# IMPACT OF MALARIA ON AGRICULTURAL LABOUR SUPPLY IN MALAWI

**MASTER OF ARTS (ECONOMICS) THESIS**

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**UNIVERSITY OF MALAWI**

**CHANCELLOR COLLEGE**

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# IMPACT OF MALARIA ON AGRICULTURAL LABOUR SUPPLY IN MALAWI

**MASTER OF ARTS (ECONOMICS) THESIS**

**By**

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**University of Malawi**

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# DECLARATION

I declare that this thesis is my own work and that it has never been submitted for similar purposes, to any university or institution of higher learning. Acknowledgements have been duly made where other people's work has been used. I am solely responsible for all errors that this document contains.

**Name**

**Signature**

**Date**

## CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval.

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# DEDICATION

To my parents, **Reverend Charles and Rose Malekano**

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## ABSTRACT

Malawi is faced with a high burden of disease with malaria as one of the top contributors to this burden. Health which is a capital stock may be expected to positively contribute to an individual's decision to participate and supply labour. The decision may in the end have some positive impact on the economy in general. The study assessed the impacts of malaria on household agriculture labour supply in Malawi and examined the effect of malaria on the decision to participate in household agriculture labour supply. The study used the integrated household survey 3 (IHS-3) data collected by the National Statistics Office (NSO) of Malawi in 2010/2011 and employed the Heckman model. Findings from the research reveal that malaria illness affects the decision of an individual on whether to participate in household agriculture or not but not the actual number of labour hours supplied to household agriculture. Other variables such as location (rural) and gender (female) were found to have a significant impact of the number of labour hours supplied to household agriculture. In terms of the decision to participate in household agriculture, factors such as age, education, marital status (married), location (rural), and household size were found to be significant. The main conclusion drawn from this study is that malaria has no significant impact on household agriculture labour supply in Malawi.

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## LIST OF ABBREVAITONS ACRONYMS

| | |
|---|---|
| ADB | African Development Bank |
| AIDS | Acquired Immune Deficiency Syndrome |
| CHAM | Christian Health Association of Malawi |
| EHP | Essential Health Package |
| FAO | Food Agriculture Organisation |
| FE | Fixed Effects |
| GDP | Gross Domestic Product |
| GoM | Government of Malawi |
| HIV | Human Immunodeficiency Virus |
| HMIS | Health Management Information System |
| IHS | Integrated Household Survey |
| ILO | International Labour Organisation |
| LAD | Least Absolute Deviation |
| MoH | Ministry of Health |
| NCD’s | Non-Communicable Diseases |
| NMCP | National Malaria Control Programme |
| NSO | National Statistical Office |
| OLS | Ordinary Least Square |
| PMI | President’s Malaria Initiative |
| TB | Tuberculosis |
| TBA’s | Traditional Birth Attendants |
| WHO | World Health Organisation |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

Agriculture continues to be an importanct sector in the African continent as it is the source of livelihood for almost three quarters of the poor in the world, mainly those who reside in rural areas, particularly in the Asian and African continents (Ravallion et al., 2007). The importance of the sector varies widely across African countries. The sector contributes from as low as 2.4 percent to 70 percent in Equatorial Guinea and Liberia respectively (ADB, 2015). According to the African Development Bank (2015), on average the agricultural sector generates 15 percent of the gross domestic product (GDP) in the African continent. The share of agriculture to GDP in sub-Saharan Africa has been decreasing from 29 percent in 2007 to 17 percent in 2015 (World Bank, 2007; ADB, 2015). In Malawi, agriculture is one of the important sectors and also contributes almost one third to the GDP.

According to FAO (2009), a large number of farmers in Africa are smallholder farmers. Sub-Saharan Africa has the largest number of farms which are small (thus less than 2 hectares). Almost 80 percent of all farms on the continent are less than 2 hectares (Wiggins & Sharada, 2013). Malawi is no exception. According to the IHS 3, on average total cultivated area  is about 1.6 hectares. Rural areas have larger cultivated land compared to urban areas. The results of the survey also show that households headed by males have larger cultivated land, 1.6 hectares, compared to their female counterparts, 0.8 hectares.

Furthermore, the agricultural sector depends heavily on manual labour which is regularly provided by household members or hired within the community (Okyere et al., 2010). Due to the fact that these farms are small and use household labour, they are exposed to disruptions. Ill health is one of the disruptions which may affect agricultural labour. Malaria illness is one of those disruptions which the agriculture sector faces (Okyere et al., 2011). Those individuals affected by malaria may be unable to supply agricultural household labour. On the other hand it should be noted that malaria does not only affect those who are sick but even other individuals who may spend their time taking care of other individuals who are sick. Apart from reducing labour supply, illness may also divert money which could have been used to hire individuals for agricultural work to cover medical costs and others.

Malaria is one of those diseases that usually presses a burden on agricultural labour supply and production (Oluwatayo, 2014). In Malawi, agriculture and malaria are closely associated. This is so because agriculture environments provide suitable conditions in which disease vectors which cause malaria in humans are able to breed (Oluwatayo, 2014). The malaria incidence rate globally was 91 per 1000 persons at risk in 2015 with 214 million cases worldwide. An estimated number of 438 000 malaria deaths globally followed. Most of the deaths were among children below the age of five (WHO, 2016).

The burden of malaria is high in sub-Saharan Africa with the incidence rate at 246 per 1000 persons (WHO, 2016). One half of all outpatients' consultations that occur in Malawi are due to malaria (WHO, 2010). Every Malawian resident lives in a region of high malaria transmission, defined as greater than one case per 1,000 residents. The prevalence of malaria declined from 43 percent in 2010 to 33 percent in 2014 due to a scale up in malaria prevention and control programs (MoH, 2014).

The majority of people affected by malaria in Malawi work in the agriculture sector, and agriculture continues to employ the greatest percent of individuals in Malawi. Food production is largely undertaken by women and so with malaria affecting more women than men income from sale of agricultural products, food security and farm labour supply are greatly compromised by malaria in Malawi (NSO, 2014).

### 1.2 Problem Statement and Significance

In Malawi the agricultural sector is important as it accounts for 32% of the GDP (CIA, 2017). Further, the sector it generates more than 80 percent of export earnings (primarily from tobacco sales) and the sectorsupports more than 85 percent of the population (GoM, 2011).

While it may seem intuitively obvious that malaria negatively affects labour supply, there are controversies on its effects. Other studies have found the effects of malaria on agriculture labour supply inconclusive (Abimbolam, 2007; Nur, 1993). On the other hand other studies have found that malaria has a negative effect on farm labour supply

(Babalola et al., 2009; Hong, 2007). It is, therefore, necessary to undertake this study in Malawi to see how malaria affects agricultural labour supply.

The bulk of literature which exists focuses on measuring the economic burden of malaria, such as those by Ettling et al., (1994) and Sandifolo (2010), which looked at the economic burden of malaria in Malawi. Other studies have focused on the cost of illness on agricultural production. . For instance, Khangamwa (2010) looked at the cost of illness on agriculture production in Zomba. It is therefore against this background that this study comes in to analyse the impacts of malaria on agricultural labour supply. Awareness of the impact of malaria on agricultural household labour supply can help target interventions efficiently which will help in dealing with malaria, so as to reduce its burden on agriculture labour participation and labour supply.

Labour supply is a crucial aspect in an economy. An increase in the rates of labour force participation is necessary for economic development (Daly & Regev, 2007). In Malawi, labour is the most abundant factor of production and it can be said that any country's well-being depends on the willingness of individuals to work.

