Certified by:

DR. HADRAT YUSIF ……………………… ……………………
(Head of Department) Signature Date

DEDICATION

This thesis is dedicated to my lovely wife, Esther Atakorah-Boateng, daughter; Myra Yiedie Atakorah and parents; Mr. Eric Christian Atakorah and Mrs. Anna AtakorahBoateng for their tremendous support throughout the programme.

ACKNOWLEDGEMENT

First and foremost, my sincere gratitude goes to the Almighty God who supplied the strength, traveling mercy and the capability to accomplish this work, without Him I would have probably tried but perhaps in vain.

I offer my sincere gratitude to my supervisor Dr. Jacob Novignon for his invaluable constructive criticisms, suggestions and corrections throughout this thesis. His comments regarding the structure and content of this work are highly appreciated.

I also thank my big family for all the support during this period when I needed each one of them most. Special thanks to my wife, Esther Atakorah-Boateng. She has been such a great inspiration and supportive not only during this period but for as long as I knew her.

Finally, my indebted heartfelt thanks go to all my course mates and entire lecturers especially, Mr. Isaac Bonuedi of the Department of Economics, KNUST who guided me in the use of Generalized Method of Moments (GMM) estimation technique. God bless you all!

ABSTRACT

Improvements in population health and health financing in SSA has been slow and relatively poor when compared with other regions (Middle East and North Africa and East Asia and Pacific) of the world. The study employed a balanced panel data for fortytwo (42) Sub-Saharan African countries over the period 1995-2013. Population health status was measured by total life expectancy at birth, infant mortality rate and under-five mortality rate. Fixed effect (FE), Random Effect (RE) and one step system Generalized Method of Moments (GMM) models were employed in estimating the relationships.

The empirical results across all the estimation techniques show that trade openness improves population health. Specifically, the results showed a positive and significant relationship between trade openness and life expectancy, negative and significant relationship between trade openness and infant mortality rate and negative relationship between trade openness and under-five mortality rate. The study also showed a positive relationship between trade openness and health financing. The study further found that countries whose openness exceeds the optimal level of openness experience deteriorated health and reduced health financing. The study recommends that countries whose openness is below the optimal openness should continue to open up to trade to enjoy the benefits of improved access to health products and medical knowledge spill over.

TABLE OF CONTENTS

CONTENT **PAGE**

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

LIST OF ABBREVIATIONS

EPA	Economic Partnership Agreement
FE	Fixed Effect
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
OECD	Organization for Economic Co-operation and Development
RE	Random Effect
SAP	Structural Adjustment Programme
SSA	Sub-Sahara Africa
WDI	World Development Indicators
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Population health and health financing is a major concern to every economy. According to Marmot, (2007) "the development of society, rich or poor, can be judged by the quality of its population's health, how fairly health is distributed across the social spectrum, and the degree of protection provided from disadvantage due to ill-health." Kindig and Stoddart, (2003) defines population health as "the health outcome of a group of individuals, including the distribution of such outcomes within the group." On the other hand, health financing as a term is used to describe how financial resources are generated, allocated and used in the health system (World Health Organization, 2002).

Economists generally affirm that economic openness is very essential for good health. The basis of their argument ranges from the classical trade theory to the new trade theory that suggest correlation between trade opening and rising living standards (Levine and Rothman, 2006). While better health forms an essential component of both human and economic development, it also facilitate the means to move above the poverty line (Welander, Lyttkens, and Nilsson, 2014). Given the numerous direct and indirect benefits associated with trade, developing countries including Sub-Saharan Africa have increasingly become more open to trade. International trade theory predicts that being more open to trade comes with much advantages and disadvantages (Kumler and Anukriti, 2012).

According to Panda, (2014) a country's ability to open up to trade affects the macro economy by influencing economic growth. Trade through economic growth also manifests itself in good health, thus economic growth leads to improvement in individual's income which is then translated into good health outcome by improved nutrition, improved access to health and sanitation (WHO, 2013).

Sub-Saharan African countries have continually seen a slow progress of population health status of its citizens (Economist Intelligence Unit, 2012). This is supported by evidence from World Health Organization's report that efforts geared toward the attainment of Millennium Development Goals (MDGs) were not motivational enough because countries within the Sub-Saharan region were far from attaining the health targets in the MDGs. Countries within the Sub-Saharan region have always found it difficult to provide clean water and sanitation let along fighting deadly killer diseases (WHO, 2012). Sub-Sahara Africa continues to be the most HIV affected region. WHO,
(2012) in 2013 shows that globally, adults with HIV in SSA alone account for about
69%.

The financing gap in health further possess constraint to finding better solutions to health care delivery in Africa (Economist Intelligence Unit, 2012). Report from International Finance Corporation indicate that although Sub-Saharan Africa account for only 11% of world's population and 24% of global disease burden, the region just command just less than 1% of global health finance. In 2011 for instance, public health expenditure as a percentage of GDP for SSA was only 2.9% compared to world average rate 6.0%. Likewise, private health expenditure as a percentage of GDP also accounted for 3.6% which is below the world average of 4.1%.

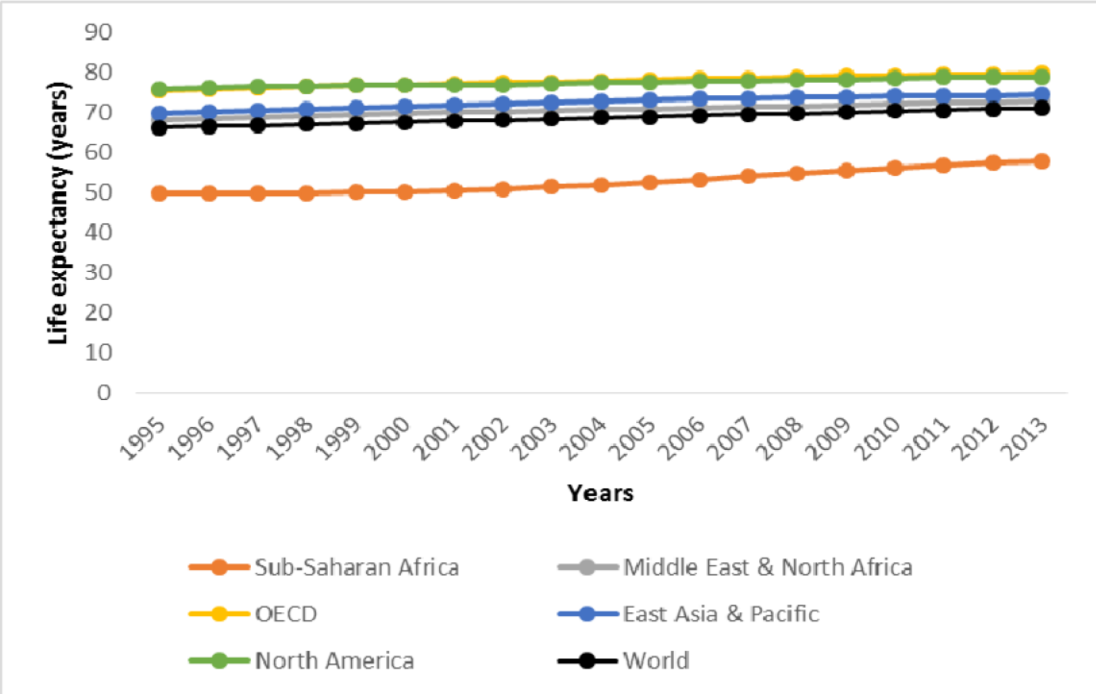
In order to address the problem of poor health financing, the Abuja declaration in 2001 was signed by 53 African countries. The rational was to devote 15% of national budget to health sector. However, as at 2009, only countries like Burkina Faso, Rwanda and Tanzania were able to meet the set target (Economist Intelligence Unit, 2012).

Health care cost in the region has largely been 'out of pocket spending' which clearly is an indication that the poor would find it very difficult to afford health treatment. The situation of 'cash and carry' has further created artificial barriers in accessing health care.

1.1.1 Brief Regional Profile

The significance of better health system in ensuring better population health for achieving sustainable growth in all aspect of an economy cannot be overemphasize. As such, ensuring the control of deadly diseases, improving life expectancy, primary healthcare and administration improvement, improving expenditure on health among others remains the focal and the cornerstone of the World Health Organization (WHO) in collaboration with governments from the SSA. Notwithstanding this concern, health indicators in SSA appear not encouraging. The figures below show a comparison of health indicators as well as trade openness of SSA with other regions across the world.

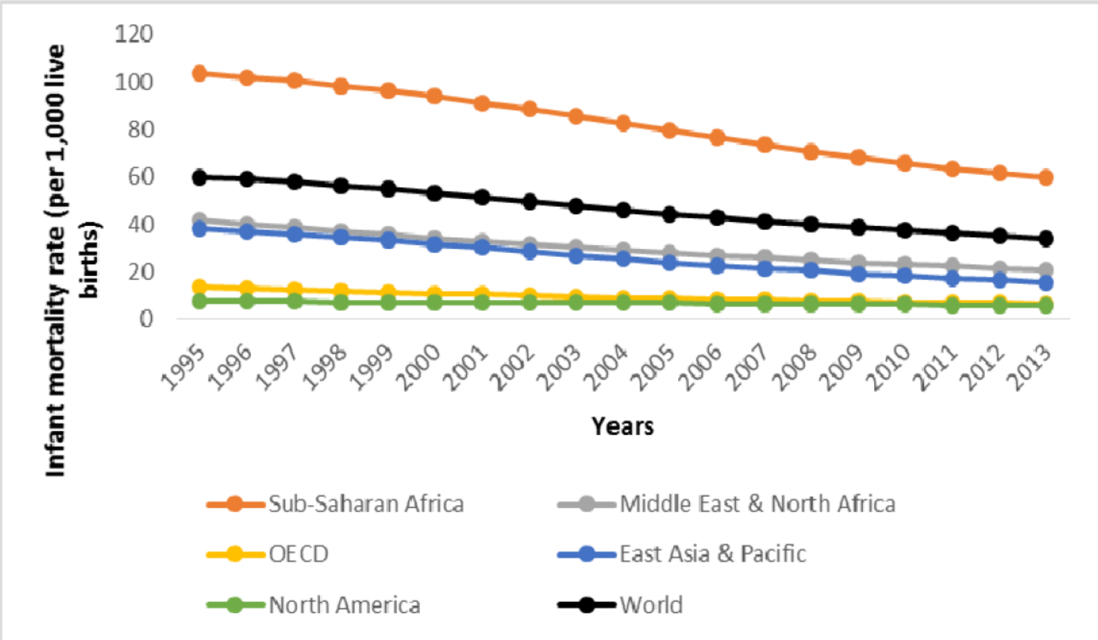
Figure 1.1: Trend in life expectancy at birth (total) across region of the world



Source: Author's compilation from WDI dataset

Figure 1.1 shows the trend of life expectancy for both male and female at birth measured in years. Looking at the trend, Sub-Sahara Africa performs relatively poor compared to all the other regions of the world. It is also pictured from the trend analysis that although average life expectancy is increasing it is far below the world average life expectancy.

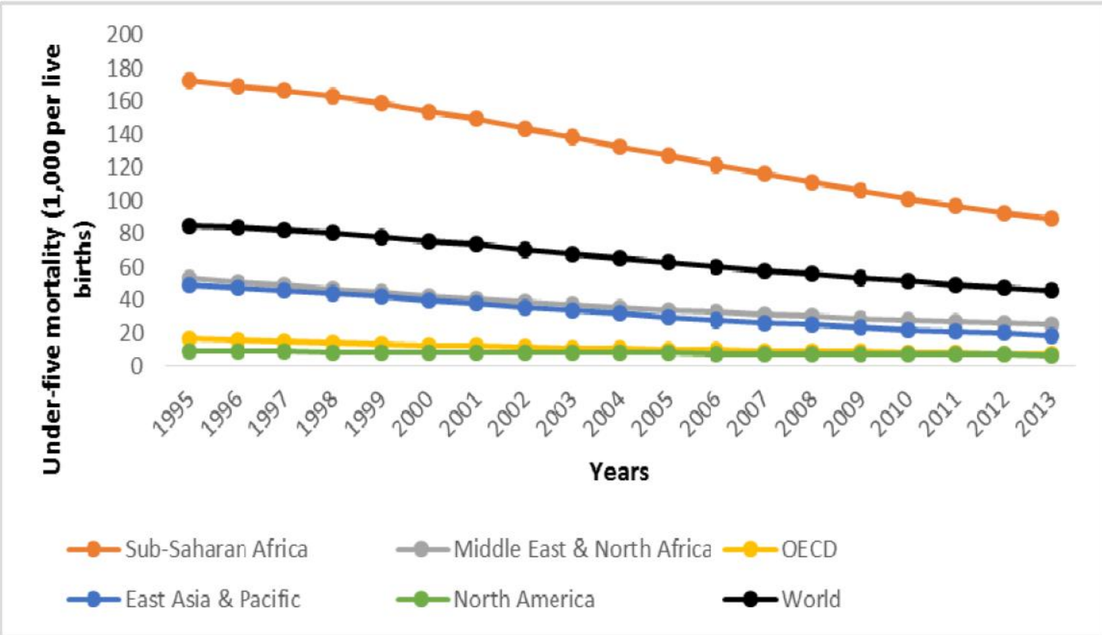
Figure 1.2: Trend in mortality rate, infant (per 1,000 live births) across region of the world



Source: Author's compilation from WDI dataset

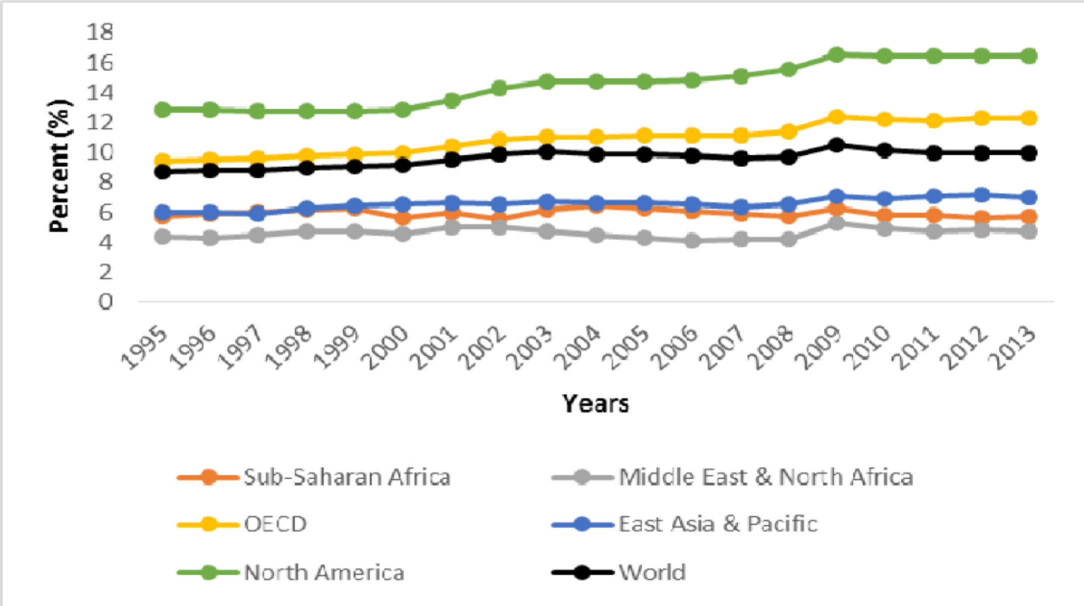
Figure 1.2 compares infant mortality rates across the region of the world. Similar to life expectancy, Sub-Sahara Africa performs relatively poor and much improved in rich countries. The average infant mortality rate per 1,000 live births for SSA is far below the world average infant mortality rate. The gap between the world average and SSA depicts the high level of infant mortality in our part of the world. WHO statistics in 2013 show that child mortality in SSA are mainly as a result of Malaria which accounts for 15% deaths, Diarrhoea which also accounts for 14% and Pneumonia accounting for 17% death all in 2010. The trend statistics seems to point to the fact that as countries grows from one stage of their income level to the other, their population health status improves.

Figure 1.3: Trend in mortality rate, under-5 (per 1,000 live births) across region of the world



Source: Author's compilation from WDI dataset

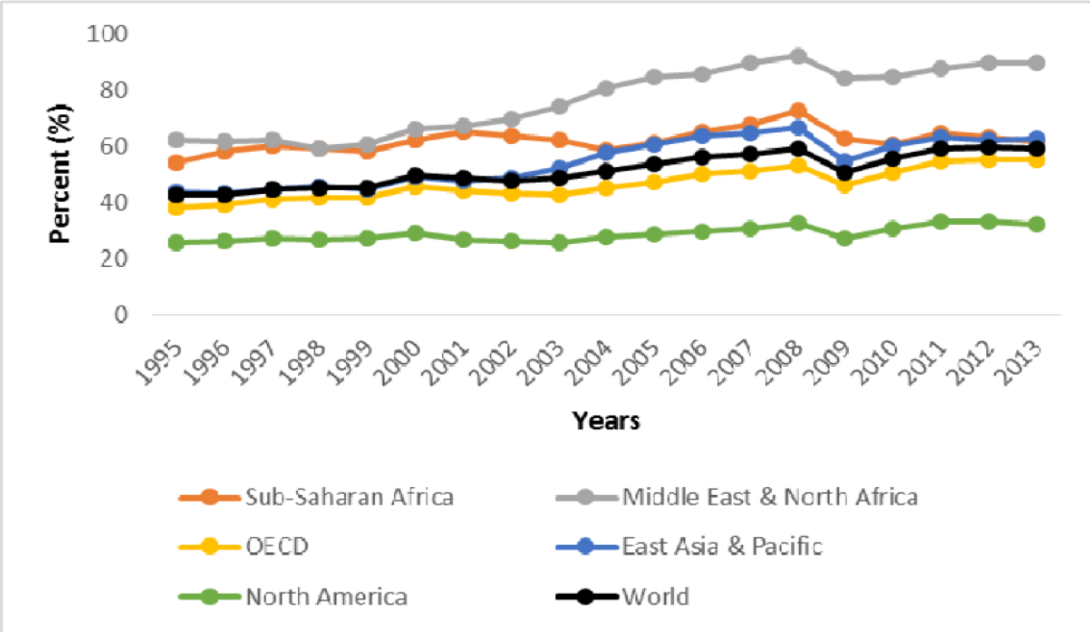
Figure 1.3 shows the average under-five mortality rate measured in per 1,000 live births across the region of the world. Once more, SSA falls below all the other region of the world. Regardless of the falling average under-five mortality rate, SSA is very far from attaining the average world under-five mortality rate. This trend is worrisome as according to WHO, (2002) "Closing inter-country or intra-country gaps between the poor and the better off by securing greater proportional improvements amongst poorer groups, is not simply a poverty issue but also a question of social justices and equity" **Figure 1.4: Trend in health expenditure (total) across region of the world**



Source: Author's compilation from WDI dataset

Figure 1.4 represents the trend of health expenditure (both public and private) across the various regions of the world. As can be clearly seen from the figure above, SSA is only better when compared to Middle East and North Africa. Meanwhile, SSA performs relatively poor when compared to North America and OECD countries. With the fluctuation nature of health expenditure in SSA, it is far from the average world health expenditure. This might suggest why developed countries continue to experience improved population health while the reverse holds for developing countries especially SSA.

