The Economic Impact of Malaria: A Focus on Africa

ECON 4990, Senior Seminar

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I. Introduction

The word 'malaria' is perhaps mentioned almost as frequently as a family member's name in households in African countries. Unfortunately it is more than just a word. Malaria is a disease which is caused by protozoan parasites of the genus plasmodium and is widespread in tropical and subtropical regions of the world, a disproportional share being in the continent of Africa. Malaria parasites are transmitted by the female anopheles mosquito to its victims, who become ill for days and in the severe cases, may die of the illness. It is one of the major health problems especially in regions where it is prevalent. According to the World Health Organization (WHO) and the World Bank (WB), malaria is a disease that is both preventable and curable but yet it kills about 2.7 million people around the world each year. Approximately 90 percent of these deaths occur in sub-Saharan Africa[1], where a child's life is lost to malaria every 30 seconds. Almost everyone that lives in sub-Saharan Africa contracts the disease at least once a year (Sachs 2005, p.197). Other than the impact of the disease on the health of people in sub-Saharan Africa, malaria also poses a threat to the economic growth and standard of living of most countries on the continent. It is estimated that malaria costs Africa $12 billion yearly and between 1965 and 1990, malarial nations worldwide have had an annual economic growth of less than one-fifth of the annual economic growth of malaria-free nations in the world (World Bank). The economic growth and standard of living is impaired by malaria as it causes an increased cost

[1] Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Angola, Comoros, Democratic Republic of Congo, Republic of Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

of healthcare, working days and days at school lost due to malaria, and loss of investment and tourism in some countries.

It is perhaps undeniable that malaria (parasite) chooses where it thrives due to geographic and climatic factors. However, with underlying evidence showing that the richest African countries are not in the high-risk malaria zones (Gallup and Sachs, 2001) and the poorest ones are, by the use of macroeconomic variables and Ordinary Least Square (OLS) regression, this paper intends to show more evidence that malaria has a significant economic effect on the standard of living of these countries. This paper is more interested in a causal relationship between malaria and poverty with the former as the cause and the latter as the effect although studies such as Gallup and Sachs (2001) that would be discussed in more detail in the literature review section, show evidence of causal relationship going in both directions. It is important to note that poverty and standard of living will be used interchangeably in this paper. In essence, the data collected and the model introduced in this paper intends to provide more evidence to answer the question- ‘Does malaria have a significant effect on the standard of living of the countries in sub-Saharan Africa?’

The following section, section II will provide a review of the literature relating to the economic relationship between malaria and poverty. In section III an empirical model will be introduced and the variables and data used will be explained in detail. Section IV presents the results obtained from running the regression equation introduced in section III, and will provide analysis of the results. The last section, Section V concludes the paper and briefly addresses policy initiatives under consideration by governments and organizations towards the control of malaria.

II. Literature Review

Several studies have been done on the relationship between malaria and poverty. It is important to note that most if not all, highlight sub-Saharan Africa as bearing a disproportionate amount of the severe cases. Gallup and Sachs (2001) argue that malaria and poverty are connected. Malaney, Spielman and Sachs (2004) pose an interesting question as to whether Africa would still be poor if freed of malaria. These two papers present general views very similar to the purpose of this paper while there are others that would also be discussed that present specific aspects of the relationship between malaria and poverty.