The study contributes to the development of empirical literature on malaria and agricultural labour supply using econometric techniques. In addition, the study contributes knowledge on how malaria affects agricultural labour supply. Information from this study can help in estimating the loss in production due to malaria and it can be used to design necessary interventions to avoid losses in labour supply and productivity.

The study has policy relevance owing to its effect on food production and overall food sufficiency for the locality and the nation at large.

## 1.3 Objectives

### 1.3.1.Main objective

The main objective is to examine the impact of malaria on agricultural labour supply.

### 1.3.2 Specific objective

The specific objectives of the study are:

i. to examine the effects of malaria on household agriculture labour supply participation decision.

ii. to measure the effects of malaria on the number of hours supplied in household agriculture.

## 1.4 Hypothesis of the Study

With concern to the above main and specific objectives, the study will test the following null hypotheses:

i. Malaria does not affect participation decision in household agriculture labour supply.

ii. Malaria does not affect the number of hours supplied in household agriculture.

## 1.5 Organisation of the Study

The rest of the thesis is organised as follows: Chapter 2 presents the overview of Malawi's health sector, malaria situation and other diseases. Chapter 3 presents the literature review and this comprises of theoretical and empirical literature. Chapter 4 presents the methodology, and Chapter 5 presents results of econometric analysis. Chapter 6 presents conclusion and policy recommendations.

## CHAPTER TWO

## OVERVIEW OF THE HEALTH SECTOR AND MALARIA SITUATION IN MALAWI

### 2.1 Introduction

This chapter provides an overview of the health sector, malaria situation and other top diseases in Malawi. Firstly it looks at the health sector, then the malaria situation. The focus is on how malaria is distributed and its distribution trends. Finally the chapter ends by presenting other top diseases which press a burden on the health sector in Malawi.

### 2.2 The Structure of the Health Sector

The Health sector in Malawi is controlled around activities of the Ministry of Health. The ministry has the overall responsibility of developing policies, planning strategies and programs for health care. Malawi's health sector structure is characterised by a dual nature, with the traditional (or informal sector) on one hand and the modern (or formal sector) on the other. The traditional health providers include the traditional healers and traditional birth attendants (TBAs). The modern health sector comprises the public sector (MoH), non-profit private sector (CHAM) and the private for profit sector. The Christian Health Association of Malawi (CHAM) operates health facilities mainly in rural areas nationwide and provides approximately one-third of health services; fees are charged for the Essential Health Package (EHP) where service level agreements with the government have not been established

## 2.3 Health Situation in Malawi

The health sectors overall policy is to raise the level of health status of all Malawians by reducing the incidence of illness and occurrence of death in the population. This is done through the development of a sound delivery system capable of promoting health; preventing, reducing and curing disease; protecting life, and fostering general well-being and increased productivity.

Malawi, being one of the developing nations, continues to struggle with poor health indicators. Some of the selected health indicators include life expectancy at birth, infant mortality rate, and maternal mortality rate. Health indicators are important in any country because they give a reflection of the health status of a country's population and performance of the health sector as a whole. According to the latest WHO data published in 2015, life expectancy in Malawi is 56.7 for males and 59.9 for females. The total life expectancy is 58.3 which gives Malawi a World Life Expectancy ranking of 165. The infant mortality rate is 66 deaths per 1,000 live births. The estimate of child mortality (age 12 months to 4 years) is 50 deaths per 1,000 live births, while the overall under-5 is 112 deaths per 1000 live births (NSO, 2012). Maternal mortality is estimated at 439 deaths per 100,000 live births (NSO and ORC Macro, 2015).

## 2.4 The Disease Burden

### 2.4.1 Malaria

#### *2.4.1.1 Malaria transmission and distribution*

Malaria is caused by a protozoon of different kinds of Plasmodium species which include Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae and Plasmodium Knowles. In Malawi it is mainly caused by Plasmodium falciparum which accounts for 98% of the infections and all severe disease and deaths (PMI, 2017).

Malaria is endemic in more than 95% of the country. In most parts of Malawi, malaria transmission occurs constantly (PMI, 2017). The distribution of malaria depends on several climatic factors such as rainfall, temperature as well as humidity. Rainy season which typically begins in November and last through April is the peak time for malaria. Its transmission is higher in areas which are wetter, hotter and more humid such as the lakeshore, the shire river valley and the central plain. On the other hand the risk of malaria is lower in the highlands such as Mzimba, Chitipa and Rumphi.

#### *2.4.1.2 Malaria incidence and prevalence*

Malaria which continues to be a major health problem in Malawi accounts for 6.2 million presumed and confirmed cases which are reported annually. Further almost 36 per cent of all outpatient visits are due to malaria (PMI, 2017). Malaria infections are more common in children who are below the age of 5**.** Among children under five years, malaria parasite prevalence by microscopy was 33 percent nationally (PMI, 2017). Malaria incidence has been declining over the past years as can be observed in figure 1 below**.** The rates have been decreasing from 484 in 2011 to 223 in 2014. The decline might be due several interventions which the Malawi government put in place. These interventions include the distribution of mosquito nets.

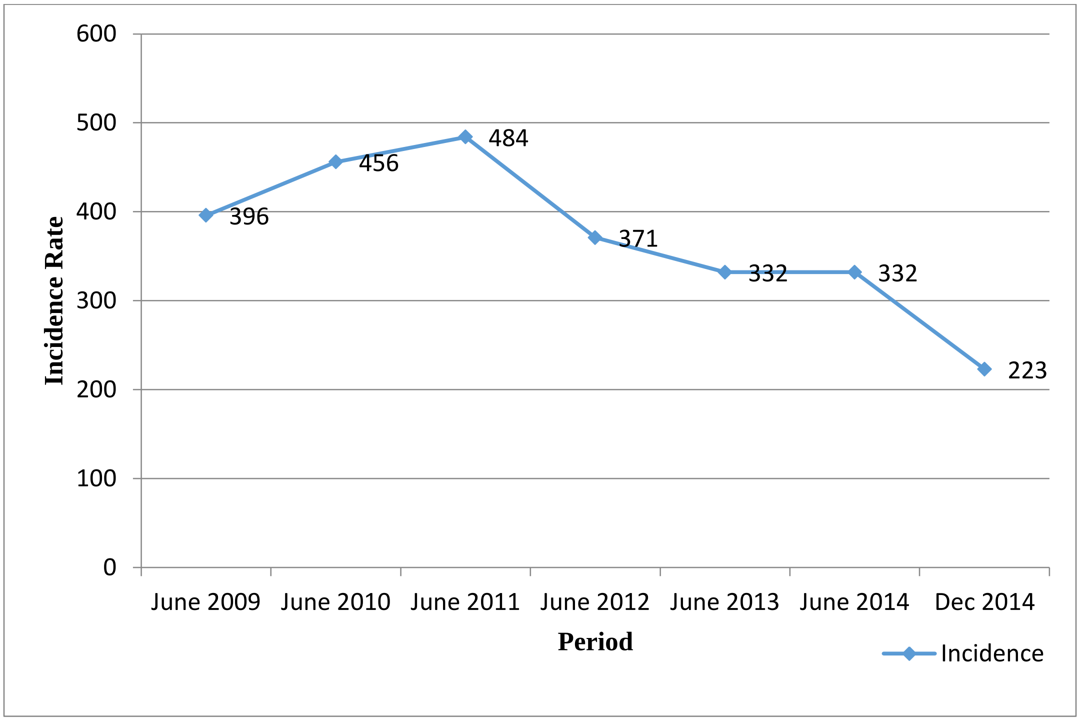


**Figure 1: Malaria incidence from 2009 to 2014**

*Source: MoH, 2015*

### 2.4.2 Other Diseases

Malawi health sector is also burdened by communicable diseases such as HIV/AIDS, tuberculosis (TB) and hypertension. It is estimated that 1,100,000 Malawians were living with HIV in 2014 and that 34,000 new infections occurred in 2014 (NMCP & ICF International, 2014). Almost 8.8 percent of the population aged 15-49 years is living with HIV/AIDS of which 10.8 percent are women and 6.4 percent men (WHO, 2017). In respect to TB, its incidence has declined over the past years. Its prevalence rate, however, still remains high with the rate at 363 per 100,000 (WHO, 2017).