Figure 1.5: Trend in trade openness across region of the world



Source: Author's compilation from WDI dataset

Critical look at the figure above indicates that Sub-Sahara Africa is the second most open region across the world. Irrespective of the fluctuation nature of openness in the SSA region, the averages openness curve lie above the world average rate. It is however interesting to note that countries with good population health status such as North America and OECD countries (see figures 1.1, 1.2 and 1.3) are less open considering the fact that their level of openness is below the world average rate.

1.2 Problem Statement

For the past few decades, Sub-Saharan Africa countries have witnessed some levels of trade openness mainly as a result of structural adjustment programme (SAP) introduced in the year 1986. Despite the core motive of the programme to improve local productivity, reduce government expenditure, improve economic competence and boost growth potential to better the chances of developing countries for future progress, countries that initiates the policy are compelled to put in place policies that ensure markets deregulation and trade liberalization (Sulaiman, Migiro, and Aluko, 2014). Recently, effort to further open up to trade in Africa has been championed by the proposed Economic Partnership Agreements (EPAs). Once countries within Africa adhere to this policy, it becomes binding and African countries are obliged to open up their market of about 80 percent to absorb European goods and services (Mcdonald et al., 2013).

Evidently, countries that open up their boarders to international trade have high access to goods and services, which improves health. According to Serrano et al., (2002) "openness facilitate the spread of knowledge and the adoption of more advanced and efficient technologies, which hastens total factor productivity growth and, hence, per capita income." Also, openness to trade enhances the consumption of medical goods and international spillovers of medical knowledge (Deaton, 2004). To improve population health status, medical goods in the form of surgical equipment and drugs (vaccines and antibiotics) are very important and are mostly imported from advanced countries. Similarly, a country's openness to trade influences health financing. Thus, improved production capacity due to openness allows for investment in population health.

It is however worth mentioning that in spite of policies geared towards trade openness, improvements in population health and health financing in Sub-Sahara Africa has been slow and relatively poor when compared with other regions across the world (see figures1.1, 1.2, 1.3 and 1.4). When country open up to trade, developing economies serves as a center for unhealthy goods in the form of unhealthy foods, alcoholic products and tobacco. This slows the pace of population health and health financing in SSA.

The question remain whether opening the boarders of a country to international trade can really influence population health and health financing particularly as most Sub-Saharan countries have consistently open up the economy to trade. Finding empirical responses to this question is what this thesis set out to accomplish. To this effect, this study sought to estimate the effect of trade openness on population health status and health financing in Sub-Sahara Africa.

1.3 Objectives of the study

The general objective of this study was to empirically examine the effect of trade openness on population health and health financing. Specifically, the study aimed to:

i. estimate the effect of trade openness on population health in Sub-Saharan Africa, ii. estimate the effect of trade openness on health financing in Sub-Saharan Africa.

iii. estimate the optimal level of trade openness on population health in Sub-Saharan Africa.

1.4 Hypothesis Statement

Hypothesis in relation to the effect of trade openness on population health

H_0: Trade openness has no effect on population health in Sub-Saharan Africa.

H_1: Trade openness affects population health in Sub-Saharan Africa.

Hypothesis in relation to the effect of trade openness on health financing

H_0: Trade openness has no effect on health financing in Sub-Saharan Africa.

H_1: Trade openness affects health financing in Sub-Saharan Africa.

1.5 Justification of the Study

The objective of every country is to achieve persistent quality health of its populace. The need for enhancing quality health has become necessary due to its impact on economic growth. Poor health status means low output leading to low growth. However, providing health financing has always been limited. This serves as a motivation to investigate whether trade openness can improve population health status and health financing in SSA. Positive results will serve as incentive for countries especially the developing ones to open their boarders to international trade while if found negative will mean an incentive to put in place measures to ensure safe trade.

Given the scanty nature of research into trade openness and health, Owen and Wu, (2002) and Razmi, (2012) looked at the relationship between trade openness and health using fixed effect estimation approach. Maryam and Hassan, (2013), Levine and Rothman, (2006) and Hudak, (2014) also looked at trade openness and health for Pakistan, 134 developed and developing countries and 30 low and high income countries respectively, by employing autoregressive distributed lag (ARDL), two stage least square (2SLS) and random effect estimation techniques respectively. However, no work has been done in respect to SSA to estimate the effect of trade openness on health financing. This study bridges the gap in the literature by estimating the effect of trade openness on health financing.

With regards to methodology, available studies have only used fixed and random effect models and have neglected the possible endogeneity problem that arises in the relationship. This study contributes to literature by using GMM to correct the potential endogeneity problem. The inference of the study, among other things, is expected to provide vital information for further studies.

1.6 Scope of the study

The study employs panel data for forty-two (42) Sub-Sahara Africa countries (see appendix A) for the period 1995-2013. The data period 1995-2013 was selected due to the availability of consistent data. Moreover, most SSA countries started their liberalization process in the late 1980s, therefore getting data beyond 1980 was not possible. All Sub-Saharan countries were not considered due to the limited data for such countries. On population health measures, the study only took into account life expectancy, infant mortality and under-five mortality albeit there are other measures of health outcomes but data on them particularly for SSA were unavailable.

1.7 Organization of the study

The project is organized into five chapters. The first chapter incorporates the background information on the topic, the statement of the problem, the objective of the study, hypothesis and significance of the study. Chapter two concentrates on literature review which consist of the theoretical framework and empirical evidence of related works. The third chapter looks at the method to be used to achieve the research objective. The fourth chapter contains the presentation of the data analysis, results and discussion. Finally, chapter five presents a summary of the major findings of the study, recommendation for policy considerations and conclusion of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

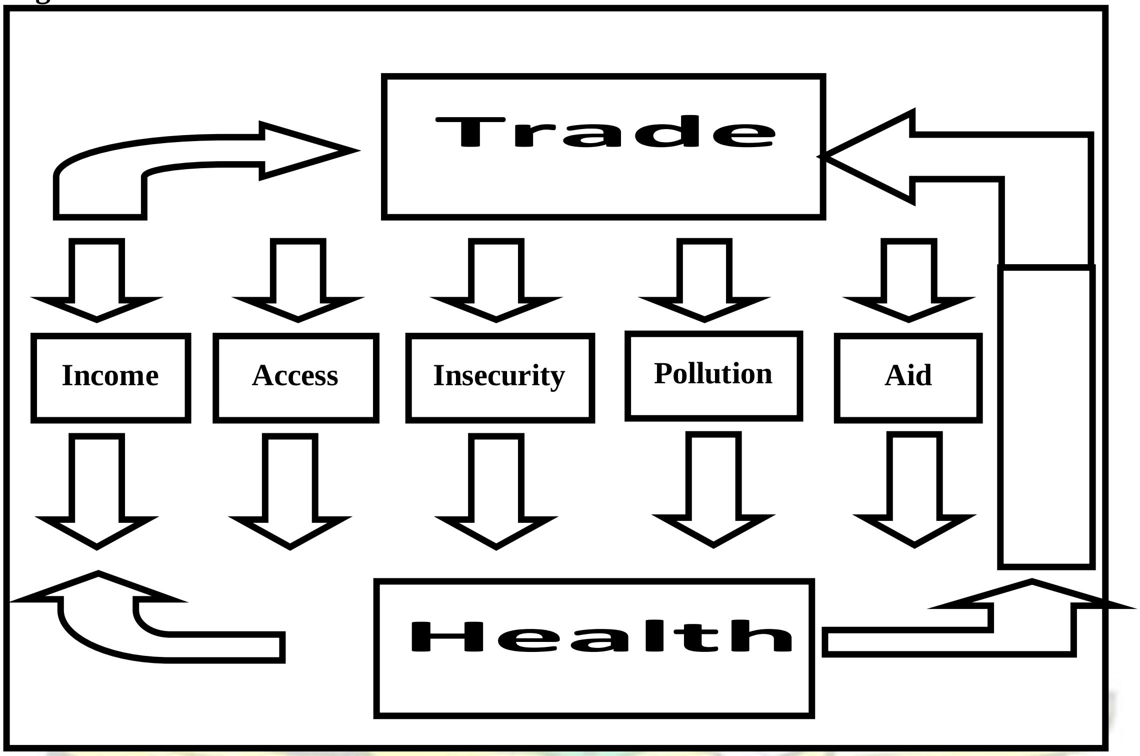
This chapter is in two parts. The first part looks at the theories that have been developed to explain trade policy, health finance and population health. In the second part empirical works relating to how well trade openness influence population health and health financing are reviewed.

2.2 Theoretical review

2.2.1 The Link between Trade and Health

Conceptually, trade is expected to affect health while the reverse is also possible (Herzer, 2014). Several conceptual hypotheses have been proposed to show the mechanisms through which improved trade performances could result in improved or deteriorated population health status within a given economy. Herzer, (2014) presented a simplified conceptual model that explains these mechanisms. The model is shown in figure 2.1 below.

Figure 2.1: Link between trade and health



Source: Herzer, (2014) pp 4

According to Herzer, (2014) trade impact health through the income mechanism, access mechanism, insecurity mechanism, pollution mechanism and the aid mechanism. The mechanisms are discussed below.

2.2.1.1 The Income Mechanism

One mechanism through which trade can be said to influence health is through income. When national income increases, it results to increased expenditure on health which is not the case when there is low level of income. This accounts for Herzer, (2014) proposition that trade affect health positively except when it can be said that trade does not impact income or negatively affect income. This assertion implies that trade does not always affect income positively rather trade can affect income negatively. The negative relationship can occurs when countries initiates policies to restrict labour activities (hours in working, minimum wage etc.) through labour regulations in the midst of excessive businesses (Freund and Bolaky, 2008). Herzer, (2014) also explained that when national income is attributed to number of working hours then less time will be devoted for sleeping, more stress, increased consumption for harmful health commodities and this will imply negative impact on health although income levels are high.

The findings from the interactions between trade and health is that trade improves health through income (see Zhang, Ondrich, and Richardson, (2004), Erpek, (2014) and Furusawa and Konishi, 2013). Meanwhile, Freund and Bolaky, (2008) finds that the relationship between trade and health through income is not always positive because restriction on labour will result to low income which can influence health negatively.

2.2.1.2 The access Mechanism

Trade boosts both consumer and producer confidence of a variety of goods and services domestically at a lesser cost than there is no trade. This boost can have positive and negative impact on population health. Clearly, when countries especially the developing ones open up for trade, they stand a better change of securing medical goods and equipment in the form of surgical instruments, vaccines and antibiotics (Owen and Wu, 2007). This has been a pathway for developing countries to secure health related items from the world governing organizations and developed countries. Trade also makes it possible for medical knowledge spread to improve population health in most developing countries (Papageorgiou, Savvides, and Zachariadis, 2007).

On the contrary, not only does access in trade have positive effect on health but also negatively influences health. For instance Huynen, Martens, and Hilderink, (2005), Dollar, (2001) and Deaton, (2004) found a negative relationship between international trade and health. They argued that international trade openness results to the spread of several infectious diseases through imported products (for example, meat and vegetables). Similarly, another negative impact of trade to health is the influx of health threatening products in the form of tobacco and alcoholic products (Dollar, 2001). Bettcher, Yach, and Guindon, (2000) suggests that trade openness comes with risks and benefits, however, such goods posing the risk and benefits depends on the kind of goods concerned. The study classified such goods into "legal and beneficial (e.g. Nutritive food and cost effective technology); legal and doubtful benefits (e.g. technologies of low cost-effectiveness); legal and harmful (e.g. tobacco, alcohol and weapons); illegal and harmful (e.g. illicit drugs)." This results to the assertion by Prabhat and Chaloupka, (2000) that increased intake of harmful commodities such as tobacco will distort the health benefits of trade openness.

2.2.1.3 The insecurity mechanism

Gradually, countries are increasingly being open to the world economy. This is particularly because countries depends on other countries for their imports to export.

Economic theory establishes that more opened and integrated world gives boost to large scale economic advantage. However, global economic integration coupled with technological advances does not as believed benefit every country. This implies that the negative effect of economic insecurity through trade on health cannot be underestimated. When trade is increased for low wage developing countries, it results to low domestic wage especially with the low skilled worker although such developing country may enjoy cheap imports (Ahearn, 2012). This makes it very difficult for the low wage earner to efficiently spend on his or her health.

According to Hecksher and Ohlin as cited in Jones, (2008) countries will have the opportunity to produce and export goods and services that they own, while they will import goods and services that require large amounts of production factors which may be in short supply. All other things being equal, as economic insecurity increases, international trade will always have negative impact on health (Rugulies et al. 2008). Thus, the more a country opens up to trade the more its insecurity in term of income and employment (Rodrik, 1998). Trade openness in developing countries most especially SSA brings a lot of threat to infant industries. Where local industries are unable to absorb competition from international industries, the security of employment is not assured among local workers. Most unemployment situations in developing countries are as a result of trade making it possible for developing countries to be served as a center for most foreign products at cheap prices.

2.2.1.4 The pollution mechanism

The effect of pollution on health is well established in the literature. The effect of pollution on health is said to be huge and accounts for 8% to 9% total global diseases (Briggs, 2003). According to the pollution haven hypothesis or population haven effect, multinational firms will relocate the production of their pollution-intensive products to countries where environmental regulations are low. When this persist over a period of time, developing countries becomes "havens" and counted as part of world polluting industries (Temurshoev, 2006). Thus according to Temurshoev, (2006) pollution becomes less in developed countries relative to developing countries as trade is intensified. This accounts for developed countries benefit in terms of environmental quality from trade while developing countries lose from trade (Temurshoev, 2006).

The factor endowment hypothesis also argues that countries with more factor abundant capital-intensive industry pollutes the more (Temurshoev, 2006). This situation is normally associated with developed countries where production is capital intensive and the emissions are so huge. Copeland and Taylor, (2007) argue that countries endowed with limited capital (developing countries) have low pollution emission while countries endowed with more capital intensive method of production (developed countries) have high pollution emission. When pollution level rises with trade, its effect is deteriorated health status. Cropper, et al., (2000) found a positive relationship between pollution and mortality rates.

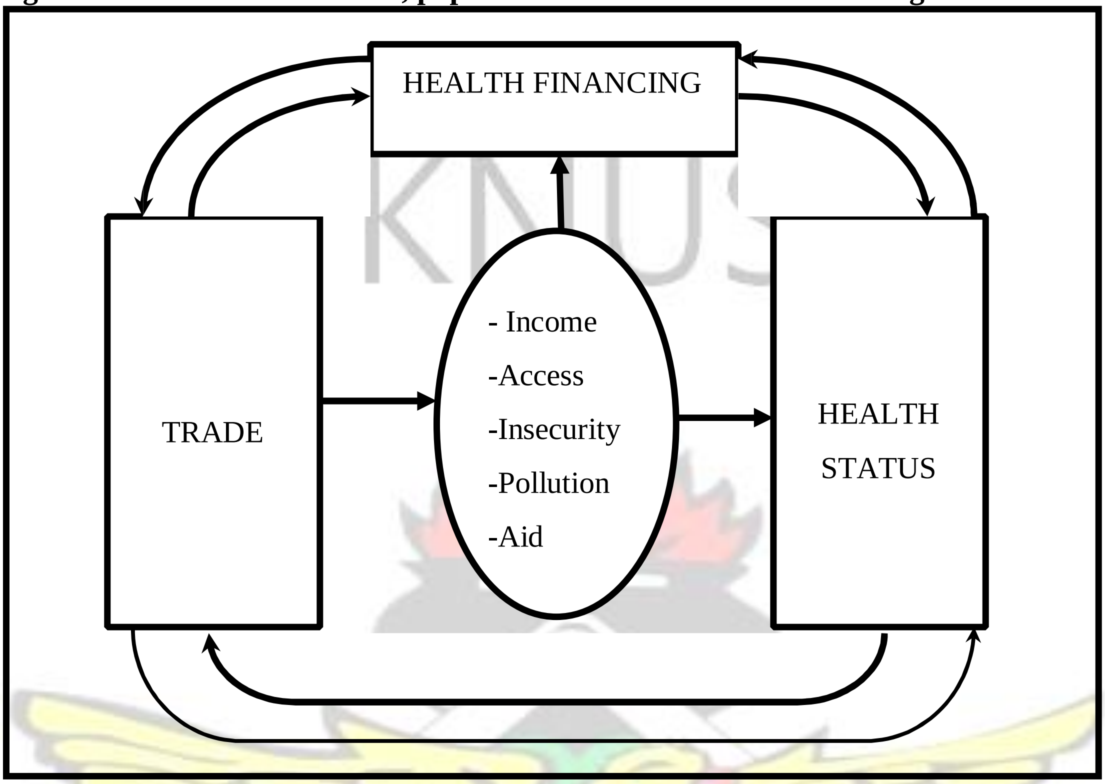
2.2.1.5 The foreign aid mechanism

Studies on trade and foreign aid establishes that trade plays a major role in attracting foreign aid. To Lloyd et al., (2002) there exist a simple but complex relationship between trade and foreign aid. Lloyd et al., (2002) is therefore of the view that the amount of foreign aid attributed to a particular country through trade depends largely on policies of donors. Trade to a very large extent results to further rise in foreign aid when donors tag the allocation to countries where they have the greatest trade links. All thing being equal, one would always expect that the higher the volume of donor exports to a country, the higher the foreign aid allocation to that particular country. This is usually done to compensate receiving donor countries for purchasing donors exports (Lloyd et al., 2002).