Non-communicable diseases (NCDs) are also on the rise. Diseases such as hypertension, diabetes, cancer are some of the NCDs which are increasing in Malawi. From the angle of hypertension, it is estimated that 33 percent of adults within the age range of 25-64 are affected. On the other hand in the same age bracket 5.6 percent are diabetic. Cancer annually registers has about 5000 new cases (WHO, 2017).

# CHAPTER THREE

# LITERATURE REVIEW

## 3.1 Introduction

The purpose of this chapter is to review literature with respect to malaria and labour supply. The theoretical literature is presented in section 3.2, which includes the static model, the life cycle model of labour supply and the human capital theory which are then linked to ill health. A critique to some of the theoretical literature is also provided. The chapter ends with a review of various papers on the impacts of malaria and labour supply.

## 3.2 Theoretical Literature

### 3.2.1 Static Utility model

Following Cahuc and Zylberberg (2004), the utility function of an individual is established on the tradeoff between consumption and leisure. The utility function is given as

$$U = U(C, L) \tag{3.1}$$

The utility function is assumed to be well behaved such that $U_C > 0, U_{CC} < O, U_L > 0, U_{LL} < 0$.

This states that both C and L are goods from which individuals enjoys positive utility but that they experience diminishing marginal utility.

The consuption of goods and leisure by an individual is constrained by the individuals time and income. Assuming an individual's total time available (t) is assumed to be allocated to either market work (h) or leisure (L), the time constraint can be depicted as

$$h = T - L \tag{3.2}$$

As stated above individuals are also faced by a budget constraint in which total consumption depends on market wage (w), time allocated to work $h$ and non-labour income (v) such that

$$C \leq wh + V \tag{3.3}$$

Since marginal utility of consumption is positive, individuals satisfy their budget constraint with equality. Combining (3.2) and (3.3) yields the full income constraint

$$C = w(T - L) + V \tag{3.4}$$

The lagrangian function, G, to represent the individual's utility maximization is:

$$\mathrm{G} = U(C, L) + \lambda(V + wT - wL - C) \tag{3.5}$$

Maximising G, with respect to L and C respectively, the first order conditions are given as (3.6) and (3.7) below.

$$U_L(C^*L^*) = \lambda w \tag{3.6}$$

$$U_C(C^*L^*) = \lambda \tag{3.7}$$

If equations 3.6 and 3.7 are divided, we yield the optimum labour supply decision.

$$\frac{U_L(C^*L^*)}{U_C(C^*L^*)} = w \tag{3.8}$$

This equilibrium condition states that individuals maximize utility by equating their subjective marginal rate of substitution between consumption and leisure to the given real wage. The reservation wage of individuals is represented by the marginal rate of substitution at the corner solution. At corner solution, the marginal rate of substitution represents individual's reservation wage. When the market wage exceeds the reservation wage individuals supply labour and the reverse is true. It can be seen that labour supply is determined by the market wage and non labour income. Factors that influence the wage market and non labour income influence labour supply of an individual.

The static model of labour supply has some weakness. For example, the model does not consider the fact that individuals are forward looking. It assumes that individual do not borrow or save. Meyer and Rosenbaum (2001) argue that the major shortfall of the static model analysis is that in the real world an individual's choice of the number of hours she/he can work is not complete. It is from this realisation that we can talk of the two forms of the labour markets, which are tight and loose markets. First, in markets which are considered tight, individuals may decide to partcipate and choose the number of labour hours to supply. This may happen if the demand for labour outways the supply. On the other hand we can talk of loose labour markets in which an individual does not have the discretion on the number of hours to work but simply accepts to work a certain number of hours given.

### 3.2.2 Life Cycle Model of Labour Supply

The motivation behind this model is to help us understand labour supply across the life cycle of an individual. This looks at the time of birth, education and training, joining the labour force and finally the time of retirement.

It must be emphasized here that these derivations are due to Benitez (1998).An individual's utility function can be shown as below (3.9). The assumption is that an individual's utility comes from leisure, L(t) and consumption of goods, C(t).

$$U = U\big(C(t), L(t); X(t), \varepsilon^*(t)\big) \tag{3.9}$$

Where U is the utility, $X(t)$ is a vector of observable individual's characteristics in a specific time period, $\varepsilon^*(t)$ represents unobservable characteristics that affect an individual utility in the specific period, t.

Expression 3.10 represents an inter-temporal utility function of an individual whose life ends after a period k+1.

$$U = \sum_{t=0}^{K}\left(\frac{1}{1+\rho}\right)^{t}.U\big(C(t), L(t); X(t), \varepsilon^*(t)\big) \tag{3.10}$$

$\rho \geq 0$ is the subjective time preference rate of the individual.

An individual's wealth determines his/her lifetime utility as shown in the below equation

$$A(0) + \sum_{t=0}^{K}\left(\frac{1}{1+r}\right)^{t}.W(t).H(t) = \sum_{t=0}^{K}\left(\frac{1}{1+r}\right)^{t}.P(t).C(t) \tag{3.11}$$

$A_0$ represents an individual's endowments of assets at the beggining of his/ her life. The exogenously given profile of wages is given as *W*(*t*), *H*(*t*) = *T*-*L*(*t*), represents the labor supply profile, $P(t)$ stands for the price of the goods which are consumed, and $r$ is the real interest rate at which individual either borrow or save in the capital market.

For an individual to maximize his/her utility, both consuption and number of work hours have to be greater than zero, thus, $C(t) > 0$ and $H(t) > 0$ respectively. The lifetime budget constraint of an individual is satisified by finding the optimum of the kuhn-Tucker.

$$\frac{\partial U}{\partial C(t)} = \left(\frac{1+\rho}{1+r}\right)^{t} . \lambda . P(t), t = 0, \dots, K, \tag{3.12}$$

$$\frac{\partial U}{\partial L(t)} \geq \left(\frac{1+\rho}{1+r}\right)^{t} . \lambda . W(t), t = 0, \dots, K, \tag{3.13}$$

where $\lambda$ is the Lagrange multiplier and is associated with the wealth constraint. Along the optimal path, it represents the marginal utility of initial wealth. In the optimal path of consuption, marginal utility, consumption utility equals to the consumption price of the good, taking into consideration the marginal utility of wealth, interest rate and time. An individual's idle time, participation and number of work hours are represented in expression 3.12. An individual can either spend all his time on leisure (if the marginal utility of leisure time exceeds the discounted period wage rate adjusted for the marginal utility of wealth) or on work (if the marginal utility of leisure at $H(t) > 0$ equals the discounted period wage rate adjusted for the marginal utility of wealth.).

In the static modelparticipation and decision of hours to work in a period depends only on the current wage. However,  in the life cycle model the participation and decision on the number of hours to work depends on the current wage, the marginal utility of wealth, taste of information, the marginal utility of wealth and the constant, $\lambda$. Holding the marginal utility constant, the model postulatesthat there is a positive relationship between period wage and period hours supplied.

Bosworth et al., (1996) argue that labour supply is positively related to wage rate, depending on three forces which include: efficiency effect, interest rate effect and time preference rate effect. An 'efficiency' effect which is due to inter-temporal substitution effect makes an individual work more during periods of higher wage rates than in periods of low wage rates. In this case, a rise in the wage rate at any time period would reduce leisure and consequently increase hours of work. However, the same rise in the real wage, ceteris paribus, entails an increase in real income which will make a rational individual agent (assuming normal goods and leisure) afford or demand more of consumption and leisure. Consequently, the individual will be motivated to work less hours, which is the negative income effect with respect to work. Secondly, an 'interest rate' effect makes an individual to work more in initial period and work less later on because of the possibility of saving as the individual effectively banks some part of earnings to earn higher interests. Because of increased opportunities to work and save, individuals tend to work more early in their life cycle and then reduce their hours of work as they near retirement stage. Finally, a 'time preference rate' effect where an individual tends to work less at first and more later because of a natural desire to take leisure presently and put off work at a later date. Thus it can be argued that when one has a positive rate of time preference, individuals tend to work less presently and enjoy more leisure in the present period.

From the labour supply model, it can be explained that malaria illness affects individual's decisions interms of time allocation. As can be noted, malaria reduces the healthy time which an individual has. It can be said that an individual who chooses to work in agricultural activities and is ill from malaria will cut off his or her time in participating in agriculture; that is to say, hours of work, $H(t)$are affected, hence reduction in labour supply. Due to the negative effect of illness on work hours, wages are also affected due to the individuals withdrawal. Wages are also affected as the individual devotes less time in the labour market. Furthermore, ill individuals spend their income in fighting malaria; consequently, their endowments, $A_0$, are also affected. The individual may sell their assets or may divert income which could be used for some investiment to treating their illness.

### 3.2.3 Human capital

Adam Smith (1977) was the first person to discuss the concept of human capital in the wealth of nations, but it was in the 1960s that the model got recognition from labour economists as an area of research. Human capital is the productive investments in aspects such as skills, values, and health of people. The investment is realised through expenditures on education, on-the-job training programs, and medical care (Todaro & Smith, 2012). Olaniyan and Okemakinde (2008) argue that human capital represents the investment people make in themselves that enhance their economic productivity. Human capital is the most fundamental source of economic growth. It is a source of both increased productivity and technological advancement. Health is viewed as a form of human capital which influences people's capacity to meet job requirements (Becker, 1962; Leibenstein, 1957; Schultz, 1961). Individuals who are ill may have a lower productivity which may translate into a lower wage as compared to those individuals who are not ill. A reduction in wages produces two effects, the substitution effect and the income effect. In terms of the substitution effect, a lower wage means a lower opportunity cost of leisure hence an individual reduces the likelihood of participating in the labour force. Secondly, in terms of income effect, the reduction in wages means a reduced level of an individual's total income, this causes them to want to work for more hours than they did before to cover for the lost income.

The link between ill health and labour supply is based on the statement that an increase in an indvidual's stock of health increases the productivity of an individual in both market and nonmarket activities (Tompa, 2002). Ill health may lower work performance and productivity due to a reduction in number of work hours. Individuals who are ill face a lower probability of participating in the labour force (Cai and Kalb, 2004). According to the human capital theory, it can be concluded that ill health negatively affects labour supply.

### 3.3 Empirical Literature

Studies on malaria and labour market outcomes such as labour productivity, labour supply, and income have been documented in Africa. In studies related to malaria and other labour market outcomes, it is assumed that the days lost due to malaria illness could be used in a productive way if the individual had no malaria. Some of the earliest studies include those of Audibert (1986), Nur (1993), Picard and Mills (1992), and Wang'ombe and Mwabu (1993).

Audibert (1986) measured the impact of malaria on rice production in which he used a production function model without controlling for illness endogeneity. In his model he included two variables which capture household health status. One of the variables captured the impact of malaria and the other addressed the issues of schistosomiasis on rice output. His study revealed that malaria has no effect on rice production. Wang'ombe and Mwabu (1993) also found similar results in which coefficient for malaria was insignificant.

A study by Ajani and Ashgidigbi (2008) on the effect of malaria on the overall farm income found out that malaria has no effect on farm income. On other determinants of productivity of farmers such as farm size, education, extension service, food expenditure and non-food expenditure, the results were statistically significant.

Different studies use different labour market outcomes in trying to assess the impacts of malaria. This can also be observed from the early studies, and several labour market outcomes were used to assess the impact of malaria. Most studies have concentrated on the use of wages as the outcome variable such as those done by Asenso-Okyere and Dzator (1997), Asenso-Okyere et al., (1997), Cropper et al., (1999). Other studies have resorted to the use of income (Ajani and Ashgidigbi, 2008: Ettling et al., 1994: Guiguemde, 1994). Studies which have looked at wages and income have encountered several problems. One of the problems is that individuals tend to hide or understate their real income as well as their wage rate hence this reduces the preciseness of results obtained from studies which concentrate on such labour market outcomes.

Apart from wages and income other studies have concentrated on labour productivity. Such studies include those by Audibert (1986), Girardin et al., (2004), Wang'ombe and Mwabu (1993), and World Bank (2007). These studies have revealed different impacts of malaria and productivity. One study in Côte d'Ivoire which assessed the impact of malaria on farmers engaged in intensive vegetable production revealed that individuals affected by malaria produced half the yield as compared to other farmers who were not ill. The study showed that those with malaria lost up to 26 work days in a 10-month period.

Different methodologies have also been used in analysing the effects of malaria and labour supply. The methodologies have revealed almost similar results but just with a different magnitude. Abimbola (2007) in his study of malaria, labour supply, and schooling in Sub-Saharan Africa used approaches as two square least method (2SLS), ordinarly least square (OLS) method and fixed effects (FE). Using OLS and FE he estimated the casual effects of malaria on labour market outcomes in which he found that malaria led to a loss in weekly work hours. Similarly using 2SLS, he estimated the effects of chronic illness for all types employment, the results are similar to those of OLS and FE; the difference was only in magnitude. The 2SLS results were that there is a decline in number of work hours by approximately 2.5 hours a week by those who were clinically ill from malaria. The results of OLS and FE showed a decline in work hours in a range of 1.45 to 2.68 hours per week

Mwabu and Fosu (2007) assessed the effect of malaria on farm output, wage income and household expenditure using household data. Their assessment was done using ordinary least squares (OLS) and Least Absolute Deviation (LAD) regression methods. They found that the effect of malaria illness on crop production was negative and statistically significant, and the negative production effect of malaria was more than twice that of other diseases.

A study by Alaba and Alaba (2009), which looked at malaria in rural Nigeria which assessed the implications of malaria on the Millennium Development Goals, used the cost of illness approach. This approach sums the direct cost of illness and the indirect cost of illness. In their study, the results revealed that malaria resulted into the reduction in supply of labour days by agrarian households.

# CHAPTER FOUR

# METHODOLOGY

## 4.1 Introduction

Chapter three presents the methodology used in the study, with section 4.2 providing the modeling framework and econometric specification. Section 4.3 gives a description of the variables used in the study and the justification of their inclusion, and section 4.4 explains the sources and type of data used in the study. Section 4.5 presents the diagonistic test.

## 4.2 Modeling Framework and Econometric Specification

### 4.2.1 Malaria and agricultural labour supply

Labour supply is modeled as a two step decision. The first thing is to look at the decision to work. When an individual decides to work, the next issue is on how many hours to supply. Participation in agriculture work is modeled as a decision variable whereas labour supply is modelled as the quantity of the number of work hours (Maglad, 1998). Those individuals who choose to supply labour have observed number of work hours.

In 1979 Heckman came up with a two staged estimation to address the problem of the zero observation. Heckman's first stage is a probit estimation, which usually estimates the probability of those that have decided to participate. The second stage estimates the actual level of participation or the actual supply. The Heckman model assumes that the

Factors that affect the decision to participate are not the same with those that determine the actual supply or level of participation.