According to Owen and Wu (2007) aid received through trade is channeled to sanitation and water related problems to address lower levels of infant mortality as well as higher life expectancy. Here the implication is that aid from trade is used to address health problems so as to improve population health status. Herzer, (2014) also noted that trade have positive and negative effect on health through aid mechanism and that developed countries stand tall in attracting foreign aid compared to the developing countries. Thus to him, the effect of trade on health following this mechanism differs in relation to less regulated and more regulated countries.

2.2.2 Trade, population health and health financing

Figure 2.2: Link between trade, population health and health financing



Source: Author's modification from Herzer, (2014)

The conceptual model by Herzer does not explicitly include the link between trade and health financing. The study therefore modify Diek's conceptual model to include health financing and also to suite the general objective of the study. Directly, health financing influence trade in healthcare goods and services. Thus, as healthcare spending increases, trade in medical equipment, drugs and movements of healthcare professionals are enhanced to affect population health. On the other hand, trade also impact health financing. When countries open up to trade they tend to integrate with other countries through which benefits in the form of grants, aids and donations can be directed mainly towards the health sector.

Indirectly, trade can influence health financing through Herzer's mechanisms (income, access, insecurity, pollution and aid mechanism) or through population health status. As countries open up to trade, gains in the form of income and aid boost both private and public spending on health. Similarly, access to different kinds of health products improves population health which is associated with increased labour supply and productivity. On the contrary, health financing impacts trade indirectly through population health. That is, as both private and public expenditure on health increases population health improves. The development associated with population health increases labour supply and improves productivity.

2.2.2 Trade and economic growth

Trade openness can influence health through several dimensions (as clearly shown in figure 1.1 above). However, the debate on the impact of trade openness on population health in literature is said to occur through an indirect means which work through economic growth. Jani and Dholakia, (2015) suggests that because no much studies have been conducted on the impact of openness and population health, studies on the subject matter have all concentrated on the indirect impact.

According to Levine and Rothman, (2006) trade increases economic growth through gains from openness to trade. Several studies including Sachs and Warner, (1995) and Wacziarg and Welch, (2003) have all prove the existence of linkage relationship between trade openness and economic growth. It is therefore believed that once a country is more opened, its growth in terms of Gross Domestic Product (GDP) is appreciated. This has been the main rational why multinational organizations including

WTO and IMF quest for countries to open up their trade (Jani and Dholakia, 2015).

When there is an increase in economic growth, what happens is that, individuals' disposable income is increased. According to Pritchett and Summers, (1993) increase in the disposable income put the individual in a better position to improve the health. Higher per capita GDP can influence higher expenditure on health care (Jani and Dholakia, 2015). Hitiris and Posnett, (1992) in their study found a negative correlation between health expenditure and crude mortality rates. Thus when there is an increase in health expenditure, crude mortality rates are minimized. This means improved GDP lead to higher income which betters population health status which emanate from both public funding of the health system as well as the direct private spending on health. Similar to the work by Hitiris and Posnett, (1992), Harttgen, Klasen, and Vollmer, (2012) also found a negative relationship between increase in per capita GDP and under-nutrition. They concluded that when income of the under nourished group increases, nutrition health is as well increased. Pinstrup-Andersen and Caicedo, (1978) (as cited in Jani and Dholakia, 2015) noticed that when income of the poor population increases, their tendency to consume more nutritional related foods are enhanced.

2.3 Empirical Evidence

Limited studies have been carried out to explain trade policy and health related issues among different countries using different estimation techniques. This section reviews some of the empirical findings.

Owen and Wu, (2002) used a panel data on 139 developed and developing countries with the motive of examining the relationship that exist between a country's openness to international trade and health. The study employed a fixed effect approach to estimate the relationship that the authors seek to achieve using a data span from 1960 to 1995. Results from their work indicate a significant relationship between international trade openness and health status for both rich and poor countries. However, results from their work turn to favour poor countries. Thus, poor countries stand a better chance to benefit more in terms of trade openness and health. Specifically, their results show a significant but negative relationship between openness and infant mortality. They emphatically noted that free trade implies free flow of health support which enhances both accessibility and improvement in the health sector. On the part of developing world, the relationship that exist between trade openness and health clearly indicate improvement in health access given the deeply concentration on pre-natal and post-natal care. On life expectancy, the study revealed a significant and positive relationship between openness and life expectancy. Statistics from their work points out that an increase in the standard deviation of log openness will raise female life expectancy by about 1.39 years. The impact of trade openness on life expectancy for males was however not different from that of the females only that while life expectancy for females raised by 1.39 years, that of the males increased by 0.3 years proving the significant impact of openness on health status (specifically life expectancy comprising of both males and females).

In a different study, Maryam and Hassan, (2013) used an Augmented Dickey Fuller and Philip Perron unit root as well as the Autoregressive distributed lag (ARDL) Bound test to examine the long and short run impact of human capital; exchange rate and gross national income on trade openness in Pakistan. Using a time series secondary data from the year 1976 to 2011, the study found that human capital in the form of per capita health expenditure have insignificant but positive impact on trade openness both in the short run and long run. In the long run the estimated results pointed that a percentage increase in per capita health expenditure leads to about 0.22 percentage rise in trade openness.

Taking annual panel data over the period 1980 to 2009 for oil rich developing countries, Razmi, (2012) in his study "Reviewing the effect of trade openness on human development" examined whether or not trade openness serves as an influential catalyst for human development. From the empirical findings based on the fixed effect model, there exists a significant as well as a strong positive relationship between trade openness and life expectance (as one of the variables for measuring human development). From the same study, trade openness was found to have a negative influence on infant mortality. This result by Razmi, (2012) is not different from that of the study by Owen and Wu, (2002) in terms of empirical findings. This means the reasons given by Owen and Wu for positive impact of trade openness and life expectancy can also hold for that of Razmi's study. The study therefore recommended for reduction in both tariff and nontariff barriers to enhance imports and exports to further improved human development in the study countries.

Another significant study on trade and health was initiated by Levine and Rothman, (2006). The import of their study was to determine whether or not trade influence child health. Considering panel analysis, a total of 134 developed and developing countries were used to determine the impact of trade on child health. Using the two-stage least square regression (2SLS) life expectancy was found to be statistically significant at 1% significant level. The estimation technique indicated that whenever there is a 20 percent increase in trade as a share of gross domestic product, the resulting effect would be that life expectancy also increase by approximately 2 log point (thus almost half year life longer). Also, using child mortality as a measure of child health, the coefficient was found to be statistically significant at 1% level of confidence. With the coefficient of child mortality been -0.63, the inferences drawn was that increased trade would lead to about more than half a year reduction in infant mortality. Overall, the study of Levine and Rothman, (2006) concluded by supporting the fact that openness to trade leads to a decline in the rates of child mortality, while on the other hand life expectancy through trade is well enhanced. Levine and Rothman just like Razmi support free trade but oppose trade restrictions as policies on trade restriction can negatively influecne imports of both essential goods and services. Levine and Rothman noted that imposing trade restriction will go a long way to impact negatively the poor nations as it will lead to lower investment in health care (most especially child health).

Hudak, (2014) explored the relationship between trade openness and differential health outcomes, considering a panel data set for thirty (30) low and high income countries from the period 1960 to 2012. Using the random effect estimation technique, result from the study indicates that at 10% significance level, an increase in open trade policies leads to 14.09 increase in life expectancy. Meanwhile, the model only explained 34% of the variance in life expectancy. Thus, the study concludes that openness to trade positively impact life expectancy.

Stevens, Urbach, and Wills, (2013) studied the relationship between free trade and health. Their empirical findings revealed that free trade is correlated with better health and this becomes clearer when dealing with low income countries. They actually attributed the strong correlation between free trade and health to two main mechanisms. Firstly, they indicated that trade is very essential for growth and when there is growth; people are in a better position to improve their standard of living hence empowering government to inject more capital into public health measures which includes sanitation and universal vaccination. Secondly, they considered 'knowledge spillover' as another way of having a relationship between free trade and health. To them, international trade will influence the injection of products and knowledge to help boost the health sector.

Using the Synthetic Control Method to estimate the effect of trade liberalization on health outcomes for the periods 1960 to 2010, Olper et al., (2014) found that in all there is a significant short run and long run fall in child mortality. In the case of Africa and specifically South Africa, the study observed that increase in child mortality rate was as a result of the wide spread of HIV/AIDS.

Mondal, Hossain, and Ali, (2009) estimated factors significant in explaining infant mortality and child mortality in Bangladesh using logistic regression. The study showed that education and sanitation facilities are important factors in determining infant and child mortality. The study noted that women with primary education stand the risk of 31.40 percent infant death compared to 52.30 percent of women without education. On sanitation, the study also found that households with hygienic toilet facilities stand the risk of 32.00 percent child mortality lower that those without such facilities. Thus according to the study, child mortality reduces when female education together with available hygienic environment is enhanced. The study therefore recommended for the expansion female education and public health system to reduce infant and child mortality.

Fayissa and Gutema, (2008) investigated a health production function in Sub-Saharan Africa. Taking into account a pooled cross-section time series data spanning from 19902000 for thirty-three (33) Sub-Sahara Africa countries, the two way random effect regression model established that food availability per capita, literacy rate and decline alcohol intake has significant impact on life expectancy. The study however found a negative relationship between health expenditure and life expectancy. The study attributed the negative relationship between health expenditure and life expectancy to the inefficient health service provision. The study further found urbanization to positively affect life expectancy. The study explained that life expectancy in SSA increases when urbanization increases.

Herzer, (2014) also estimated the long run relationship between trade and population health using a panel time series data from 1960-2010 for seventy-four (74) developed and developing countries. The study found a positive relationship between life expectancy and trade openness while a negative relationship between infant mortality and trade openness. The study therefore concluded that trade openness has positive and significant impact on population health. The study also found a long-run causality running from both directions.

Anyanwu and Erihijakpor, (2007) examined the link between African countries' per capita total health expenditure together with government health expenditure to two health outcomes (under-five mortality and infant mortality) for the period 1999-2004. The estimation results using robust ordinary least square (ROLS) and fixed effect models found per capita total health expenditure to be significant and negative to affect under-five mortality as well as infant mortality. According to the empirical results, 10 percent increase in per capita total health expenditure results to a fall in under-five mortality by about 21 percent as the same 10 percent rise in per capita health expenditure will reduce infant mortality by approximately 22 percent. Also, results from the study established a significant and negative relationship between urbanization and infant mortal and urbanization and under-five mortality.

Issa and Ouattara, (2005) studied the effect of private and public health expenditure on infant mortality rate across 160 developed and developing countries from 1980 to 2000. Using the ordinary least square and fixed effect and random effect estimation techniques, the study showed that health expenditure has negative relationship with infant mortality. Similarly, the study found a negative relationship between female education and infant mortality rates across the countries under study.

Shetty and Shetty, (2014) examined the correlation between health spending and infant mortality in 34 Asian countries. The study found that health spending reduces infant mortality. The study also noted that higher budget allocation to health is significant in reducing infant mortality rate.

Using an Error correction model (ECM) to study the determinants of healthcare expenditure in Ghana, for the period 1970-2006, Angko, (2013) established that urbanization significantly and positively affect the growth of per capita healthcare expenditure in Ghana. The empirical estimation results also confirmed that one period lagged of urbanization was positive and significantly influence per capita healthcare expenditure. That is, previous year urbanization rates translate into current year to influence per capita healthcare expenditure positively. Urbanization rate and its lagged had coefficient of 4.33 and 3.96 respectively. According to this figures, when urbanization rate increases by 1 percent, per capita healthcare expenditure will also rise by approximately 4 percent. The study also found GDP to be a key determinant of healthcare expenditure. At 1 percent significant level, both GDP and its lagged coefficients of 1.709 and 1.249 were found to be significant and positive in the short run.

Investigating the determinants of healthcare spending in Iran, Rezaei et al., (2016) used Autoregressive distributed lag (ARDL) approach and error correction method (ECM) for the period 1978-2011. The study estimates provided evidence of positive relationship between healthcare spending and illiteracy rates, urbanization and GDP per capital in both the short run and long run.

Dhoro et al, (2011) examined the determinants of public health expenditure in Zimbabwe using yearly time series data for the period 1975-2005. Employing EngleGranger cointegration technique, the study found GDP per capita and literacy rate to be key determinants of public health expenditure in Zimbabwe. Specifically, the study found GDP per capita to be significant and positive to determine public health expenditure. At 10 percent significant level, literacy rate was also found to influence public health spending positively.

Amiri and Ventelou, (2012) studied the causality between healthcare expenditure and GDP in United States using data between the period 1965-1984, 1975-1994, 1985-2004 and 1965-2004. Results from the modified Granger causality test showed a unidirection running from GDP to healthcare expenditure between 1985-2004 while from 1965-1984 a bilateral relationship was established between healthcare expenditure and GDP.

In a similar study, Mehrara et al., (2012) employed a cointegration analysis for 13 MENA countries based on data sampled between 1995-2005. The results showed that there is a long run relationship between healthcare expenditure and GDP.

From the literature reviewed, focus has been on trade openness and health status while the link with health financing has been ignored. Also no study explicitly explains the link in the context of Sub-Saharan Africa. Again studies on the relationship between trade openness and population health have ignored the possible endogeneity problems. This study attempt to solve the endogeneity problem by using GMM estimation technique. The study therefore considers these lapses in literature very important and serves as a motivation to address these issues in the current study. Based on the theoretical and empirical studies reviewed, one could expect that if there is appreciation in term of openness to trade, then, population health status surely would be on a rise.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter critically looks at the methodological framework. Specifically, the chapter looks at the theoretical and empirical framework applied in estimating the effect of trade openness on both population health status and health financing. The chapter further captures the detailed description of the variables as well as the data source. One step system generalized method of moments, fixed effect (FE) and random effect (RE) estimation techniques was adopted for estimations in the study.

3.2 Theoretical Framework

This study adapts the framework presented by Fayissa and Gutema, (2008) and Novignon and Lawanson, (2015) based on the theoretical health production function developed by Grossman, (1972). Similar to Grossman, (1972), Fayissa and Gutema, (2008) took into consideration social, economic and environmental factors as inputs for the health production system. The theoretical health production function is stated as:

$$H = f(X) \qquad (3.1)$$

Where

H = Individual health output

X = Vector of individual inputs to the health production function f.

The elements of the vector include nutrient intake, income, consumption of public goods, education, time devoted to health related procedures, initial health stock and the environment.

The above model presents the micro (individual) health production analysis. To account for the macro level health production, Fayissa and Gutema, (2008) presented a macro level specification of equation (3.1) by representing the elements of the vector **X** as per capita variables and then regrouped them into sub-sectors vectors of social, economic and environmental factors. This current study aims to analyze the health production at the level of the health sector as a whole. The macro level health production function is represented in the equation below

$$h = f\left(Y, S, V, O\right) \qquad (3.2)$$

Where **h** is the aggregate population health status outcome, **Y** is a vector of per capita economic variables, **S** is a vector of per capita social variables **V** is also a vector of per capita environmental factors and **O** is the vector of openness. By transforming the above equation (3.2) to its scalar form, we have,

$$h = f\left(y_1, y_2,\ldots, y_n; s_1, s_2,\ldots, s_m; v_1, v_2,\ldots, v_l; o_1, o_2,\ldots, o_p\right) \qquad (3.3)$$

Where **h** is population health status (life expectancy, infant mortality rate and under-five mortality), $\left(y_1, y_2,\ldots, y_n\right) = Y$; $\left(s_1, s_2,\ldots, s_m\right) = S$; $\left(v_1, v_2,\ldots, v_l\right) = V$; $\left(o_1, o_2,\ldots, o_p\right) = O$

Assuming a Cobb-Douglas production function involving inputs and outputs, equation

(3.3) can be stated as

$$h = \Omega \prod y_i^{\alpha_i} \prod s_j^{\beta_j} \prod v_k^{\gamma_k} \prod o_l^{\lambda_l} \qquad (3.4)$$

Where α_i, β_j, γ_k and λ_l are the elasticities.

From equation (3.4) the term Ω estimates the initial health stock as it measures the health status that would have been observed if it is considered that there was no depreciation in health or health improvement due to changes in social, economic and environmental factors used in the production process. In the same way,

$\left(\prod y_i^{\alpha_i} \prod s_j^{\beta_j} \prod v_k^{\gamma_k} \prod o_l^{\lambda_l} - 1\right) \times 100\%$ estimates the percentage change in health status by reason of social, economic and environmental factors.

Taking the logarithm of equation (3.4) and rearranging yields equation (3.5) as presented below.

$$Inh = \Omega + ln \sum \alpha_i (lny_i) + \sum \beta_j (lns_j) + \sum \gamma_k (lnv_k) + \sum \lambda_l (\ln o_l) \qquad (3.5)$$

Where $i = 1,2,...,n$; $j = 1,2,...,m$; $k = 1,2,...,l$, $o = 1,2,...,p$ and Ω is an estimate of the initial health stock.