As already explained the model has two stages

The participation decision:

$$d_i^* = x_{1i}\beta_1 + u_i; \qquad u_i \sim N(0,1) \dots \dots \dots \dots \dots \dots \dots \dots \dots . (4.1)$$

$$d_i = \begin{cases} 1 \; if \; d_i^* > 0 \\ 0 \; otherwise \end{cases} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . (4.2)$$

The level of participation decision:

$$h_i^* = x_{2i}\beta_2 + v_i; \qquad v_i \sim N(0, \sigma^2) \dots \dots \dots \dots \dots \dots \dots \dots \dots \; (4.3)$$

$$h_i = \begin{cases} h_i^* if \; d_i^* = 1 \\ 0 \; if \; d_i = 0 \end{cases} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . (4.4)$$

$x_{1i}$ and $x_{2i}$ are vectors of explanatory variables in two stages of decision. The model assumes that the independent variables which influence the two stages are different. $\beta_1$ and $\beta_2$ are corresponding vectors of parameters; $d_i^*$ is a latent variable that denotes binary censoring; $d_i$ is the observed value representing the participation decision. When the number of reported hours is positive, then the number of observed hours of work equals with the unobserved latent value; otherwise it takes the value zero. $u_i \; and \; v_i$ are the error terms and are assumed to be independently distributed. The assumption means that the decisions made in the two stages are not related.

Estimation labour supply in this study using OLS would be biased and inconsistent if the selection problem arises in the data, then the error term from such a regression in such samples used to estimate parameters of labour supply will not be white noise. Therefore, use of techniques such as the Heckman model to estimate jointly the parameters of probabilistic participation equation and labour supply equation must be adopted. The Heckman model has the advantage of computing a hazard variable also known as the Inverse Mills Ratio (IMR) and testing and controlling for selection bias in the second stage of the estimation of parameters.

In this case the number of observed hours, $h_i$, which is the dependent variable is denoted LS. This refers to the number of labour hours supplied by individuals who were involved in agriculture per week. The labour supply model is estimated using cross sectional data for ages between 15 and 85 adopting (Blundell and Meghir, 1986).

The explanatory variables of interest are: *mal_illness, edu, residence, age, age2, hhsize, gender and marital status. Mal_illness* denotes whether the individual had malaria or not, and *edu*, the education attainment by the individual, measured by the number of schooling years by an individual. *Residence* is a dummy variable where it takes 1 if rural and 0 otherwise. Age is denoted by *age*, while *age2* represents the square of the age variable used to capture non-linear effect of age. Household size is denoted as *hhsize*; this refers to the number of members in a household. *Gender* is a dummy variable which takes 1 if an individual is a female and 0 otherwise. *Marital status* is also a dummy variable which take 1 if an individual is married and 0 otherwise and the error term in the model is being represented by $U_i$.

### 4.2.3 Inclusion and exclusion of variables in the selection and outcome equation

Having all the variables in the selection model and outcome model has some implications; one of which is that, one would get estimates which are imprecise in terms of the outcome equation. Further, if the variation between the dependent variable and the independent variable is little in the selection equation then it is hard to get estimates which are precise in the outcome equation as there will be high multicolinearity and large standard errors. Due to the issues of identification, it is advisable to at least have one independent variable that appears in the selection equation but does not appear in the outcome equation. That is to say, we need a variable that affects selection, but does not affect the outcome (Sartori, 2003). It is from this realisation that some variables explained below are not in the supply model but rather are included in the section equation. The variables in the participation are malaria illness, age, the square of age, education, married, female, household size and residence. On the other hand the outcome equation includes variables such as malaria illness, age, the square of age, education, female, and residence.

### 4.3 Variables Used in Study

| **Dependent variable** | |
|---|---|
| Agriculture household Labour supply(ls2) | number of hours worked in household agriculture per week by an individual |
| **Explanatory Variables** | |
| malaria_illness | a dummy variable which takes 1 if the individual has malaria, 0 otherwise. |
| Age | Age is the number of years that a person has lived or existed. |
| Age2 | represents the square of age used to capture non-linear effect of age. |
| Married | a dummy variable, 1 if an individual is married and 0 if single. |
| Education | this is the level of schooling in years. |
| Rural | a dummy variable which take 1 if the individual reside in the rural area and 0 urban. |
| Household size | number of family members in a household. |
| Female | takes the value of 1 if an individual is female and 0 if male. |

Illness, specifically, malaria illness is the main explanatory variable of interest in this study. It is included in the model as it is expected to affect the number of hours an individual works which affects the time allocation of an individual and the tradeoff between leisure and work (Becker, 1962; Grossman, 1972, Leibenstein, 1957; Schultz, 1961).

Education is included in the model because it is a human capital form which influences wages and hence labour supply (Mincer, 1958).

Marital status is included in the model to capture familial environment (Cahuc & Zylberberg, 2004). The supply of labour by those who are married and unmarried tends to differ. For example, research has shown that married men are more likely to work than married women (Ahituv and Lerman, 2005).

Residence is included in the labour supply model due to differences which may exist in the labour market such as job opportunities. Thus opportunities may differ in rural and urban areas (Bridges & Lawson, 2008; Mugume & Canagarajah, 2005).

Household size is included in the model because it is expected that the members of a family with a greater number of children will supply more labour than those with a few household size.

Age is included in the model because an individual's labour supply differs with age. Those who are young spend most of their time in school unlike the middle aged and older, who may participate in the labour force and the later retire. Furthermore, age measured in years is a proxy for work experience (Mincer, 1958). Experience and skills are acquired by individuals with passage of time; this leads to increased productivity. In jobs where physical effort is needed, however, productivity tends to decline with age (Becker, 1962; Mincer, 1958).

## 4.4 Source and Type of Data

The study used data from the third integrated household survey (IHS-3), which was conducted from March 2010 to March 2011 by the National Statistical Office of Malawi. The IHS-3 is the third survey conducted under the National Statistics Office integrated household survey program. These surveys are designed to provide information on the various aspects of the socio-economic status of households in Malawi. The survey collected information from households pertaining to demographic characteristics, education, health, household enterprises, labour force, welfare, poverty, credit and loans just to mention a few. The IHS-3 collected information from 12,271 households statistically designed to be representative at both national, district, urban and rural level enabling the provision of reliable estimates for those levels.

The availability of aspects of health, demographic characteristics and labour force information in the IHS-3 makes it an appropriate source of data in relation to this study. The IHS-3 also contains variables of interest for this study. Furthermore, considering that the IHS-3 conducted research in the whole Malawi, the data is suitable for this study. This study observed the characteristics of 24,147 individuals. These individuals are only those that are involved in agriculture.

## 4.5 Diagnostic Test

### 4.5.1 Multicollinearity

Undertaking a multicollinearity test among all the explanatory variables in the regression is necessary before carrying out regressions. There is need to avoid excessive multicollinearity. One possible way to detect multicollinearity is by a pairwise correlation.

### 4.5.2 Heteroskedasticity

Due to the fact that in cross-sectional data we observe values for households which have different characteristics, presence of heteroskedasticity is expected which may introduce variability. Such variability may be captured by the error term in the regression. To control for heteroskedasticity the study will use bootstrap standard errors. According to Cribari-Neto and Zarkos (1999) the bootstrap method can be used to obtain variance of linear parameter under non-normality.

### 4.5.3 Wald test

Through the use of the Wald test we can test the significance of a particular explanatory variable in a Heckman model. The Wald test is one of the ways of testing whether parameters associated with a group of explanatory variables are equal to zero. Due to non-linearity of the model F-Test is not applicable. Log Likelihood ratio test or the Wald test may be used in undertaking a parameter restriction test as these tests are asymptotic in nature and the parameter are nonlinear in the model. We will, therefore, conclude whether there is loss or not in the log likelihood. If the p-value is less than 0.05, then we may conclude that the model is well specified and that the parameters are jointly significant at 5% significance level.

# CHAPTER FIVE

# RESULTS AND INTERPRETATIONS

## 5.1 Introduction

The estimated results using a Heckman model provide findings that explain the probability of participation and hours of work among individuals in the sample. The next section provides the descriptive results followed by a presentation of the Heckman model results in section 5.3.

## 5.2 Descriptive Statistics

**Table 1: Descriptive Statistics**

| Variable | Observations | Mean | Std.Dev |
|---|---|---|---|
| Labour supply | 24147 | 8.1 | 11.92 |
| Household size | 24147 | 5.41 | 2.4 |
| Age | 24147 | 30.94 | 14.02 |
| Square of age | 24147 | 1154.01 | 1139.72 |
| Education | 24147 | 7.34 | 3.47 |
| Malaria_illness | 24147 | 0.06 | 0.24 |
| Rural | 24147 | 0.78 | 0.42 |
| Married | 24147 | 0.6 | 0.49 |
| Female | 24147 | 0.48 | 0.5 |

The statistics reveal that the mean agricultural labour supply hours are 8 per week and the maximum is 84. The results reveal that the mean household size is around 5. The average age of individuals in the sample is 30 years and their mean years of schooling are 7.

Among the farming population considered in this study almost 77 percent live in the rural areas and 23% is from the urban areas. In terms of gender, more males than females participate in household agriculture in respect to this sample, thus 53% and 47% respectively.

### 5.3 Heckman Estimation Results

This section presents results of Heckman Model equation. Correlation analysis was done to detect possible multicollinearity among explanatory variables in the system of equation. Based on pair-wise t-tests, results reveal absence of serious multicollinearity among covariates as shown by the correlation matrix in the appendix.

### 5.3.1 Household agricultural labour supply regression results

**Table 2:Household agriculture labour supply regression**

| | |
|---|---|
| **Agricultural labour supply model** | |
| Malaria status | 0.051 |
| | (0.0489) |
| Sex | -0.097*** |
| | (0.024) |
| Residence | -1.250*** |
| | (0.246) |
| Age | 0.003 |
| | (0.006) |
| Age squared | -0.000 |
| | (0.000) |
| Education | 0.005 |
| | (0.007) |
| Lambda | 0.234*** |
| | (-1.339) |
| Constant | 4.377*** |
| | (0.441) |
| **Decision to participate model** | |
| Malaria status | -0.099** |
| | (0.041) |
| Sex | 0.020 |
| | (0.020) |
| Residence | 1.425*** |
| | (0.031) |
| Age | 0.030*** |
| | (0.003) |
| Age squared | -0.000*** |
| | (0.000) |
| Education | -0.043*** |
| | (0.003) |
| Household size | -0.008** |
| | (0.004) |
| Marital status | 0.157*** |
| | (0.020) |
| Constant | -1.434*** |
| | (0.076) |

Standard errors in parentheses
$^{*}p< 0.10$, $^{**}p< 0.05$, $^{***}p< 0.01$

### 5.3.2 Interpretation of results

Detailed results of the regression are shown in the appendix table 3. In reference to table 6 in the appendix the Wald Test is highly significant meaning that all parameters are jointly significant in the labour supply regression in the bi-variate regression.

From table 3 in the appendix, the correlation coefficient of the error terms, as shown, is not zero ($\rho$= -0.92) meaning that the error term in the decision to participate in the farm labour market is negatively associated with the decision to supply specified amount of working time by farmers.

Thirdly, the non-selection hazard coefficient (inverse mills ratio) is highly significantly different from zero ($\lambda$ =1.33, p-value 0.000). Therefore, the significance of inverse mills ratio means that there is selection bias in the sample. We can, therefore, conclude that it was equally useful to estimate structural labour supply equation using Heckman model because the methodology can control for selection bias.

Specific objectives of this study were twofold. First was to examine if malaria has an impact on an individual's decision to participate in agriculture labour supply and second was to examine if malaria has an impact on the number of labour hours supplied in agriculture.

As previously stated the heckman model has two equations. The first (decision to participate model) will help us achieve the first specific objective. While the second equation(agriculture labour supply) will help us achieve the second objective.

First results on the decision to participate will be explained followed by the agriculture labour supply.

### 5.3.3 Decision to participate in agricultural labour supply

First with respect to the main variable of interest which is malaria, the results show that it is significant at 1% and has the expected negative sign aprior. This means individuals who suffer from malaria are less likely to participate in household agriculture labour supply compared to those who are not suffering from malaria. In this case it really shows that malaria negatively affects an individual's decision to participate in agriculture labour supply.

Rural has an expected positive sign and statistically significant at 1%. This implies that individuals who are in the rural areas are more likely to participate in household Agriculture than those in the urban areas. This is true in Malawi as most of household agriculture is done in rural areas unlike in urban areas.

Age has a positive sign as expected and significant at 1%, that is to say as age increases the probability to participate in household agriculture also increases. On the other hand, age2 has a negative sign aprior which is expected and is significant at 1%. It may be worthwhile to argue that the second degree polynomial of age has a nonlinear effect on an individual’s decision to participate in household agriculture which means at younger age an individual may be eager to participate in household agriculture because they are energetic. The older an individual grows, however, the less willing they are to work in household agricultural activities.

Education has a negative expected sign and statistically significant at 1%. That is to say, as one’s education levels increase the probability to engage in household agriculture decreases. This is so as the individual has some better work opportunities which he/ she can participate in other than household agriculture.

Household size has a negative sign and statistically significant at 1%; that is to say, as a household increases by a member, the probability to participating in household agriculture by other members in the household decreases. The coefficient of female has a positive sign and statistically insignificant at all levels of significance.

Marriage has a positive sign and significant at 1%. The probability of participating in household agriculture is great for those who are married than those individuals who are single. Mathebula (2015) also found that the probability of participating in household agriculture was positive and significant for individuals that were married. This can be attributed to married household members devoting more work days to farming to provide household food needs (Tijan et al., 2010).

### 5.3.4 Household agriculture labour supply

The results reveals that malaria, which is the main variable of interest, is insignificant in explaining the number of hours which an individual supplies in household agriculture. This means that malaria does not affect the number of hours which an individual supplies to household agriculture.

Rural has a negative sign and statistically significant as 1%. This implies that the number of hours supplied in household agriculture is less for those in rural areas than those in urbans. This result reveals some characteristics which are hidden in agriculture labour markets that they are white collar jobs in the urban area where individuals may work more hours than in the rural labour markets.

Female has a negative sign and statistically significant at 1%. That is to say that females supply less household agriculture labour hours than males. This is true as females may have to do other household chores. The findings are consistent with those by Abimbola (2007) who did a study in sub-Saharan Africa. His results revealed that being male increases the work hours in agriculture labour supply by 4.46 hours a week.

The present study reveales that age of an individual has no significant impact of agriculture labour supply. The finding contradicts with the findings by Abimbola who found that an increase in the age of an individual resulted in a 0.040 increase in the number of hours worked per week.

Education of an individual is statistically insignificant at all significance levels. This result contradicts with theory. According to the Human Capital theory it is expected that as more investiment is made in education the more an individual is expected to supply labour. The results in this study can be supported by the fact that indiviuduals who increase their years of schooling may seek for job opportunities which pay them some wage unlike supplying their labour in household agriculture. The incentives which may arise in other jobs may be greater than supplying agricultural household labour hours.