3.3 Econometric specification

To be able to provide estimates for the parameters of the study, an econometric specification of the model to be used is necessary. To this effect, the study follows

Baltagi, (2008) which serves as the starting point for estimating the relationship between trade openness and population health status as well as openness and health financing outcomes in a panel regression as specified below.

$$y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \qquad (3.6)$$

Where $i = 1,2,...,N$ is the country index, $t = 1,2,...,T$ is the time index, α is the scalar, β is $k \times l$ vector and X_{it} is the i^{th} observation on k^{th} explanatory variables.

From the above theoretical model, population health status and health financing function for this study takes the reduce form as follows:

Population health and trade openness

$$PHS = f(TO, TOSQ, HF, GDPG, S, URBN, EDU, FR) \qquad (3.7)$$

Equation (3.7) become estimable in a natural logarithm form as

$$lnPHS_{it}^{l} = \alpha + \lambda_i + \lambda_1 lnTO_{it} + \lambda_2 lnTOSQ_{it} + \lambda_3 \ln HF_{it} + \lambda_4 GDPG_{it} + \lambda_5 lnS_{it} + \lambda_6 lnUBN_{it} + \lambda_7 lnEDU_{it} + \lambda_8 lnFR_{it} + \varepsilon_{it} \qquad (3.8)$$

Where $lnPHS^{l}$ = different population health status (that is life expectancy, infant mortality and under-five mortality).

TO = Trade openness

$TOSQ$ = Square of trade openness

HF = Health finance

$GDPG$ = Gross domestic product growth rate

S = Sanitation facilities

UBN = Urbanization

EDU = Education

FR = Total fertility rate ε=

Error term

Health finance and trade openness

$$HF = f(TO, TOSQ, GDPG, S, URBN, EDU, FR) \quad (3.9)$$

In the same way, equation (3.9) become estimable in a natural logarithm form as

$$\ln HF_{it} = \alpha_i + \lambda_1 lnTO_{it} + \lambda_2 lnTOSQ_{it} + \lambda_3 GDPG_{it} + \lambda_4 lnS_{it} + \lambda_5 lnUBN_{it} + \lambda_6 lnEDU_{it} + \lambda_7 lnFR_{it} + \varepsilon_{it} \quad (3.10)$$

From equation (3.8) and (3.10), α_i represent a country specific intercept, $\lambda_i ..... \lambda_n$ (where i =1,2,...,n) are the elasticity coefficient and ε_i is the white noise term (which is assumed to be identically and independently distributed with mean zero and homoscedastic variance) that is not correlated with the independent variables.

3.4 Data Source

The study relied solely on secondary annual data (balanced panel data) from 1995 to 2013 for forty-two (42) Sub-Saharan Africa countries (see appendix A). With the exception of educational data which was sourced from UNDP database, all other variables used in the study were sourced from World Development Indicators (WDI) online database.

3.4.1 Variable description

3.4.1.1 Population health status (PHS)

Population health status as measured by life expectancy at birth, infant mortality and under-five mortality are the dependent variables. Life expectancy at birth is measured by the number of years a newborn infant could live if prevailing pattern of mortality at the time of its birth were to stay the same throughout its life. Infant mortality is also measured by the number of infants dying before reaching age one, per 1,000 live birth in a given year. Under-five mortality on the other hand is measured by the number of newborn infants who will probably die before attaining the age of five. These variables (life expectancy at birth, infant mortality and under-five mortality) were included in the model due to the fact that they are critical measures of population health and ignoring any one of the variables would not give a holistic measure of population health.

3.4.1.2 Trade openness (TO)

Trade openness is measured by the addition of export and imports of goods and services expressed as a percentage of gross domestic product (GDP). This measure actually shows the level of openness of a country to the world trade and the impact it has on the economy with respect to how income is generated. Although Sub-Saharan countries are considered small economies, they have a large number of trade constituting a greater proportion of their gross domestic product (GDP). A number of studies in recent times (see Herzer, 2014; Razmi, 2012; Levine and Rothman, 2006 etc.) have shown that trade openness influence population hence its inclusion in the study.

3.4.1.3 Trade openness square (TOSQ)

This is calculated by squaring the sum of exports and imports of goods and services expressed as a percentage of gross domestic product. Trade openness square as a variable was included in the model to help estimate the optimal levels of trade openness.

3.4.1.4 Health financing (HF)

Health financing is used both as a dependent and independent variable. In the context of this study, it refers to the expenditure incurred by private and the public on healthcare services. It is measured by summing public and private health spending expressed as a percentage of gross domestic product (GDP). This variable was included in the model for the reason that a boost in health financing positively influence population health while the vice versa is also possible (Dhoro et al., 2011).

3.4.1.5 Real gross domestic product growth (RGDPG)

Real gross domestic product growth is measured by annual percentage growth rate of gross domestic product measured in constant 2005 United States dollars. Economic theory predicts that higher growth or decline in gross domestic product influences the macro economy. Therefore, it is expected both a decline and growth in real GDP could affect population health and health financing.

3.4.1.6 Sanitation (S)

When considering population health, sanitation is described as important variable due to its effect on population health and health financing. Sanitation in this study is measured by the percentage of the population using improved sanitation facilities. It covers ventilated improved pit (VIP) latrine, pit latrine with slab etc. Improved sanitation facilities are highly associated with ensuring personal hygiene. Thus improved sanitation is a necessary healthcare practice which can influence population health and health financing hence the need to include it in the estimation model.

3.4.1.7 Urbanization (UBN)

Urbanization as a variable in the study is used to represent the percentage of people living in urban areas according to the criteria used by the different countries national statistical offices. Urbanization was included in the model to help estimate how increase in the proportion of population living in urban centers could influence population health and health financing in Sub-Saharan Africa. The justification of the inclusion of the variable is that, urban centers are identified as job creation areas where one can easily secure job and spend part of their generated income on improving population health compared to those in the rural centers. Also, urban centers are associated with high waste generation which leads to the risk of higher spread of infectious diseases. Again, urban centers are noted for easy access to good healthcare facilities.

3.4.1.8 Education (EDU)

Education is a vital variable when considering population health and health financing. According to Mondal, Hossain and Ali, (2009) education is classified the most influential variable when studying infant and child mortality levels within the socioeconomic factors. Education as used in the estimation model refers to the number of people with secondary school enrolment as a percentage of total secondary (private and public) enrolment. Just as

Mondal, Hossain and Ali, (2009), Grossman, (1972) is also of the view that education affects many decisions (including one's ability to eat balanced food and one's ability to efficiently use medical care) which influence the quality of life.

3.4.1.9 Total fertility rate (TFR)

Total fertility rate of a country represents the total number of children that would be born to a woman given the current age-specific fertility rate. Studies on fertility (see Kumler and Anukriti, 2012) have shown that high fertility rate of women influence their population health and health financing hence its inclusion in the study.

Table 3.1: Summary of description of study variables

Variables	Description
Population Health Status (PHS)	Population health outcome measures including life expectancy, infant mortality and under-five mortality rate.
Life expectancy rate (LE)	Number of years a newborn infant would live.

Infant mortality rate (IMR)	Number of infants dying before reaching the age of one.
Under-five mortality rate (U5MR)	The probability that a newborn baby will die before reaching the age of five.
Trade openness (TO)	The sum of exports and imports of goods and services expressed as a percentage of gross domestic product (GDP).
Trade openness square (TOSQ)	Square of the sum of exports and imports of goods and services expressed as a percentage of gross domestic product (GDP).
Health finance (HF)	The sum of public and private health expenditure expressed as a percentage of gross domestic product.
Real GDP growth rate (GDPG)	Annual percentage growth rate of GDP measured in constant 2005 U.S. dollars.
Sanitation (S)	The percentage of the population using improved sanitation facilities. Covers ventilated improved pit (VIP) latrine, pit latrine with slab etc.
Urbanization (UBN)	Percentage of people living in urban areas according to the criteria used by separate countries.
Education (EDU)	Secondary school enrolment as a percentage of total secondary (private and public) enrolment.
Total fertility rate (FR)	Total number of children that would be born to a woman given the current age-specific fertility rates.

Source: Author's compilation

3.4.2 Expected signs

Table 3.2: Relationship and expected signs

	Dependent variable			
Independent Variable	LE	IMR	U5M	HF
Trade openness	+	-	-	+

Note: '+' and '-' represent positive and negative relationship.

3.5 Optimal level of the effect of trade openness on health status

This section seeks to find out what the optimal level of openness should be for SubSaharan countries to achieve better health status. To find the optimal level of openness, the study uses the elasticities from the regression analysis to solve for the first order conditions for the optimization problem. Both governments and individuals face the optimization problem of maximizing population health subject to trade openness. Using the elasticity coefficients, the first order condition for the optimization problem are computed as:

$$PHS = \beta_0 + \beta_1 TO + \beta_2 TO^2$$

$$\frac{\partial PHS}{\partial TO} = \beta_1 + 2\beta_2 TO = 0 \qquad (3.11)$$

Solving for TO gives

$$\beta_1 + 2\beta_2 TO = 0$$

$$\beta_1 = -2\beta_2 TO \qquad (3.12)$$

$$TO^* = -\frac{\beta_1}{2\beta_2}$$

TO^* = The optimal level of trade openness that gives the best improvement in population health.

3.6 Estimation Issues

The choice of estimation is vital most especially when dealing with panel data set. Because employing an ordinary regression estimation technique is not optimal (due to the reason that estimates may be subject to omitted variables), this study applies the generalized method of moments (GMM), fixed effect (FE) as well as the random effect (RE) estimation techniques to estimate the relationship that exist between the outcome and the predictor variables. All empirical estimations presented were done with the help of STATA version 13.

3.6.1 Dynamic Panel Data

To analyze the effect of trade openness on population health status and health financing, a dynamic panel regression model is estimated. The dynamic panel model is specified as

$$y_{it} = \alpha y_{i,t-1} + \beta X_{it} + \varepsilon_{it} \qquad (3.13)$$

Where α is a scalar, X_{it} is a $1\times k$ vector of the explanatory variables and β is a $k\times 1$ vector of the coefficient and $\varepsilon_{it} = \mu_i + v_{it}$. Here, $\mu_i \sim iid\left(0,\sigma_u^2\right)$ and $v_{it} \sim iid\left(0,\sigma_v^2\right)$

Given that $\varepsilon_{it} = \mu_i + v_{it}$, then equation (3.14) can be rewritten as

$$y_{it} = \alpha y_{i,t-1} + \beta X_{it} + \mu_i + v_{it} \qquad (3.14)$$

Where i is the country index, t is the time index, y_{it} population health/health financing outcome, $y_{i,t-1}$ is the lag of population health/health financing outcome, X_{it} is a vector of other conditional variables that affect population health status and health financing, μ_i is unobserved country-specific time invariant effect and v_{it} is the individual error term.

According to Greene, (2003) to estimate dynamic panel models using fixed and random effect comes with some problems. For instance, the lag of the dependent variable is correlates with the error term. To overcome the problem associated with the use of fixed and random effect estimations, the generalized method of moments (GMM) estimator is adopted (Green, 2003). The essence of generalized method of moments is first of all to provide control for specific country effect which cannot be done with country-specific dummies due to the dynamic structure of the regression equation. Secondly, to provide control for simultaneity bias as a result of some explanatory variables serving as endogenous variable, the generalized method of moment is preferred. Precisely, the use of generalized method of moments (GMM) is to address endogeneity.

However, for generalized method of moments (GMM) to produce efficient and consistent results, data to be used must demonstrate features identified below.

i. Time period T must be small and the sampled countries N must be large.

ii. There should not be any form of correlation between the error terms across countries.

iii. Some explanatory variables must serve as endogenous variables. iv. There is lagged dependent variable which affect the dependent variable.

v. There must exist country specific fixed effect which is randomly distributed.

vi. There is country specific serial correlation and heteroscedasticity in the error term.

In literature, two main GMM estimation techniques have been identified. They are the system GMM proposed by Blundell and Bond, (1998) and Areliano and Bover, (1995) and the differenced GMM also initiated by Arellano and Bond, (1991). Using the difference GMM, inconsistency problems as a result of endogeneity of some regressors in the estimation process is resolved. The difference GMM process eliminates the source of the inconsistencies by applying the first difference operator to the equation to be estimated. The difference equation comes in the form:

$$y_{it} - y_{i,t-1} = \alpha\left(y_{i,t-1} - y_{i,t-2}\right) + \beta\left(X_{it} - X_{i,t-1}\right) + \left(v_{it} - v_{i,t-1}\right) \quad (3.15)$$

To be able to solve simultaneity bias of the explanatory variables and the correlation between $\left(y_{i,t-1} - y_{i,t-2}\right)$ and $\left(v_{it} - v_{i,t-1}\right)$, it is preferred that the lagged values of the regressors are used as instruments (Arellano and Bond, 1991). This becomes possible under the assumption that the error term is not serially correlated and the lag of the regressors are weakly exogenous.

In spite of the fact that the differenced GMM estimator is able to control for simultaneity bias and country effect, it is not devoid of shortcoming. According to Blundell and Bond, (1998) each time the dependent variables are persistent, the lagged variables then become weak instruments. If the instruments are considered as weak then, the sample distribution of GMM are in general non-normal. This will also mean the standard GMM estimates, hypothesis tests, and confidence intervals are unreliable. To Blundell and Bond, (1998) weak parameter estimates will result to biased estimates for smaller samples. In other to overcome the problem of weak instruments as in the case of the differenced GMM, the system GMM estimator is used by using the level equation and the differenced equation Blundell and Bond, (1998).

For the system GMM estimator to produce consistent and reliable estimates, two key test needs to be performed. The first test is the J test of over-identification introduced by Hansen, (1982) which actually test for the null hypothesis that the model is correctly specified and that GMM is consistent and hence overidentifying restrictions should be close to zero. The second test is the Sargan test which tests the null hypothesis that overidentitying restrictions are valid.

3.6.2 Fixed Effect (FE) and Random Effect (RE)

In analyzing panel data, fixed and random effect models can be applied. This is a result of the assumption between the time-invariant error term and the explanatory variables employed in the study.

The fixed effect (FE) model investigates the relationship that exists between the outcome and the predictor variables within an entity. The assumption behind the uses of the fixed effect model is that the country-specific time invariant effect correlates with the explanatory variables. Therefore the use of the fixed effect model becomes feasible when it is assumed countries have individual characteristics which are unique and are time-invariant. However, the existence of the country specific time invariant effect results to endogeneity problems which further results to biasness in the estimates. To eliminate the time-invariant effect so as to get rid of the endogenity problem, the fixed effect model uses within transformation to demean the variables. To do that, equation (3.14) is used to illustrate the within transformation as shown below.

Recall from equation (3.14) that $y_{it} = \alpha + \beta y_{i,t-1} + X_{it} + \mu_i + v_{it}$.

Demeaning the variables results to equation (3.16) illustrated below.

$$y_{it} - \bar{y}_i = \beta\left(X_{it} - \bar{X}_i\right) + \left(\mu_i - \bar{\mu}_i\right) + \left(v_{it} - \bar{v}_i\right) \quad (3.16)$$

Where $\bar{y}_i = \frac{1}{T}\sum_{i=1} y_{it}$, $\bar{X}_i = \frac{1}{T}\sum_{i=1} X_{it}$, $\bar{\mu}_i = \mu_i$ and $\bar{v}_i = \frac{1}{T}\sum_{i=1} v_{it}$

From equation (3.16) first, the means of the variables are computed and then deducted from the actual variable values. However, because the country specific error term does not change over time, its mean is not different from the actual mean.

On the other hand, the random effect model assumes that country specific time invariant effects are uncorrelated with the dependent or explanatory variables. The random effect model is used when the variations across countries are assumed to be random and uncorrelated with the explanatory variables. That is, the random effect model assumes time invariant variables such as culture, institution, gender etc. to be random. This statement makes it possible to specify a fixed effect model where the time invariant variables are included in the intercept. This is shown in equation (3.17) below.

$$Y_{it} = +\alpha\ \beta\ \mu_i X_{it} + {}_{it} \qquad (3.17)$$

Where $\alpha\ \alpha\ \varepsilon_i = +\ {}_{it}$

The variations across entities from the random effect model are not only assumed to be random and uncorrelated with the independent variables rather, they are included in the model as well. This can be represented as

$$Y_{it} = +\alpha\ \beta\ \mu\ \varepsilon X_{it} + +_{it\ it} \qquad (3.18)$$

From equation(3.18)the random effect model assumes that the country specific time invariant error terms are not correlated with the explanatory variables, therefore it is possible to include time invariant variables as explanatory variables as shown in the equation above.

To determine which model to use, the Hausman specification test at 5 percent levels determines whether or not to use the fixed or random effect model. The Hausman test tests the null hypothesis that the coefficients obtained using the random effect estimator is not different from the estimates obtained with the fixed effect estimator. According to Torres-reyna, (2007) if Prob>chi2 is lower than 0.05 then the use of fixed effect model is more preferred. Similarly, when Prob>chi2 is greater than 0.05 then it is ideal to use the random effect model.

CHAPTER FOUR

EMPIRICAL RESULTS AND ANALYSIS

4.1 Introduction

This chapter of the study presents the findings and discussion from the estimated models presented in chapter three. The chapter is divided into four main sections. The first section begins with a descriptive analysis of the variables employed for the study. This is followed by results from Fixed effect (FE), Random effect (RE) and generalized method of moments (GMM) estimation technique as well as some diagnostic tests. The final section discusses the empirical results from the study.

4.2 Descriptive statistics

Table 4.1 below provides summary statistics of variables included in the study. The mean, standard deviation, minimum and the maximum values of the variables are reported. The statistics show an average life expectancy for the period was 55 years. The range however, is between 55 years and 75 years. The average infant mortality rate was 73.94 percent, with a minimum of 12.1 percent and a maximum of 158.3 percent. Average under-five mortality is 117.65 percent with minimum and maximum values of
14 percent and 279.5 percent respectively.

Table 4.1: Descriptive statistics

Variables	Mean	Standard deviation	Minimum	Maximum
Life Expectancy	55.05185	7.166296	31.63451	74.46
Infant Mortality	73.9381	28.80783	12.1	158.3
Under-five mortality	117.654	52.06193	14	279.5
Trade Openness	77.36844	52.61439	14.77247	531.7374
Health finance	5.451303	2.105236	1.446244	14.15385
GDP growth	5.362847	8.867792	-36.0471	149.973
Sanitation Facilities	32.24173	22.72838	3	98.4
Urbanization	36.90741	15.08526	7.211	86.658
Education	0.37625	0.136053	0.09762	0.795511
Fertility rate	5.280016	1.302044	1.44	7.749

Source: Author's computation

Health finance, comprising of both public and private recorded an average of 5.5 percent with minimum value of 1.4 percent and a maximum value of 14.2 percent. Average openness is 77.34 percent with minimum of 14.8 percent and maximum of 531.74 percent.

Average gross domestic growth rate is 5.36. It ranges between a minimum value of -36.0 percent and a maximum value of 149.97 percent. This clearly tells the story of income disparity in the region. The average sanitation facility over the period is 32.24 percent, with a minimum of 3 percent and a maximum of 98.4 percent.

The average urbanization rate for the region over the period is 36.91 percent. The associated minimum and maximum values were 7.21 percent and 86.66 percent respectively. Average secondary school enrolment over the period is 0.38 percent, with a minimum of 0.10 percent and a maximum of 0.80 percent. Average fertility rate in the region over the study period is 5.28 percent. The minimum and maximum values of 1.44 percent and 7.75 percent were recorded over the period.

4.3 Estimation Results

This part of the study reports the empirical results using fixed effect (FE), random (RE) and generalized method of moments (GMM) estimation techniques.

4.3.1 Life expectancy and trade openness

Table 4.2 below shows the effect of trade openness on life expectancy. The F-test statistics for the fixed effect and Wald chi-square test for the random effect models are used to test whether all the coefficients are different from zero. In testing for heteroscedasticity, the modified Walt test for groupwise heteroscedasticity was performed. The Wald test is based on the null hypothesis that there is the presence of constant variance (homoscedasticity). The test strongly confirmed the presence of heteroscedasticity by rejecting the null hypothesis at 5 percent level of significance (see table 4.3). This implies that the use of ordinary least square estimation techniques would yield inconsistent and biased estimates, leading to unreliable result. To control for heteroscedasticity, robust standard errors were reported throughout the estimation. Also, the hausman test as presented in table 4.3 failed to reject the fixed effect estimation for all the models in favour of the random effect at 5 percent level of significance. The test for autocorrelation confirmed the absence of autocorrelation in the second order for all the regressors, therefore the need to reject the null hypothesis of no autocorrelation (see table 4.3). This implies that the error terms are not correlated the each other. The results of sargan test for overidentification also failed to reject the null hypothesis that overidentification restrictions are valid. This indicates that the results produced are consistent and reliable.

Table 4.2: Life Expectancy and Trade Openness

Variables	Fixed Effect (FE)	Random Effect (RE)	GMM
LnLE (-1)			0.7720***
			(0.1137)
LnTO	0.1135*	0.1272**	0.3807***
	(0.0967)	(0.0976)	(0.1430)
LnTOSquare	-0.0114*	-0.0130*	-0.0389***
	(0.0106)	(0.0108)	(0.0143)
LnTHE	0.0298***	0.0350***	0.0404**
	(0.0231)	(0.0238)	(0.0174)
GDPG	-0.0004	-0.0004	-0.0004
	(0.0003)	(0.0004)	(0.0007)
LnS	0.0289***	0.0302***	0.0274
	(0.0184)	(0.0175)	(0.0173)
LnURBN	0.1688***	0.1441***	0.0026
	(0.0566)	(0.0416)	(0.0213)
Ln EDU	0.1141***	0.1043***	0.0105
	(0.0287)	(0.0247)	(0.0199)
LnFR	-0.0941***	-0.0899***	-0.003
	(0.0727)	(0.0622)	(0 .0324)
Constant	2.7416***	2.8136***	
	(0.3329)	(0.3084)	
Within R^2	0.4730	0.4720	
Between R^2	0.2828	0.2851	
Overall R^2	0.2998	0.3033	
Probability>F	0.0000	0.0000	0.000
No. of Observations	798	798	756
No of Countries	42	42	42

Notes: LnLE is the dependent variable. **, ** and *** indicate statistical significance of the estimates at 10%, 5% and 1% respectively. Robust standard errors are reported in parentheses. GMM represents one step system GMM.*

Source: Author's computation

Table 4.3: **Diagnostic tests for Life Expectancy**

Test	Fixed Effect	Random Effect	GMM
Hausman (Chi^2)	280.39*** (0.0000)	280.39 (0.0000)	
Wald test(Chi^2)	1.40E+05 (0.0000)		
Arellano–Bond [AR(2),Prob>z]			0.157
Sargan (Prob> Chi^2)			0.288

Notes: **** indicate statistical significance of the estimates at 1%. Values in parentheses are probability values.*

Source: Author's computation

Results from table 4.2 shows that one period lag of life expectancy is positive and significant (at 1 percent level) in explaining the current life expectancy in SSA. The results also suggest that using different estimators, trade openness is significant at 10 percent, 5 percent and 1 percent for FE, RE and GMM respectively. The estimated elasticity with the positive sign of 0.11, 0.13 and 0.38 indicates that a 10 percent increase in trade openness results in increase in life expectancy by approximately 1.1 percent, 1.3 percent and 3.8 percent for FE, RE and GMM models respectively. The result seems that the elasticities are higher using GMM to estimate the effect of trade openness on life expectancy compared to FE and RE estimators. The square of trade openness predicts that increasing trade above the optimal level of openness leads to reduction in life expectancy. This is shown by its negative and significant relationship.

At 1 percent level of significance, health finance showed a positive relationship with life expectancy for fixed effect and random effect models. However, using GMM model, the study found a positive relationship between life expectancy and total health expenditure at 5 percent level of significance. The estimated elasticities showed that 10 percent increase in total health expenditure leads to 0.2, 0.3 and 0.4 percent increase in life expectancy. GDP growth was found to be negative but not statistically significant for all the estimated models. Sanitation, urbanization and education were also positive and significant at 1 percent for FE and RE models but insignificant and positive for GMM model. This suggests that development in sanitation facility, education and urbanization enhances life expectancy across SSA. Again, the result shows a negative and statistically significant (at 1 percent) relationship between fertility rate and life expectancy for FE and RE. Although fertility rate is found to be insignificant, it has a negative relationship with life expectancy.

4.3.2 Infant mortality and trade openness

Table 4.4 provides estimates of the effect of trade openness on infant mortality in SSA. The probability values from both the FE and RE models confirm the joint significance of the models at 1 percent level. From the diagnostics test as presented in table 4.5, the Wald test for heteroscedasticity confirmed the presence of heteroscedasticity which necessitated the report of robust results throughout. Similarly, the hausman test which provides the choice between FE and RE confirms the use of FE estimation over the RE estimation. The test for autocorrelation failed to reject the null hypothesis of no autocorrelation in the second order for the regressors. Overidentification test performed using the sargan test showed no problem of overidentification, implying that overidentification restrictions are valid.

Table 4.4: **Infant Mortality and Trade Openness**

Variables	**Fixed Effect (FE)**	**Random Effect (RE)**	**GMM**
LnIMR (-1)			0 .6279***
			(0.2199)
LnTO	-0.4517***	-0.4987***	-1.2945*
	(0.3495)	(0.3583)	(0.7430)
LnTOSquare	0.0392**	0.0449**	0.1395*
	(0.0395)	(0.0406)	(0.0791)
LnTHE	-0.0779***	-0.0964***	-0.1237**
	(0.0586)	(0.0563)	(0.0515)
GDPG	0.0018***	0.0019***	0.0018
	(0.0007)	(0.0007)	(0.0022)
LnS	-0.2311***	-0.2286***	-0.0799
	(0.1163)	(0.1072)	(0.0503)
LnURBN	-0.4222***	-0.3383***	-0.0342
	(0.1278)	(0.0906)	(0.0792)
Ln EDU	-0.2730***	-0.2538***	-0.0890
	(0.1023)	(0.1024)	(0.0905)
LnFR	0.6330***	0.6503	0.3043
	(0.2224)	(0.1903)	(0.2948)
Constant	7.6878***	7.4127***	
	(1.1436)	(1.0653)	
Within R^2	0.6038	0.6020	
Between R^2	0.5463	0.5729	
Overall R^2	0.5450	0.5679	
Probability>F	0.0000	0.0000	0.000
No. of Observations	798	798	756
No of Countries	42	42	42

Notes: LnIMR is the dependent variable. **, ** and *** indicate statistical significance of the estimates at 10%, 5% and 1% respectively. Robust standard errors are reported in parentheses. GMM represents one step system GMM.*

Source: Author's computation

Table 4.5: Diagnostic tests for Infant Mortality

Test	Fixed Effect	Random Effect	GMM
Hausman (*Chi*^{2})	65.75*** (0.0000)	65.75 (0.0000)	
Wald test (*Chi*^{2})	83111.42 (0.0000)		
Arellano–Bond [AR(2),Prob>z]			0.188
Sargan (Prob> *Chi*^{2})			0.629

Notes: **** indicate statistical significance of the estimates at 1%. Values in parentheses are probability values.*

Source: Author's computation

According to the estimated results, one period lag of infant mortality has significant (at 1 percent level) and positive effect on current infant mortality rate. The elasticity estimate of 0.63 indicates that 10 percent increase in infant mortality in previous year lead to 6.3 percent increase in infant mortality in the current year.

The results also shows a negative and significant relationship between trade openness and infant mortality for all the estimators. The negative correlation between trade openness and infant mortality suggests that 10 percent increase in the estimated elasticities (thus 0.45, 0.49 and 1.29 for FE, RE and GMM respectively) decreases infant mortality by 4.5 percent, 4.9 percent and 1.29 percent using the FE, RE and GMM estimators respectively. The result supports the a priori expectation of a negative relationship between trade openness and infant mortality across the alternative estimators at highly significant level of 1 percent for FE and RE as well as 10 percent for

GMM model.

The degree of openness measured by trade openness square showed a positive and significant relationship with infant mortality. With the elasticity estimates of 0.039, 0.045 and 0.140 for FE, RE and GMM, the interpretation is that, 10 percent increase in openness over the optimal level increases infant mortality by approximately 0.39 percent, 0.45 percent and 1.40 percent for FE, RE and GMM estimators respectively.

A negative and significant (at 1 percent) relationship is observed between health finance and infant mortality for both FE and RE models. The GMM model also shows a negative and significant (at 5 percent) relationship between infant mortality and total health expenditure. Also, GDP growth rate across the alternative estimators is significant (at 1 percent level for FE and RE) and positively correlates with infant mortality. That is, increase in GDP growth increases infant mortality across the region. Sanitation, urbanization and education for all the estimators shows a negative and highly significant (at 1 percent for only FE and RE) relationship with infant mortality. A positive and significant (at 1 percent for FE) relationship was also established between fertility rate and infant mortality.

4.3.3 Under-five mortality and trade openness

Table 4.6 below shows the estimation results for under-five mortality and trade openness for the different estimators. Similar to the other diagnostic tests presented earlier, the presence of heteroscedasticity was again detected (see table 4.7). Due to this, robust standard errors are reported at all level of estimations. The hausman test also showed that the use of fixed effect estimation is preferred to the random effect estimation. The second order autocorrelation probability of 0.203 indicates the absence of autocorrelation hence, the error terms are not correlated. The diagnostic test further revealed no problem of overidentification with sargan probability value of 0.704.

From table 4.6, one period lag of under-five mortality was found to be positive and significant at 1 percent. The elasticity estimate of 0.754 suggests that 10 percent increase in previous year's under-five mortality in SSA leads to about 7.54 percent increase in current under-five mortality rate in SSA. The result presented above also reveals a negative relationship between trade openness and under-five mortality. The expected signs are consistent for all the estimators and highly significant (at 10 percent for FE and RE). The negative correlation between trade openness and under-five mortality implies that 10 percent increase in trade openness in SSA reduces under-five mortality by 5.29 percent, 5.79 percent and 12.04 percent for FE, RE and GMM estimators respectively. The result for degree of openness was found to be positive and significant for all the estimators. The interpretation is that 10 percent increase in openness beyond the optimal level of openness leads to increase in under-five mortality by 0.46 percent, 0.517 percent and 1.27 percent in FE, RE and GMM respectively.

Table 4.6: **Under-five Mortality and Trade Openness**

Variables	Fixed Effect (FE)	Random Effect (RE)	GMM
LnU5M (-1)			0.7536***
			(0.1768)
LnTO	-0.5293***	-0.579***	-1.2042*
	(0.4133)	(0.4270)	(0.6248)
LnTOSquare	0.0456**	0.0517**	0.1274*
	(0.0465)	(0.0481)	(0.0662)
LnTHE	-0.0873 ***	-0.1129***	-0.119**
	(0.0673)	(0.0628)	(0.0516)
GDPG	0.0019**	0.0019**	0.0017
	(0.0007)	(0.0007)	(0.0016)
LnS	-0.2850***	-0.2782 ***	-0.1309
	(0.1392)	(0.1255)	(0.0813)
LnURBN	-0.5371***	-0.4185***	-0.1370
	(0.1589)	(0.1072)	(0.0872)
Ln EDU	-0.3802 ***	-0.3510***	0.0701
	(0.1173)	(0.1168)	(0.0666)
LnFR	0.6580 ***	0.6995***	0.2052
	(0.2498)	(0.21403)	(0.2113)
Constant	9.2623***	8.7939***	
	(1.345)	(1.2503)	
Within R^2	0.6225	0.6198	
Between R^2	0.5939	0.6271	
Overall R^2	0.5873	0.6154	
Probability >F	0.0000	0.0000	0.000
No. of Observations.	798	798	756

No of Countries	42	42	42

Notes: LnU5M is the dependent variable.*, ** *and *** indicate statistical significance of the estimates at 10%, 5% and 1% respectively. Robust standard errors are reported in parentheses. GMM represents one step system GMM.*

Source: Author's computation

Table 4.7: **Diagnostic tests for Under-five Mortality**

Test	Fixed Effect	Random Effect	GMM
Hausman (*Chi*^{2})	88.22*** (0.0000)	88.22 (0.0000)	
Wald test (*Chi*^{2})	58245.97 (0.0000)		
Arellano–Bond [AR(2),Prob>z]			0.203
Sargan (Prob> *Chi*^{2})			0.704

Notes: *** *indicate statistical significance of the estimates at 1%. Values in parentheses are probability values.*

Source: Author's computation

Health finance correlates negatively with under-five mortality at 1 percent significance level for both FE and RE models. However, at 5 percent level of significance (for GMM model) total health expenditure influences under-five mortality negatively. A negative and significant (at 1 percent for FE and RE models) relationship was found between sanitation, urbanization and under-five mortality across all the estimators. On education, the empirical results shows a negative and significant (at 1 percent level for FE and RE models) relationship with under-five mortality, while the GMM result indicates a positive but insignificant relationship between education and under-five mortality. Fertility rate was identified to correlate with under-five mortality positively for all the estimators.

4.3.4: Health finance and trade openness

From table 4.8, the regression results using different estimators to show the effect of trade openness on health finance are reported. Table 4.9 report heteroscedasticity test, hausman test, autocorrelation test and sargan test for overidentification restrictions. The Wald test (see table 4.9) with the probability value of 0.0000 indicates the presence of heteroscedasticity. To control the problem of heteroscedasticity, robust standard errors were reported throughout the estimation. The choice between fixed effect and random effect was facilitated with hausman test. The result of the test (see table 4.9) confirms the use of fixed estimation across all specification of the model. Arellano and Bond test for autocorrelation in the second order found that the error terms are not correlated with each order. The sargan test performed failed to reject the null hypothesis that overidentification restrictions are valid. This shows that the instruments used were valid.

Similar to the findings presented earlier, one period lag of health finance is positive and significant at 1percent level. That is previous year's spending on health positively affect current health spending. The result also indicates that trade openness positively and significantly (at 10 percent and 5 percent for RE and GMM estimations respectively) correlates with health finance in SSA. Albeit the result for trade openness was not significant under fixed effect estimation, the expected sign (positive) was met. The empirical result implies that 10 percent increase in openness in trade across SSA countries increases health finance by about 3.29 percent (for FE estimation), 3.81 percent (for RE estimation) and 5.23 percent (for GMM estimation).