From the results in table 2, it shows that malaria is only significant in determining the decision of an individual to participate in agriculture labour supply; on the other, it is insignificant in determining number of labour hours supplied in household agriculture. This implies that it is the intensity of malaria that affects agriculture labour supply.

# CHAPTER SIX

# CONCLUSION AND POLICY RECOMMENDATIONS

## 6.1 Introduction

This chapter concludes the study by presenting the summary of findings in section 6.2, Policy recommendations in section 6.3, limitations of the study and further areas of research are summarized in section 6.4.

## 6.2 Conclusion

The study set out to assess the impact of malaria on household agriculture labour supply in Malawi. Other objectives included examining the effects of malaria on agricultural labour participation decision and further examined how malaria affects the number of hours individuals supply in agriculture. The main variable of interest was malaria. Other independent variables included age, education, household size, residence, marital status, education and gender.

Based on the results from the first stage of participation, the findings reveal that participation in agriculture labour supply is greatly determined by individual and demographic factors such as age, education, marital status, household size and residence. In respect to the main variable of interest, which is malaria, it was found that an individual suffering from malaria is likely to reduce the probability to participate in household agriculture. On the other hand, once an individual chooses to participate, the number of hours the individual supplies are not significantly affected by malaria illness. This implies that it is the intensity of malaria that affects agriculture labour supply.

### 6.3 Policy Recommendations

As revealed by the results in respect to the main variable of interest, it shows that malaria affects the decision of an individual's participation in household agriculture negatively. The effects of malaria illness on agricultural labour participation could be reduced depending on the health and agricultural systems to the individuals who are affected. In order for policy makers to make decisions which are informed, they need evidence which is based on scientific research which this study provides. Strategies to alleviate the burden of malaria particularly on the poorest households, which are least likely to afford the necessary expenditures, need to be joined with proper communication and behavior change activities both to reduce the costs of malaria-related commodities and to support appropriate use of those commodities.

### 6.4 Limitations and area of further study

The major limitation for the study is that it uses secondary data from the IHS-3, which was collected by the National Statistics Office, and was designed to provide and update information on various aspects of welfare and socio-economic status of the population of Malawi and not specifically designed for the present study hence little data was collected. The data is based on integrated survey and most variables may have potential measurement errors in estimating female labour force participation decision. This is a common problem in labour market research. Such limitations can be addressed if primary data is collected by the researcher. The study is not an end to itself; others can also assess how other diseases like HIV/AIDS, TB and others affect labour supply, wages, labour productivity and other labour market outcomes.

# REFERENCES

Abimbola, T. (2007). Malaria, labour supply, and schooling in Sub-Sahara Africa. Graduate thesis and dissertations, University of South Florida. http://scholarcommons.usf.edu/etd/588.

ADB. (2015). *Transforming Africa's Agriculture to improve compititiveness.* Africa Development Bank.

Ahituv, A., & Lerman, R. (2005, July). How do marital status, wage rates and work commitment interact?, IZA Discussion Papers, No.1688

Ajani, Y., & Ashagidigbi, M. (2008, September). Effects of malaria on rural households' farm income in Oyo state,Nigeria. *African Journal of Biomedical Research, 11*(3), 259-265.

Alaba, A., & Alaba, O. (2009). Malaria in rural Nigeria: Implication for the millennium development goal. *Afr. Dev.Rev., 21*(1), 73-85.

Asenso-Okyere, W.K., & Dzator, J.A. (1997). Household cost of seeking malaria care. A retrospective study of two districts in Ghana. Social Science and Medicine, 45 (5), 659-667.

Audibert, M. (1986). Agricultural non-wage production and health status: A case study in the tropica environment. *Journal of Development Economics, 24*, 275-291.

Babalola, D., Awoyemi, T., & Awoyinka, Y. (2009). Effects of malaria on rural farming household labour supply: the case of Ikenne Local Government, Ogun State, Nigeria. *Journal ofLife and Physical Science, 3*(1), 19-24.

Becker, G. (1962). Investment in Human Capital: A Theoretical Analysis. *The Journal of Political Economy 70*, 9-49.

Benitez, H.S. (1998). The Neoclassical labor supply model: Inter-temporal and life cycle models. Lecture notes.

Blundell, R. and Meghir C, (1986) Selection Criteria for a Microeconometric Model of Labour Supply, *Journal of Applied Econometrics*, *1*(1), 55-80.

Bosworth, D., Dawkins P, & Stromback, T. (1996). The Economics of the Labour Market, England: Longman.

Bridges, S., & Lawson, D. (2008). A Gender-based Investigation into the Determinants of Labour Market Outcomes: Evidence from Uganda. *Journal of African Economies, 18,* 461–495.

Cahuc, P., & Zylberberg, A. (2004). Labour Economics.Cambridge: MIT Press.

Cai, L., & Kalb, G.(2004). *Health status and labour force participation: Evidence from the HILDA Data.* Melbourne institute working paper No.4/04.

CIA.(2017). World factbook.http://www.cia.gov/library/publication/the-world-factbook.

Cropper M.L., Haile, M.A., Poulos, C., Whittington, D. (1999). The Value of Preventing Malaria in Tembeien, Ethiopia, Working Paper. Washington, DC: The World Bank.

Daly, M., & Regev, T.(2007). Labour force participation and the prospects for U.S growth. Federal Reserve Bank of San Francisco, economic Letter. 2007-33.

(November 2). http://www.frbsf.org/publication/economics/letter/2007/el2007-33.html.

Ettling, M., McFarland, D. A., Schultz, L.J. &Chitsulo, L. (1994).Economic impact of malaria in Malawian Households.*Trop. Med. Parasitol*., 45: 74-79.

FAO.(2009).*The special challenge for Sub-Saharan Africa. How to feed the world in 2050,* Rome: FAO.

Girardin, O., Daoa, D., Koudou, B.G., Essé, C., Cissé, G., Yao, T., N'Goran, E.K., Tschan-nen, A.B., Bordmannd, G., Lehmannc, B., Nsabimana, C., Keiser, J., Killeen, G.F.,Singer, 30 B.H., Tanner, M., Utzinger, J., 2004. Opportunities and limiting factors of intensive vegetable farming in malaria endemic Côte d'Ivoire. Acta Tropica, 89, 109–123.

GoM. (2011). *Malawi health strategic plan 2011-2016.* Ministry of Health. Lilongwe: GoM.

Grossman. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, 80, 223-255.

Hong, S.C. (2007). The burden of early exposure to malaria in the United States,1850 – 1860: Malnutrition and immune disorder. *Journal of Economic History, 67(4), 1001-1035.*

Khangamwa, L. (2010). The cost of illness on agriculture production of rural households:The case of Teuka village, Zomba District. Zomba, Malawi, *(Unpublished)* MA Economics Research paper, University of Malawi.

Leibenstein, H. (1957). The Theory of Underemployment in Backward Economies. *Journal of Political Economy*, 65, 91-103.

Maglad, (1998).Female labour supply in Sudan, *AERC Special Paper 30*, Nairobi, Kenya: African Economic Research Consortium.

Mathebula, H. (2015). Determinants of household participation in agricultural production in Shatale region of the Bushbuckridge local municiparity.*Thesis:* University of Limpopo.

Meyer, B., & Rosenbaum, D. (2001). Welfare, the earned income tax credit and the labour supply of single mothers. *Quarterly Journal of Economics*, *116* (3), 1063-1114.

Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of Political Economy, 66*(4), 281-302.

Mugume, A., & Canagarajah, S. (2005). Employment, labour markets, and Uganda's structural change. Washingnton, DC:World Bank. Mimeo.