Table 4.8: **Health finance and Trade Openness**

Variables	Fixed Effect (FE)	Random Effect (RE)	GMM
LnTHE (-1)			0.8558***
			(0.1049)
LnTO	0.3294	0.3818*	0.5230**
	(0.4753)	(0.4845)	(0.2591)
LnTOSquare	-0.0311	-0.0386	-0.0473
	(0.0588)	(0.0599)	(0.0321)
GDPG	0.0008	0.0008	0.0005
	(0.0010)	(0.0010)	(0.0032)
LnS	-0.0604	-0.0506	-0.1533*
	(0.1057)	(0.0830)	(0.0835)
LnURBN	0.1565***	0.0613	-0.1151*
	(0.1828)	(0.1201)	(0.0644)
Ln EDU	0.2624***	0.2559***	0.0340
	(0.1018)	(0.0974)	(0.0755)
LnFR	-0.3275***	-0.2274**	-0.1998***
	(0.2057)	(0.1619)	(0.1256)
Constant	0.0428	0.1198	
	(1.2358)	(1.1984)	
Within R^2	0.1482	0.1441	
Between R^2	0.0706	0.0536	
Overall R^2	0.0186	0.0104	
Probability>F	0.0000	0.0000	0.000

No. of Observations	798	798	756
No of Countries	42	42	42

Notes: LnTHE is the dependent variable*, *** and *** indicate statistical significance of the estimates at 10%, 5% and 1% respectively. Robust standard errors are reported in parentheses. GMM represents one step system GMM.*

Source: Author's computation

Table 4.9: Diagnostic tests for Health Finance

Test	Fixed Effect	Random Effect	GMM
Hausman (*Chi*^{2})	62.83*** (0.0000)	62.83 (0.0000)	
Wald test(*Chi*^{2})	5520.92 (0.0000)		
Arellano–Bond [AR(2), Prob>z]			0.624
Sargan test (Prob> *Chi*^{2})			0.142

Notes: **** indicate statistical significance of the estimates at 1%. Values in parentheses are probability values.*

Source: Author's computation

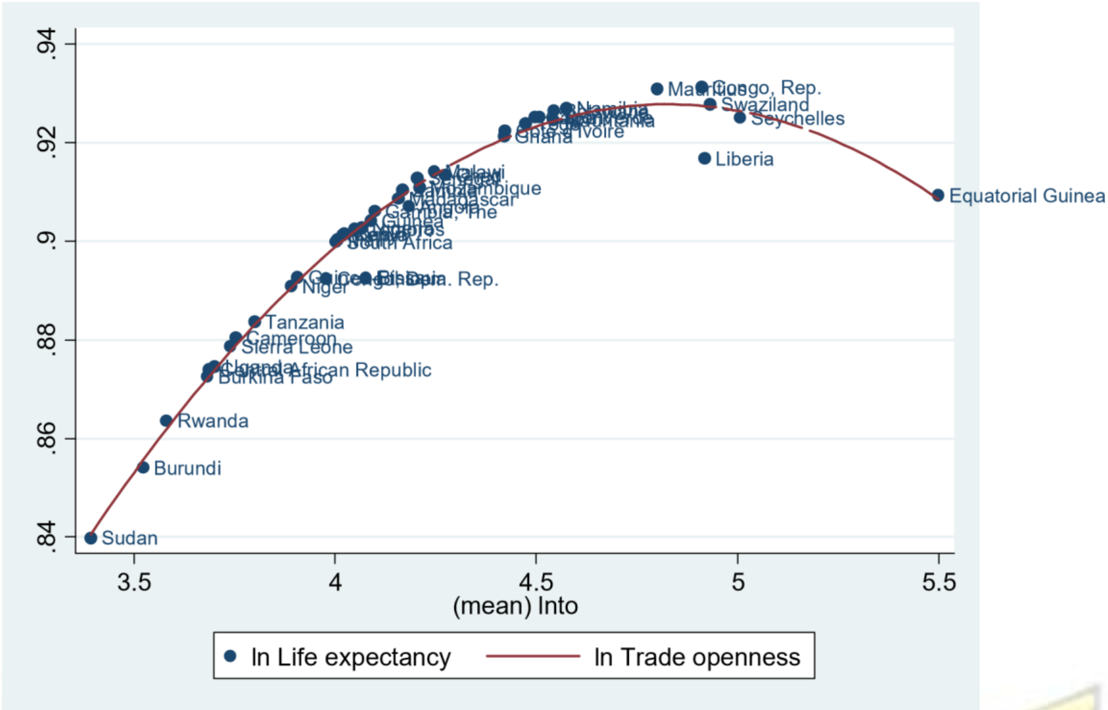
The degree of openness measured by trade openness square indicates that increase in the level of trade over the optimal level of openness leads to a negative impact on health finance. The result indicates that 10 percent increase in openness over the optimal level reduces health financing in SSA by approximately 0.31 percent (for FE estimation), 0.39

percent (for RE estimation) and 0.47 percent (for GMM estimation). GDP growth rate and education also impacted health finance negatively.

A significant (at 1 percent and 10 percent level for FE and GMM respectively) relationship was established between urbanization and health finance under FE and GMM estimations. While the relationship was found positive under FE estimation, GMM estimation was negative. The positive sign between urbanization and health finance implies that the higher the rate of migrants to urban centers the higher the spending on health while the reverse holds for the negative relationship under the GMM estimation. Results on sanitation shows a negative and significant (10 percent level for GMM model) correlation with health finance for all the models. Fertility rate also shows a negative and significant (at 1 percent, 5 percent and 1 percent for FE, RE and GMM respectively) relationship with health finance across all the models.

4.3.5 Optimal level of trade openness and health status

Figure 4.1: Optimal level of trade openness for life expectancy

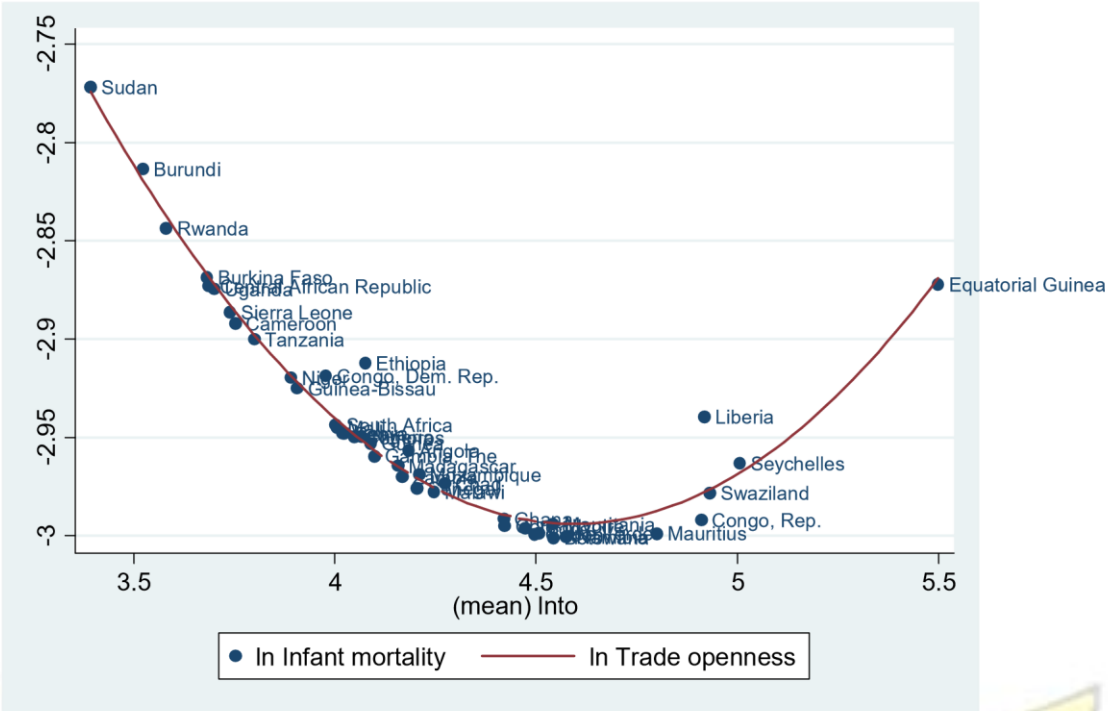


Source: Author's computation

Figure 4.1 shows an inverted U-shape relationship between trade openness and life expectancy in Sub-Sahara Africa. From the figure, countries like Burundi, Rwanda, Burkina Faso among other countries benefits when they open up their boarders to international trade. However, after the optimal level of openness, countries including Mauritius, Liberia, Congo Republic etc. experience decrease in their life expectancy.

The figure suggests that trade openness improves life expectancy up to the optimal point and thereafter life expectancy begins to deteriorate. Given the computed optimal trade openness to be 4.974 in natural log or 144.65 percent (see appendix B) indicate that countries whose openness is beyond 144.65 percent of their GDP are in danger of experiencing declining life expectancy.

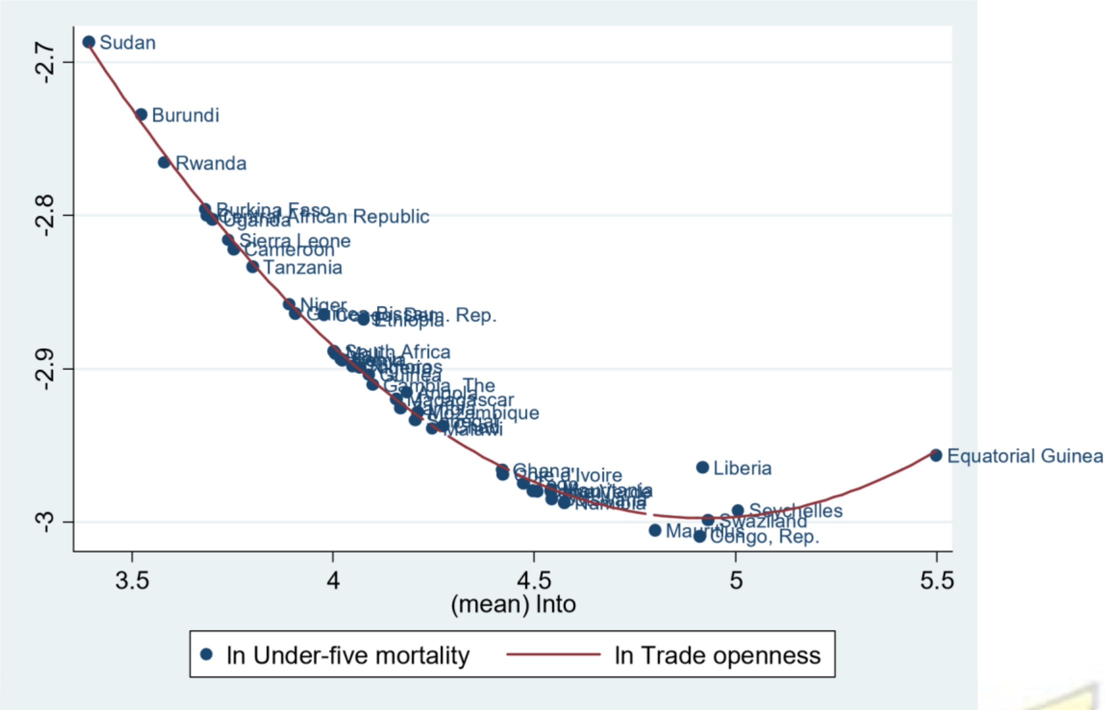
Figure 4.2: Optimal level of trade openness for infant mortality



Source: Author's computation

Figure 4.2 depicts a U-shape relationship between trade openness and infant mortality. From the figure, as trade openness increases, infant mortality decreases up to the point where the optimal level of openness is 4.640 in natural log or 103.54 percent (see appendix B). Beyond the optimal point of trade openness any increase in trade openness result to increase in infant mortality in SSA.

Figure 4.3: Optimal level of trade openness for under-five mortality



Source: Author's computation

From figure 4.3, an inverse (U-shaped) relationship is seen between trade openness and under-five mortality. Given the optimal level of openness to be ln5 (in natural log) or 148.41 percent (see appendix B) implies that, countries that open up their boarder to international trade above 148.41 percent of their GDP are vulnerable to increased underfive mortality rate.

4.5 Discussion of Empirical Results

The empirical results obtained implies that trade openness significantly improves population health status across SSA countries. Specifically, across all the estimators, life expectancy as a measure of population health status exhibited a positive and significant correlation with trade openness. The study also showed a negative and significant relationship between trade openness and infant mortality. A negative and significant correlation was also found between trade openness and under-five mortality. This result is in line with theoretical prediction of the access and income mechanism. The access mechanism suggests that as countries open up to trade, they are able to consume several health goods and services at affordable cost which previously was difficult to come by, which affect health status either positively or negatively. According to Papageorgiou et al., (2007) medical knowledge spillover will entice developing countries to open up their economy to international trade. Another potential reason for the positive link between openness and population health status is the income mechanism. Trade openness for developing countries raises aggregate income (Davis, 1996). The income mechanism therefore suggests that as aggregate income increases, the proportion of income allocated to health increases to improve population health. The study therefore supports the assertion by Razmi, (2012) who found a positive and significant relationship between trade openness and life expectancy as a measure of population health. Owen and Wu, (2002) also used infant deaths and life expectancy to test for the relationship between population health and international trade openness for 139 developed and developing countries. The results from the study showed that international openness to trade positively influence population health especially for poor countries. Similarly, Olper et al., (2014), Mondal et al., (2009) and Hudak, (2014) pointed out that openness to trade positively influence population health status.

The findings also show that previous population health status (when one lag was introduce) is strongly significant (at 1 percent level) in explaining current population health status within SSA. The result predicts that improvement in the form of investment on health will have immediate impact on population health. This means investment in health should not be a one day wonder instead should be continuous to ensure good population health status.

Studies on the subject matter (trade openness and population health) have created the impression that continuous openness always results in improved population health. However, the current study provides evidence on whether openness over the optimal openness level impact population health in SSA. First of all, result from the study found an inverted U-shaped relationship between trade openness and life expectancy. The results suggest that as countries openness to trade increases, the life expectancy of its population improves up to the optimal level of openness. Exceeding the optimal level of openness deteriorates expected life expectancy of such countries. An inverse (U-shaped) relationship was also established between infant mortality, under-five mortality and the level of openness. The result explains that as countries increases their openness level initially, they stand to benefit from several health goods and services which reduces infant and under-five mortality. However, as countries within the region open up their boarders to trade beyond the optimal level of openness, infant mortality and under-five mortality begins to increase. That is, as countries become more open, the import and export of harmful commodities in the form of tobacco, alcoholic related products and infectious diseases through consumable products affects population health status negatively. According to Prabhat and Chaloupka, (2000) increased consumption of harmful commodities could offset some of the health benefits of trade openness.

Results on trade openness and health finance met the a priori expectation. The coefficient of trade openness was positive across the estimation models and in terms of significance, RE and GMM estimators were significant at 10 percent and 5 percent respectively. One period lag of health finance also showed a positive and significant (at 1 percent level) relationship with current health finance. The implication is that an improved health financing this year lead to an improved health financing next year. Theoretically, the possible reason for the positive relationship between trade openness and health expenditure is the correlation between aggregate income and openness. All things being equal, as aggregate income is increased, allocation of income to the health sector increases health spending. Another reason is the population increasing effect which suggest that higher population growth lead to higher demand for health which creates avenues for both governments and private individual to invest more on health.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter concludes the study. It gives a summary of the major findings obtained from the study. The chapter further provides recommendation based on the study findings. Limitations of the study as well as suggestions for further research are discussed in the chapter.

5.2 Summary of findings

This study estimated the effect of trade openness on population health status and health financing in Sub-Saharan Africa using a panel data from 1995 to 2013. Specifically, the study estimated the effect of trade openness on life expectancy, infant mortality, underfive mortality and health financing using the fixed effect (FE), random effect (RE) and generalized method of moments (GMM) approaches. In general, the diagnostics tests performed indicated the presence of heteroscedasticity which necessitated the reporting of robust standard errors throughout the estimation procedure. Also, the test for second order autocorrelation revealed that the error terms were not correlated with each other. The hausman test showed that the use of fixed effect estimation was appropriate while the sargan test supported the null hypothesis of the validity of overidentifying restrictions, implying that the models were not weakened by many instruments. All the empirical estimations and diagnostics tests were performed with the help of STATA version 13.0. Below are the summaries of major findings of the study.

The empirical evidence revealed that trade openness improves population health status in Sub-Saharan Africa. Accordingly, the study found that increase in trade openness increases life expectancy in SSA. Also, increase in trade openness resulted in reduction in both infant mortality and under-five mortality for the Sub-Saharan countries considered in the study.

The estimation result also shows that health finance improves population health in SubSaharan Africa. That is, as financing to the health sector increases, life expectancy will increase while infant mortality and under-five mortality will reduce.

Previous population health status was found to be highly significant and exerted greater impact on current population health status in Sub-Saharan Africa. This means that the past improvements in population can influence current improvements in population health status.

The study found an inverted U-shaped relationship between trade openness and life expectancy. Thus, as countries open up to international trade above the optimal level of openness, life expectancy decreases. Again, the computed result for optimal level of openness revealed that, trade openness reduces infant mortality and under-five mortality up to the optimal point. This was shown by the U-shaped relationship between infant mortality, under-five mortality and trade openness. That is beyond the minimum optimal level of openness population health status measured by infant mortality and under-five mortality worsens.

Furthermore, the study found a positive relationship between trade openness and health financing in Sub-Saharan Africa. This implied that countries that opened up their boarders to international trade benefited from health funding which escalated population health status.

Finally, the study found that previous year's health financing influenced current health financing positively. This implied that countries whose health financing improved last year due to its openness to trade will have a good health financing this year towards its improvement in population health.

5.3 Conclusion

The study sought to estimate the effect of trade openness on population health and health financing in Sub-Saharan Africa (SSA). The results suggest that trade openness has positive impact on health finance. Similarly, it was found that trade openness has positive impact on population health status (measured by life expectancy at birth), while it exerts a negative impact on population health status (measured by infant mortality and under-five mortality).

5.4 Recommendations of the study

The results from the study shows that trade openness improve population health (measured by life expectancy, infant mortality and under-five mortality) in Sub-Saharan Africa (SSA) up to the optimal point of openness. The study therefore recommends countries whose openness level is below the optimal point to open up their boarders to international trade. By opening up to trade up to the optimal level of openness, it is expected that there will be increase in access to more health technologies at a relatively cheaper prices, medical knowledge spill over, secure of grants and other form of assistance to invest in the health sector. The availability of these benefits will intend to improve population health in SSA.

The study also found that beyond the optimal level of trade openness, trade tends to deteriorate health. This is because of the possibility of the importation of harmful products that are detrimental to health. Developing countries usually tend to import substandard goods which are harmful to health. Countries that are beyond the optimal are advised to take steps to ensure that products that come in meet the health standard. Restriction in this case is not a plausible recommendation because of integration and retaliations. The findings draw the implication that while it is good for countries to open up their boarder to international trade, governments must ensure that the level of openness does not exceeds the optimal level.