Mwabu, G., & Fosu, A. (2007). Understanding Malaria and Poverty in Africa: A Framework', In Fosu A. and Mwabu G. (eds), Malaria and Poverty in Africa, AERC Collaborative Research on Malaria and Poverty in Africa, University of Nairobi Press, Chapter 2, 11-41.

National Malaria Control Programme (NMCP) [Malawi] and ICF International. 2014. *Malawi Malaria Indicator Survey (MIS) 2014.* Lilongwe, Malawi, and Rockville, Maryland, USA: NMCP and ICF International.

NSO (2012) Integrated Household Survey Report (2010—11). Zomba: Government Printing Press.

NSO (2014). *Malawi labour force survey 2013.* Zomba: Government Printing Press.

NSO & ORC Macro (2015), Malawi Demographic and Household Survey Report (2015), Macro. Zomba: National Statistics Office.

Nur, E. (1993). The impact of malaria on labour use and efficiency in Sudan. *Journal of Social Science and Medicine, 37*(9), 1115-1119.

Okyere, K., Aragon, C., Thangata, P., Andam, K., & Mekonnen, D. (2010). HIV and AIDS and farm labour productivity: A review of recent evidence in Africa. *Journal of Development and Agricultural Economics, 2*(12), 406-415.

Okyere, K., Chiang, C., Thangata, P., Andam, K., & Mekonnen, D. (2011). Understanding the interaction between farm labour productivity, and health and nutrition: A survey of the evidence. *Journal of Development and Agricultural Economics, 3*(3), 80-90.

Olaniyan, D., & Okemakinde, T. (2008). Human capital theory: Implication for educational development. *Pakitsan Journal of Social Science, 5*(5), 479-483.

Oluwatayo, I. (2014). Socioeconomic burden of malaria of rice farmers in rural southwest, Nigeria. *Mediterranean Journal of Social Science, 5*(15), 175-181.

Picard, J., & Mills, A. (1992). The effect of malaria on work time. *Journal of Tropical Medicine and Hygiene,95,* 382–389.

PMI. (2017). *Malaria Operational Plan FY*. USAID, Department of health and Human Services. USAID.

Ravallion, M., Chen, S., & Sangraula, P. (2007). New evidence on the urbanisation of global poverty. *Policy Research Working Paper, 4199*. Washington,D.C.:World Bank.

Sandifolo, S. (2010). Economic burden of malaria. *(Unpublished)* MA Economics Research paper, University of Malawi.

Schultz, T. W. (1961). Investment in human capital. *American Economic Review*, 51(1),1-17

Sartori, A. (2003). An Estimator for some Binary-Outcome selection models without exclusion restriction. *Political Analysis, 11*, 111-138.

Tijan, B. A., Benisheik, K., Muatapha, A., & Danaladima, W. (2010). Analysis of factors influencing labour supplied to non-farm sub-sector by households in mubi North Local Government area of Adamawa state, Nigeria. *Nigerian Journal of Basic and Applied Science*, 18(1), 35-43.

Todaro, M., & Smith, S. (2012). *Economic development* (11 ed.). (S. Yagan, Ed.) New York: Addison-Wesley Longman.

Tompa, E.(2002). The impact of health on productivity: Empirical evidence and policy implications. *The Review of Economic Performance and Social Progress, 2002*, 181:202

Wang'Ombe, J., & Mwabu, G. (1993). Agricultural land use patterns and malaria conditions in Kenya. *Social Science and Medicine*, *37*(9), 1121-1130.

WHO. (2016). *World health statistics 2016: monitoring health for the SDGs, sustainable development goals.* 20 Avenue Appia, 1211 Geneva 27, Switzerland: WHO Press.

WHO. (2017). *Country corperation startegy at a glance.* Geneva: World Health Organisation.

Wiggins, S. and K. Sharda (2013). *Looking back, peering forward: what has been learned from the food-price spike of 2007– 2008?* London: Overseas Development Institute.

World Bank (2007). *World Development Report 2008: Agriculture for development.* Washington, D.C: World Bank.

## APPENDICES

**Table 3: Household agricultural labour supply regression results**

| | | | | |
|---|---|---|---|---|
| | | | Number of obs | 24147 |
| | | | Censored obs | 11819 |
| | | | Uncensored obs | 12328 |
| | | | Wald chi2(6) | 181.87 |
| | | | Prob> chi2 | 0.0000 |
| Variable | Coef | Bootstr. Std err. | z | p>z |
| **ls2** | | | | |
| Malaria_illness | 0.0507 | 0.0476 | 1.06 | 0.287 |
| Age | 0.0025 | 0.0057 | -0.44 | 0.662 |
| age2 | -0.00004 | 0.00006 | -0.67 | 0.504 |
| Rural | -1.2497 | 0.2458 | -5.08 | 0.000 |
| female | - 0.0969 | 0.0236 | -4.10 | 0.000 |
| Edu | 0.0046 | 0.0065 | 0.71 | 0.479 |
| Cons | 4.3767 | 0.4406 | 9.93 | 0.000 |
| **select** | | | | |
| Malaria_illness | -.0992 | .0352 | -2.81 | 0.005 |
| Age | .0297 | .0028 | 10.26 | 0.000 |
| age2 | -.0002 | .00003 | -7.83 | 0.000 |
| hhsize | -.0083 | .0035 | -2.33 | 0.020 |
| Edu | -.0434 | .0025 | -16.92 | 0.000 |
| female | .0202 | .0202 | 1.00 | 0.319 |
| married | .1572 | .0204 | 7.69 | 0.000 |
| Rural | 1.4254 | .0230 | 61.96 | 0.000 |
| Const | -1.4343 | .0620 | -23.11 | 0.000 |
| *Lambda* | *-1.3398* | *.2345* | *-5.71* | *0.000* |
| *Rho* | *-0.9271* | | | |
| *Sigma* | *1.4451* | | | |

**Table 4: Pairwise correlation t-test matrix for explanatory variables (Participation equation)**

| | Malaria_ illness | female | rural | age | Age2 | edu | hhsize | married |
|---|---|---|---|---|---|---|---|---|
| Malaria_illness | 1.000 | | | | | | | |
| female | -0.053 | 1.000 | | | | | | |
| Rural | -0.233 | 0.234 | 1.000 | | | | | |
| Age | -0.020 | -0.035 | 0.105 | 1.000 | | | | |
| Age2 | 0.011 | 0.015 | -0.049 | -0.978 | 1.000 | | | |
| Edu | -0.053 | 0.222 | 0.389 | -0.092 | 0.1184 | 1.000 | | |
| hhsize | 0.186 | 0.079 | 0.006 | 0.235 | -0.257 | 0.137 | 1.000 | |
| married | 0.129 | -0.100 | -0.055 | -0.507 | 0.468 | 0.046 | -0.105 | 1.000 |

**Table 5: Pairwise correlation t-test matrix for explanatory variables (Hours equation)**

| | Malaria_illness | female | rural | age | Age2 | edu |
|---|---|---|---|---|---|---|
| Malaria_illness | 1.000 | | | | | |
| Female | 0.012 | 1.000 | | | | |
| Rural | -0.402 | -0.024 | 1.000 | | | |
| Age | -0.217 | -0.059 | 0.754 | 1.000 | | |
| Age2 | 0.187 | 0.045 | -0.679 | -0.988 | 1.000 | |
| Edu | 0.367 | 0.091 | -0.796 | -0.706 | 0.656 | 1.000 |

**Table 6**: The Wald test

(1) [ls2] malaria illness = 0

(2) [ls2] female = 0

(3) [ls2] rural = 0

(4) [ls2] age = 0

(5) [ls2] age2 = 0

(6) [ls2] edu = 0

chi2 (6) = 109.93

Prob> chi2 = 0.0000