Based on the positive effect of health finance on population health, the study recommends that both government and the private sector should go ahead to invest more in providing healthcare facilities. This is confirmed by the results that there exist high levels of persistency in population health and health financing. Thus, previous population health and health financing were statistically significant in affecting current population health and health financing in Sub-Saharan Africa.

5.5 Limitations of the Study and Areas for Further Research

This study did not look at some other aspect of measuring population health status. The study only took into account life expectancy at birth, infant mortality and under-five mortality as the population health outcomes. However, a holistic analysis of population health outcome considers both morbidity and mortality indicators. For instance, such morbidity variables may include health adjusted life expectancy and disability adjusted life expectancy. Data on these variables were difficult to obtain especially for countries within the Sub-Saharan region. Studies in the future may consider this same topic by incorporating other morbidity measures of population health outcomes.

REFERENCES

Ahearn, R. J. (2012). *Globalization , Worker Insecurity , and Policy Approaches*. Congressional Research Service.

Amiri, A., and Ventelou, B. (2012). *Causality test between health care expenditure and GDP in US: comparing periods*. Retrieved from https://halshs.archivesouvertes.fr/halshs-00520326v2

Angko, W. (2013). The Determinants of Healthcare Expenditure in Ghana. *Journal of Economics and Sustainable Development*, *4*(15), 102–125.

Anyanwu, J. C., and Erihijakpor. (2007). *Health expenditure and health outcomes in Africa* (Vol. 91).

Areliano, M., and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(August 1990), 29–51.

Arellano, M., and Bond, S. (1991). Some Tests of Specification for Panel Carlo Application to Data : Evidence and an Employment Equations. *The Review of Economic Studies*, *58*(2), 277–297. Retrieved from http://www.jstor.org/stable/2297968

Baltagi, B. H. (2008). *Econometric analysis of panel data* (4th ed.). West Sussex: John Wiley and Sons.

Bettcher, D. W., Yach, D., and Guindon, G. E. (2000). Global trade and health: key linkages and future challenges. *Bulletin of the World Health Organization*, *78*(4), 521–534.

Briggs, D. (2003). Environmental pollution and the global burden of disease. *British Medical Bulletin*, *68*(1), 1–24. http://doi.org/10.1093/bmb/ldg019

Copeland, B. R., and Taylor, M. S. (2007). Trade , Growth , and the Environment. *Journal of Economic Literature*, *42*(1), 7–71. Retrieved from http://www.owlnet.rice.edu/~econ480/notes/Trade.pdf

Cropper, L., Simon, N., Alberinni, A., and Sharma, P. (2000). *The health effect of air pollution in Delhi, India*. In Press.

Davis, D. R. (1996). *Trade liberalization and income distribution* (NBER WORKING PAPER SERIES).

Deaton, A. (2004). *Health in an age of Globalization*. Center for Health and Welbeing, Princeton University.

Dhoro, N. L., Chidoko, C., Sakuhuni, R. C., and Gwaindepi, C. (2011). Economic Determinants of Public Health Care Expenditure in Zimbabwe. *International Journal of Economics and Resource*, *2*(6), 13–25.

Dollar, D. (2001). Is globalization good for your health ? *Bulletin of the World Health Organization*, *79*(01), 827–833.

Economist Intelligence Unit. (2012). *The future of healthcare in Africa*. The Economic Intelligence Unit Limited.

Erpek, H. (2014). *The effect of international trade on income*. All Theses. Paper 1939. Retrieved from http://tigerprint.clemson.edu/all_theses/1939

Fayissa, B., and Gutema, B. (2008). *A Health Production Function for Sub-Saharan Africa (SSA)* (Department of Economics and Finance).

Freund, C., and Bolaky, B. (2008). Trade, regulations, and income. *Journal of Development Economics*, *48*(2), 309–321.

Furusawa, T., and Konishi, H. (2013). International Trade and Income Inequality. Retrieved from http://fmwww.bc.edu/EC-P/wp849.pdf.

Greene, W. H. (2003). *Econometric Analysis* (5th ed.). Prentice Hall, New Jersey.

Grossman, M. (1972). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy*, *80*(2), 223–255. Retrieved from http://links.jstor.org/sici?sici=0022-3808(197203/04)80:2<223:OTCOHC>2.0.CO;2-8

Hansen, L. P. (1982). Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica*, *50*(4), 1029–1054.

Harttgen, K., Klasen, S., and Vollmer, S. (2012). *Economic Growth and Child Undernutrition in Africa* (No. 013). Retrieved from http://www.undp.org/content/dam/rba/docs/Working Papers/Economic Growth and Child Undernutrition.pdf

Herzer, D. (2014). The long-run relationship between trade and population health: evidence from five decades. Retrieved from http://hdl.handle.net/10419/100441

Hitiris, T., and Posnett, J. (1992). The determinants and effects of health expenditure in developed countries. *Journal of Health Economics*, *11*(2), 173–181.

Hudak, K. M. (2014). Differential Health Outcomes and Trade: Does openness to trade affect childhood underweight and overweight?

Huynen, M. M. T. ., Martens, P., and Hilderink, H. B. . (2005). The health impacts of globalisation: a conceptual framework. *Global Health*, *14*(1), 1–12.

Issa, H., and Ouattara, B. (2005). The Effect of Private and Public Health Expenditure on Infant Mortality Rates : does the level of development matters ? *The Journal of Economic Perspectives*, *44*(0). Retrieved from http://citeseerx.ist.psu.edu/messages/downloadsexceeded.html

Jani, V., and Dholakia, R. H. (2015). Economic Globalization: Boon or Bane for African Health ?, 1–26.

Jones, R. W. (2008). Heckscher-Ohlin Trade Flows : A Re-appraisal. *Trade and Development Review*, *1*(1), 1–6.

Kindig, D., and Stoddart, G. (2003). What is population health? *American Journal of Public Health*, *3*(93), 380–383.

Kumler, T. J., and Anukriti, S. (2012). The Effects of Trade Liberalization on Fertility and Child Health Outcomes in India, (October).

Levine, D. I., and Rothman, D. (2006). Does trade affect child health ? *Journal of Health Economics*, *25*, 538–554. http://doi.org/10.1016/j.jhealeco.2005.10.001

Lloyd, T., Mcgillivray, M., Morrissey, O., and Osei, R. (2002). Investigating the Relationship Between Aid and Trade Flows by. *Centre for Research in Economic Development and International Trade*, *10*(98).

Marmot, M. (2007). Achieving health equity : from root causes to fair outcomes, *370*, 1153–1163. http://doi.org/10.1016/S0140-6736(07)61385-3

Maryam, A., and Hassan, M. S. (2013). Human Capital : Is it Beneficial for Trade Openness in Pakistan ? *Middle-East Journal of Scientific Research*, *17*(7), 965–975. http://doi.org/10.5829/idosi.mejsr.2013.17.07.1366

Mcdonald, S., Lande, S., and Matanda, D. (2013). *Why Economic Partnership Agreements undermine Africa's Regional Integration*.

Mehrara, M., Fazaeli, A. A., Fazaeli, A. A., and Fazaeli, A. R. (2012). The Relationship between Health Expenditures and Economic Growth in Middle East and North Africa (MENA) Countries. *International Journal of Business, Management, Economics, Res.*, *3*(1), 425–428.

Mondal, N. I., Hossain, K., and Ali, K. (2009). Factors Influencing Infant and Child Mortality : A Case Study of Rajshahi District , Bangladesh. *Journal of Hum Ecol*, *26*(1), 31–39.

Novignon, J., and Lawanson, A. O. (2015). Health expendiiture and child health outcomes in Sub-Sagarab Africa.

Olper, A., Curzi, D., and Swinnen, J. (2014). Food Security , Health and Trade Liberalization.

Owen, A. L., and Wu, S. (2002). Is Trade Good for your Health?, (August).

Panda, P. (2014). Does Trade reduce Infant Mortality ? Evidence from Sub-Saharan, 1–57.

Papageorgiou, C., Savvides, A., and Zachariadis, M. (2007). International medical technology diffusion. *Journal of International Economics*, *72*(2), 409–427.

Prabhat, J., and Chaloupka, F. J. (2000). *Tobacco control in developing countries*. Oxford University Press, Inc., New York.

Pritchett, L., and Summers, L. H. (1993). *Wealthier is Healthier* (No. 1150).

Razmi, M. J. (2012). Reviewing the effect of Trade Openness on Human Development. *Interdisciplinary Journal of Contemporary Research in Business*, *4*(6), 970–978.

Rezaei, S., Fallah, R., Karyani, A. K., Daroudi, R., Zandiyan, H., and Hajizadeh, M. (2016). Determinants of healthcare expenditures in Iran : evidence from a time series analysis. *Medical Journal of the Islamic Republic of Iran*.

Rodrik, D. (1998). Why do more open economies have bigger governments? *Journal of Political Economy*, *106*(5), 997–1032. Retrieved from https://www.sss.ias.edu/files/pdfs/Rodrik/Research/why-do-more-open-economieshave-bigger-governments.pdf

Rugulies, R., Aust, B., Burr, H., and Bültmann, U. (2008). Job insecurity , labour market chances and decline in self-rated health in Denmark. *Journal of Epidemiology and Community Health*, *62*(3), 245–250.

Sachs, J. D., and Warner, A. (1995). Openness and Growth: What Have We Learned? *Brookings Papers on Economic Activities*. Retrieved from http://www.un.org/en/development/desa/policy/wess/wess_bg_papers/bp_wess2006_rodriguez_openness_growth.pdf

Serrano, G., Lopez-Bazo, E., and Garcia-Sanchis, J. R. (2002). *Complementarity between human capital and trade in regional technological progress* (Working Papers in Economics).

Shetty, A., and Shetty, S. (2014). The correlation of health spending and infant mortality rate in Asian countries. *International Journal of Contemporary Pediatrics*, *1*(2), 100–105. http://doi.org/10.5455/2349-3291.ijcp20140808

Stevens, P., Urbach, J., and Wills, G. (2013). Healthy Trade: The Relationship Between Open Trade and Health. *Foreign Trade Review*, *48*(1), 125–135. http://doi.org/10.1177/001573251204800106.A

Sulaiman, L. A., Migiro, S. O., and Aluko, O. A. (2014). The structural adjustment programme in developing economies : pain or gain ? Evidence from Nigeria. *Journal of Public and Municipal Finance*, *3*(2).

Temurshoev, U. (2006). *Pollution haven hypothesis or factro endowment hypothesis: theory and empirical examination for the US and China* (ISSN 1211-3298).

Torres-reyna, O. (2007). Panel Data Analysis: Fixed and Random Effects using Stata. *Princeton University*. Retrieved from https://www.princeton.edu/~otorres/Panel101.pdf

Wacziarg, R., and Welch, K. H. (2003). *Trade liberalization and growth: New evidence* (No. 10152). Retrieved from http://www.nber.org/papers/w10152

Welander, A., Lyttkens, C. H., and Nilsson, T. (2014). Globalization and Child Health in Developing Countries : The Role of Democracy, (1016).

WHO. (2012). *World health statistics*. Geneva: World Health Organisation.

WHO. (2013). *World health statistics*. Geneva. World Health Organisation.

Zhang, S., Ondrich, J., and Richardson, J. D. (2004). The Link between Trade and Income : Export Effect , Import Effect , or Both ?, 1–35.

APPENDICES

APPENDIX A

LIST OF SUB-SAHARAN COUNTRIES INCLUDED IN THE SAMPLE

Angola	Liberia
Benin	Madagascar
Botswana	Malawi
Burundi	Mali
Burkina Faso	Mauritania
Cabo Verde	Mauritius
Cameroon	Mozambique
Central African Republic	Namibia
Chad	Niger
Comoros	Nigeria
Congo, Dem. Rep.	Rwanda
Congo, Rep.	Senegal
Cote d'Ivoire	Seychelles
Equatorial Guinea	Sierra Leone
Ethiopia	South Africa
Gabon	Sudan
Gambia, The	Swaziland
Ghana	Tanzania
Guinea	Togo
Guinea-Bissau	Uganda
Kenya	Zambia

APPENDIX B

OPTIMAL LEVEL OF OPENESS

Calculation of the optimal level of openness at various population health status was done using elasticity estimates from generalized method of moments model.

Note: Figures used in the calculation are in natural logs

Optimal level of openness for Life Expectancy

Finding the maximum optimal level of openness,

$LE = 0.3807TO - 0.0389TO^2$

Differentiating with respect to trade openness (TO) yields

$$\frac{\partial LE}{\partial TO} = 0.3807 - (2 \times 0.0389)TO = 0 \qquad (1.0)$$

Solving for TO gives

$0.3807 - (2 \times 0.0389)TO = 0$

$0.3807 - 0.0777TO = 0$

$0.3807 = 0.0777TO \qquad (1.1)$

$$TO = \frac{0.3807}{0.0778}$$

$\therefore TO = 4.974$

Converting 4.974 in natural log to its original value (as expressed in percentages in WDI dataset) we have 144.65 percent.

Optimal level of openness for Infant mortality rate

Finding the minimum optimal level of openness,

$IMR = -1.2945TO + 0.1395TO^2$

Differentiating with respect to trade openness (TO) yields

$$\frac{\partial IMR}{\partial TO} = -1.2945 + (2 \times 0.1395)TO = 0 \qquad (1.0)$$

Solving for TO gives

$$-1.2945+(2\times0.1395)TO = 0$$

$$-1.2945+0.279TO = 0$$

$$1.2945 = 0.279TO \qquad (1.1)$$

$$TO = \frac{1.2945}{0.279}$$

$$\therefore TO = 4.640$$

Converting 4.640 in natural log to its original value (as expressed in percentages in WDI dataset) we have 103.54 percent.

Optimal level of openness for under-five mortality rate

Finding the minimum optimal level of openness,

$$UM5 = -1.2042TO + 0.12042TO^2 \qquad (1.0)$$

Differentiating with respect to trade openness (TO) yields

$$\frac{\partial U5M}{\partial TO} = -1.2042 + (2\times0.12042)\, TO = 0$$

Solving for TO gives

$$-1.2042+(2\times0.12042)TO = 0$$

$$-1.2042+ 0.24084TO= 0$$

$$1.2042 = 0.24084TO \qquad (1.1)$$

$$TO = \frac{1.2042}{0.24084}$$

$$\therefore TO = 5$$

Converting 5 in natural log to its original value (as expressed in percentages in WDI dataset) we have 148.41 percent.

APPENDIX C

RESULTS OF FIXED EFFECT AND RANDOM EFFECT APPROACH

Life expectancy and trade openness

```
Fixed-effects (within) regression            Number of obs      =       798 Group variable:
country1                       Number of groups   =        42

R-sq:  within  = 0.4730                      Obs per group: min =        19        between =
0.2828                                     avg =       19.0        overall = 0.2998
max =        19

                                             F(8,748)           =     83.93 corr(u_i, Xb)  = -
0.5851                      Prob > F           =    0.0000
```

lnle	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnto	.1134499	.0595564	1.90	0.057	-.0034677	.2303675
lntosq	-.0114075	.0067183	-1.70	0.090	-.0245965	.0017815
lnthe	.0298412	.0098624	3.03	0.003	.0104798	.0492025
gdpg	-.0003778	.0002352	-1.61	0.109	-.0008395	.0000839
lns	.0289255	.0105201	2.75	0.006	.0082731	.049578
lnubn	.1687658	.0158918	10.62	0.000	.1375679	.1999636
lnedu	.1141212	.0145423	7.85	0.000	.0855727	.1426698
lnfr	-.0940684	.0272442	-3.45	0.001	-.1475525	-.0405843
_cons	2.741561	.1501531	18.26	0.000	2.44679	3.036333
sigma_u	.119539					
sigma_e	.05168118					
rho	.84251985	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(41, 748) =    54.57              Prob > F = 0.0000
```

```
Random-effects GLS regression                Number of obs      =       798 Group variable:
country1                       Number of groups   =        42

R-sq:  within  = 0.4720                      Obs per group: min =        19        between =
0.2851                                     avg =       19.0        overall = 0.3033
max =        19

                                             Wald chi2(8)       =    633.38 corr(u_i, X)   =
0 (assumed)                    Prob > chi2        =    0.0000
```

lnle	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnto	.1271788	.0604005	2.11	0.035	.0087961	.2455616
lntosq	-.0129474	.0068141	-1.90	0.057	-.0263027	.000408
lnthe	.0350345	.0096647	3.63	0.000	.0160921	.0539769
gdpg	-.0003789	.0002406	-1.57	0.115	-.0008504	.0000927
lns	.0302409	.0096787	3.12	0.002	.011271	.0492108
lnubn	.1441054	.0144403	9.98	0.000	.115803	.1724078
lnedu	.1042572	.0143651	7.26	0.000	.0761021	.1324123

lnfr	-.0898645	.0254446	-3.53	0.000	-.139735	-.0399941
_cons	2.813599	.1503421	18.71	0.000	2.518934	3.108264
sigma_u	.0814654					
sigma_e	.05168118					
rho	.71303482	(fraction of variance due to u_i)				

Diagnostic tests   Hausman test for life expectancy

```
. hausman fixed_le random_le
```

	---- Coefficients ----			
	(b) fixed_le	(B) random_le	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnto	.1134499	.1271788	-.0137289	.
lntosq	-.0114075	-.0129474	.0015399	.
lnthe	.0298412	.0350345	-.0051933	.0019652
gdpg	-.0003778	-.0003789	1.06e-06	.
lns	.0289255	.0302409	-.0013154	.0041225
lnubn	.1687658	.1441054	.0246604	.0066354
lnedu	.1141212	.1042572	.0098641	.0022631
lnfr	-.0940684	-.0898645	-.0042038	.0097374

```
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(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =      280.39
Prob>chi2 =      0.0000
(V_b-V_B is not positive definite)
```

Heteroscedasticity test in fixed effect regression model for life expectancy

Modified Wald test for groupwise heteroskedasticity in fixed effect

regression model H0: sigma(i)^2 = sigma^2 for all i

chi2 (42) = 1.4e+05 Prob>chi2 =
0.0000

Infant Mortality and trade openness

Fixed-effects (within) regression Number of obs = 798 Group
variable: country1 Number of groups = 42

R-sq: within = 0.6038 Obs per group: min = 19
between = 0.5463 avg = 19.0 overall =
0.5450 max = 19

F(8,748) = 142.51 corr(u_i,
Xb) = -0.4732 Prob > F = 0.0000

lnimr	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnto	-.451699	.1648457	-2.74	0.006	-.7753143	-.1280837
lntosq	.039178	.0185955	2.11	0.035	.0026724	.0756836
lnthe	-.0779063	.0272982	-2.85	0.004	-.1314964	-.0243161
gdpg	.0018429	.0006509	2.83	0.005	.000565	.0031207
lns	-.231066	.0291185	-7.94	0.000	-.2882297	-.1739023
lnubn	-.4222168	.0439868	-9.60	0.000	-.5085691	-.3358645
lnedu	-.2730321	.0402515	-6.78	0.000	-.3520514	-.1940128
lnfr	.632979	.0754089	8.39	0.000	.4849407	.7810173
_cons	7.687838	.4156076	18.50	0.000	6.871942	8.503735
sigma_u	.36003627					
sigma_e	.14304793					
rho	.86366266	(fraction of variance due to u_i)				

F test that all u_i=0: F(41, 748) = 57.66 Prob > F = 0.0000

Random-effects GLS regression Number of obs = 798 Group variable:
country1 Number of groups = 42

```
R-sq:  within  = 0.6020                          Obs per group: min =        19        between =
0.5729                                         avg =      19.0        overall = 0.5679
max =        19

                                                 Wald chi2(8)       =   1140.73 corr(u_i, X)   =
0 (assumed)                      Prob > chi2        =    0.0000
```

lnimr	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnto	-.4987246	.1682251	-2.96	0.003	-.8284397	-.1690094
lntosq	.0449348	.0189782	2.37	0.018	.0077382	.0821314
lnthe	-.0964209	.0269552	-3.58	0.000	-.1492521	-.0435896
gdpg	.0018674	.0006698	2.79	0.005	.0005546	.0031801
lns	-.228554	.0270651	-8.44	0.000	-.2816006	-.1755074
lnubn	-.3382803	.0404006	-8.37	0.000	-.417464	-.2590965
lnedu	-.2537583	.0400574	-6.33	0.000	-.3322693	-.1752473
lnfr	.6503325	.0711116	9.15	0.000	.5109563	.7897086
_cons	7.412703	.4190868	17.69	0.000	6.591308	8.234098
sigma_u	.2312383					
sigma_e	.14304793					
rho	.72322951	(fraction of variance due to u_i)				

Diagnostic tests Hausman test for infant mortality

```
. hausman fixed_Imr random_Imr

                    —— Coefficients
```

	(b) random_Imr	(B) Difference	(b-B) S.E.	sqrt(diag(V_b-V_B)) fixed_Imr
lnto	-.451699	-.4987246	.0470255	.
lntosq	.039178	.0449348	-.0057568	.
lnthe	-.0779063	-.0964209	.0185146	.0043136
gdpg	.0018429	.0018674	-.0000245	.
lns	-.231066	-.228554	-.002512	.0107409
lnubn	-.4222168	-.3382803	-.0839365	.0173963
lnedu	-.2730321	-.2537583	-.0192738	.0039482
lnfr	.632979	.6503325	-.0173535	.0250928

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(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 65.75
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

Heteroscedasticity test in fixed effect regression model for infant mortality

Modified Wald test for groupwise heteroskedasticity

in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (42) = 83111.42
Prob>chi2 = 0.0000

Under-five mortality and trade openness

Fixed-effects (within) regression Number of obs = 798
Group variable: country1 Number of groups = 42

R-sq: within = 0.6225 Obs per group: min = 19
between = 0.5939 avg = 19.0 overall = 0.5873 max = 19

F(8,748) = 154.15
corr(u_i, Xb) = -0.4917 Prob > F = 0.0000

lnu5mr	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnto	-.5293417	.1934561	-2.74	0.006	-.9091232	-.1495602
lntosq	.0456374	.0218229	2.09	0.037	.0027959	.0884789
lnthe	-.0872779	.032036	-2.72	0.007	-.150169	-.0243867
gdpg	.0019175	.0007639	2.51	0.012	.0004179	.0034172
lns	-.2850396	.0341722	-8.34	0.000	-.3521246	-.2179547
lnubn	-.5370491	.0516211	-10.40	0.000	-.6383886	-.4357096
lnedu	-.3802188	.0472375	-8.05	0.000	-.4729526	-.2874851

lnfr	.6579669	.0884968	7.43	0.000	.4842354	.8316985
_cons	9.262267	.4877397	18.99	0.000	8.304765	10.21977
sigma_u	.40511953					
sigma_e	.1678751					
rho	.85345044	(fraction of variance due to u_i)				

F test that all u_i=0: F(41, 748) = 48.30 Prob > F = 0.0000

Random-effects GLS regression Number of obs = 798 Group variable: country1 Number of groups = 42

R-sq: within = 0.6198 Obs per group: min = 19 between = 0.6271 avg = 19.0 overall = 0.6154 max = 19

Wald chi2(8) = 1238.81 corr(u_i, X) = 0 (assumed) Prob > chi2 = 0.0000

lnu5mr	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnto	-.579066	.1984142	-2.92	0.004	-.9679506	-.1901814
lntosq	.0517243	.0223845	2.31	0.021	.0078515	.0955971
lnthe	-.1129373	.0315603	-3.58	0.000	-.1747942	-.0510803
gdpg	.0019381	.0007917	2.45	0.014	.0003863	.0034899
lns	-.2781768	.0312546	-8.90	0.000	-.3394348	-.2169189
lnubn	-.4184708	.0465304	-8.99	0.000	-.5096688	-.3272728
lnedu	-.3510074	.0469414	-7.48	0.000	-.4430108	-.259004
lnfr	.6994811	.0823621	8.49	0.000	.5380544	.8609078
_cons	8.793896	.4921333	17.87	0.000	7.829332	9.758459
sigma_u	.23969877					
sigma_e	.1678751					
rho	.67091481	(fraction of variance due to u_i)				

Diagnostic tests Hausman test for under-five mortality

. hausman fixed_U5m random_U5m

Coefficients

	(b) random_U5m	(B) Difference	(b-B) S.E.	sqrt(diag(V_b-V_B))	fixed_U5m
lnto	-.5293417	-.579066	.0497243	.	
lntosq	.0456374	.0517243	-.0060869	.	
lnthe	-.0872779	-.1129373	.0256594	.0055005	
gdpg	.0019175	.0019381	-.0000206	.	
lns	-.2850396	-.2781768	-.0068628	.0138163	
lnubn	-.5370491	-.4184708	-.1185783	.022353	
lnedu	-.3802188	-.3510074	-.0292114	.0052805	
lnfr	.6579669	.6994811	-.0415141	.0323754	

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(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
        =      88.22
Prob>chi2 =      0.0000
(V_b-V_B is not positive definite)
```

Heteroscedasticity test in fixed effect regression model for under-five mortality

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

```
chi2 (42)  =   58245.97
Prob>chi2 =      0.0000
```

Total Health expenditure and trade openness

```
Fixed-effects (within) regression               Number of obs      =       798
Group variable: country1                        Number of groups   =        42

R-sq:  within  = 0.1482                         Obs per group: min =        19
between = 0.0706                                               avg =      19.0
overall = 0.0186                                               max =        19

                                                F(7,749)           =     18.61
corr(u_i, Xb)  = -0.6745                        Prob > F           =    0.0000
```

lnthe	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnto	.3293866	.2203212	1.50	0.135	-.1031339	.7619071
lntosq	-.0311261	.0248645	-1.25	0.211	-.0799386	.0176864
gdpg	.0008203	.0008708	0.94	0.346	-.0008891	.0025298
lns	-.0604347	.0389131	-1.55	0.121	-.1368265	.0159571
lnubn	.1564738	.0585991	2.67	0.008	.0414358	.2715118
lnedu	.2624342	.0530173	4.95	0.000	.1583541	.3665144
lnfr	-.327519	.1002246	-3.27	0.001	-.5242735	-.1307646
_cons	.042767	.5562977	0.08	0.939	-1.049321	1.134855

sigma_u	.42043395
sigma_e	.19147283
rho	.82822266 (fraction of variance due to u_i)

F test that all u_i=0: F(41, 749) = 43.24 Prob > F = 0.0000


```
Random-effects GLS regression                  Number of obs      =       798
Group variable: country1                       Number of groups   =        42

R-sq:  within  = 0.1441                        Obs per group: min =        19
       between = 0.0536                                       avg =      19.0
       overall = 0.0104                                       max =        19

                                               Wald chi2(7)       =     95.01
corr(u_i, X)   = 0 (assumed)                   Prob > chi2        =    0.0000
```

lnthe	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnto	.3817732	.2225237	1.72	0.086	-.0543653	.8179116
lntosq	-.0386158	.0251134	-1.54	0.124	-.0878371	.0106055
gdpg	.0008114	.0008882	0.91	0.361	-.0009295	.0025523
lns	-.0505747	.0354084	-1.43	0.153	-.1199739	.0188245
lnubn	.0612925	.0528006	1.16	0.246	-.0421948	.1647799
lnedu	.2559381	.0521098	4.91	0.000	.1538048	.3580713
lnfr	-.2274301	.092954	-2.45	0.014	-.4096166	-.0452435
_cons	.1197961	.5540158	0.22	0.829	-.966055	1.205647
sigma_u	.2884202					
sigma_e	.19147283					
rho	.69409729 (fraction of variance due to u_i)					

Diagnostic tests Hausman test for total health expenditure

```
. hausman fixed_the random_the

                  ---- Coefficients
```

	(b) fixed_the	(B) random_the	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnto	.3293866	.3817732	-.0523866	.
lntosq	-.0311261	-.0386158	.0074897	.
gdpg	.0008203	.0008114	8.94e-06	.
lns	-.0604347	-.0505747	-.00986	.0161393
lnubn	.1564738	.0612925	.0951813	.0254155
lnedu	.2624342	.2559381	.0064962	.0097676
lnfr	-.327519	-.2274301	-.100089	.0374768

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)
        =       62.83
Prob>chi2 =      0.0000
(V_b-V_B is not positive definite)
```

Heteroscedasticity test in fixed effect regression model for total health expenditure

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i

```
chi2 (42)  =    5520.92
Prob>chi2 =       0.0000
```

APPENDIX D

RESULT OF GENERALIZED METHOD OF MOMENTS APPROACH

Life expectancy and trade openness

```
Dynamic panel-data estimation, one-step system GMM

Group variable: country1                        Number of obs      =       756
Time variable : year                            Number of groups   =        42
Number of instruments = 60                      Obs per group: min =        18 F(9,
41)       =    135.84                                     avg =     18.00
Prob > F       =     0.000                                max =        18
```

lnle	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnle L1.	.7719805	.1136925	6.79	0.000	.5423739	1.001587
lnto	.3806907	.1430221	2.66	0.011	.0918517	.6695296
lntosq	-.0388859	.0143192	-2.72	0.010	-.0678042	-.0099677
lnthe	.040429	.0173784	2.33	0.025	.0053326	.0755255
gdpg	-.0004153	.0006744	-0.62	0.541	-.0017773	.0009466
lns	.0273957	.0172545	1.59	0.120	-.0074505	.062242
lnedu	.0105405	.0199427	0.53	0.600	-.0297347	.0508156
lnubn	.0026119	.0213248	0.12	0.903	-.0404544	.0456781
lnfr	-.0031015	.0323943	-0.10	0.924	-.0685232	.0623202
_cons	-.1791885	.4093699	-0.44	0.664	-1.005928	.6475508

```
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.lnedu
    L3.gdpg
```

```
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.lnedu
    DL2.gdpg

Arellano-Bond test for AR(1) in first differences: z =  -1.42  Pr > z =  0.155
Arellano-Bond test for AR(2) in first differences: z =   1.41  Pr > z =  0.157

Sargan test of overid. restrictions: chi2(50)    =  55.11  Prob > chi2 =  0.288   (Not
robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(50)    =  34.70  Prob > chi2 =  0.951
  (Robust, but weakened by many instruments.)
```

Infant mortality and trade openness

```
Dynamic panel-data estimation, one-step system GMM

Group variable: country1                          Number of obs      =       756
Time variable : year                              Number of groups   =        42
Number of instruments = 60                        Obs per group: min =        18
F(9, 41)       =    109.27                                       avg =     18.00
 Prob > F      =     0.000                                       max =        18
```

lnimr	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnimr L1.	.6278839	.2199325	2.85	0.007	.1837212	1.072047
lnto	-1.294495	.7430171	-1.74	0.089	-2.795048	.2060589
lntosq	.1394994	.0790587	1.76	0.085	-.0201629	.2991616
lnthe	-.1236855	.0515409	-2.40	0.021	-.2277745	-.0195966
gdpg	.0017742	.0021467	0.83	0.413	-.0025611	.0061095
lns	-.0798542	.0503022	-1.59	0.120	-.1814415	.0217331
lnedu	-.0890309	.0904938	-0.98	0.331	-.2717869	.093725
lnubn	-.0342014	.07921	-0.43	0.668	-.1941692	.1257664
lnfr	.3043291	.2947488	1.03	0.308	-.2909282	.8995863
_cons	4.878324	2.378816	2.05	0.047	.0742084	9.68244

```
Instruments for first differences equation
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.lnedu
    L3.gdpg
Instruments for levels equation
  Standard
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
```

```
    D.lnedu
    DL2.gdpg

 Arellano-Bond test for AR(1) in first differences: z =  -1.45  Pr > z =  0.148
Arellano-Bond test for AR(2) in first differences: z =   1.32  Pr > z =  0.188


 Sargan test of overid. restrictions: chi2(50)    =  46.14  Prob > chi2 =  0.629
                                 (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(50)    =  33.81  Prob > chi2 =  0.962
   (Robust, but weakened by many instruments.)
```

Under-five mortality and trade openness

```
Dynamic panel-data estimation, one-step system GMM

      Group variable: country1                          Number of obs      =
                                                                         756
Time variable : year                                   Number of groups    =
42
Number of instruments = 95                             Obs per group: min =
18 F(9, 41)       =    296.11                                         avg =
18.00 Prob > F      =     0.000                                       max =
18
```

lnu5mr	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnu5mr L1.	.7536119	.1768273	4.26	0.000	.3965018	1.110722
lnto	-1.204237	.6248163	-1.93	0.061	-2.466079	.057605
lntosq	.1273721	.0661529	1.93	0.061	-.0062263	.2609705
lnthe	-.1118679	.0515829	-2.17	0.036	-.2160416	-.0076941
gdpg	.0016821	.0015925	1.06	0.297	-.0015341	.0048982
lns	-.1308554	.0812539	-1.61	0.115	-.294951	.0332402
lnedu	.0701167	.0666232	1.05	0.299	-.0644316	.204665
lnubn	-.1370145	.087226	-1.57	0.124	-.3131709	.039142
lnfr	.2051654	.2112465	0.97	0.337	-.2214556	.6317863
_cons	4.388476	2.26149	1.94	0.059	-.1786956	8.955647

```
Instruments for first differences equation
  GMM-type  (missing=0,  separate  instruments  for  each  period  unless
collapsed)
    L.(lnedu lnfr)
    L3.gdpg
Instruments for levels equation
```

Standard
_cons
GMM-type (missing=0, separate instruments for each period unless collapsed)
D.(lnedu lnfr)
DL2.gdpg

Arellano-Bond test for AR(1) in first differences: z = -1.41 Pr > z = 0.157
Arellano-Bond test for AR(2) in first differences: z = 1.27 Pr > z = 0.203

Sargan test of overid. restrictions: chi2(85) = 77.58 Prob > chi2 = 0.704
(Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(85) = 27.58 Prob > chi2 = 1.000
(Robust, but weakened by many instruments.)

Total health expenditure and trade openness

Dynamic panel-data estimation, one-step system GMM

Group variable: country1 Number of obs = 756
Time variable : year Number of groups = 42 Number of instruments = 59 Obs per group: min = 18
F(8, 42) = 1596.81 avg = 18.00 Prob > F = 0.000
max = 18

lnthe	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf. Interval]
lnthe L1.	.8558274	.1048963	8.16	0.000	.6441382 1.067517
lnto	.5230037	.2591031	2.02	0.050	.0001125 1.045895
lntosq	-.0472769	.0320607	-1.47	0.148	-.1119779 .0174242

gdpg	.0004985	.0032397	0.15	0.878	-.0060394	.0070364
lns	-.1533262	.0835043	-1.84	0.073	-.3218448	.0151923
lnedu	.0340083	.0755137	0.45	0.655	-.1183846	.1864012
lnubn	-.1150899	.0643872	-1.79	0.081	-.2450284	.0148487
lnfr	-.1998925	.1256278	-1.59	0.119	-.4534197	.0536346

Instruments for first differences equation

GMM-type (missing=0, separate instruments for each period unless collapsed)

L.lnfr

L3.lnedu

Instruments for levels equation

GMM-type (missing=0, separate instruments for each period unless collapsed)

D.lnfr

DL2.lnedu

Arellano-Bond test for AR(1) in first differences: z = -3.58 Pr > z = 0.000 Arellano-Bond test for AR(2) in first differences: z = -0.49 Pr > z = 0.624

Sargan test of overid. restrictions: chi2(51) = 61.85 Prob > chi2 = 0.142

(Not robust, but not weakened by many instruments.)

Hansen test of overid. restrictions: chi2(51) = 33.85 Prob > chi2 = 0.969 (Robust, but weakened by many instruments.)