The content of the study done by Gallup and Sachs (2001) is very closely related to the study done in this paper. In their paper, they address the question as to if the dramatic correlations they find between growth of income per capita and malarial countries mean that malaria causes poverty and low growth in three ways. First, they consider the correlation between malaria and income levels after controlling for other factors that are likely to affect the world distribution of income such as geography, history, and policy. Secondly, they discuss the determinants of malaria risks which they argue that unlike other diseases in poor countries caused by deficient living conditions such as diarrhea and tuberculosis, malaria is not primarily a consequence of poverty but rather largely determined by climate and ecology. Lastly, they explore the impact of malaria on subsequent economic growth thereby providing the most direct evidence of the importance of malaria as a cause of poverty. The first way they address the question as to if malaria causes poverty and low growth is of more importance to the content of this paper than the other two. The study uses an index of malaria prevalence derived from historical maps of the geographical extent of high malaria risk digitized from maps by Pampana and Russell and the WHO. It also uses as an index of malaria intensity, the fraction of the populations at risk of malaria multiplied by the fraction of cases of malaria that are falciparum malaria as most malaria mortality and severe morbidity is due to the malignant *Plasmodium falciparum* (one of the four malaria species). To encompass their belief that there exist strong patterns between geography and income levels around the world, they include geographic variables in their model. These geographic variables include a country's accessibility to the coast (measured by the share of population within 100 km of the coast), which they argue is an important indicator of success in foreign trade and integration into the global economy, and hence is related to high income levels. Other geographic measures Gallup and Sachs (2001) use are minimum distance to the core world markets like New York, Rotterdam and Tokyo, resource deposits proxied by the log of hydrocarbon reserves per person, and percentage of a country's land area in the geographical tropics. When the regression is run with the logarithm of the Gross Domestic Product (GDP) per capita as the dependent variable and the geographic variables and falciparum malaria index explained above as the independent variables, both in two different years 1950 and 1995, the coefficient on malaria is negative and significant (at 1% level) in both cases. When indicators for former colonies and socialist countries in the post-World War II era and trade openness in the 1965- 1990 period are added as more independent variables, the coefficient on malaria still remains negative and significant at the 1% level. They point out that geography, history and policy all have clear correlations with income levels but taking them into account does not alter pattern of lower incomes in malarial countries; thus, the association of malaria with poverty seems to be more than just a facade for other possible causes of low income.

In addition, Malaney, Spielman, and Sachs (2004) present an interesting economic methodology for evaluating the burden of malaria. They state that the standard method of calculating the Cost-of-Illness (COI) is COI= Private Medical Costs+ Non-Private Medical Costs+ Forgone Income+ Pain and Suffering. From a case study performed using COI analysis in some African countries, the studies indicated that a case of malaria in Africa cost $9.84 in 1987, of which $1.83 was direct and $8.01 was indirect due to forgone income as a result of malaria morbidity and mortality. An important point about the COI analyses that supports the claim of a relationship between malaria and poverty is that it shows the poor bear proportionately more of the cost as the figure represents a higher percentage of their income. The COI approach is also criticized for its ability to omit costs that are not easily estimated numerically and its general difficulty in assessment. Another approach – Willingness-to-Pay (WTP) is presented whereby through household surveys they try to determine the value a household places on trying to avoid the disease. Such an approach was also criticized under the context of 'existence' values and the kind of inaccurate answers such survey may produce. They also support the suggestion that causation runs in both directions between malaria and poverty and the effect of malaria on trade and vice versa. The study of this paper is more closely related to that of Malaney et al (2004) in the result which further supports the suspected causal relationship between malaria and poverty than in the approaches used. While their paper makes use of the COI and WTP approaches that involve medical costs and household surveys, this paper makes us of a very different model that involves macroeconomic variables.

Furthermore, Sachs, Mellinger and Gallup (2000) provide a convincing argument on the effect of physical geography on economic performance. Their study shows evidence which supports the argument that it is more than a coincidence that most of the countries with lower economic growth than the rest of the world have a high-risk of malaria. These same countries with lower economic growth happen to be in similar geographic areas that are different from the geographic areas where countries with higher economic growth are found. Together with the other results they found such as cost of trade and agricultural productivity and their effect on the economy, they mention that the prevalence of diseases such as malaria have a lasting foothold in certain geographic zones. (Sachs, Mellinger, Gallup, 2000)

On another hand, Laximinarayan (2004) focuses on the households. His study points out that government is yet to give adequate attention to reducing the incidence of malaria and blame the situation on poor understanding of the economic impact of the disease. It is mentioned that both the members who suffer from an episode of malaria and those that do not in households are adversely affected by malaria. The effect is neither always apparent nor measurable because of the long history of adaptive coexistence with the disease. The paper argues that even without being direct victims of the disease, households suffer because they have less access to various economic opportunities. Macroeconomists speculate that economic opportunities that are affected include foreign direct investment, tourism, and limitations on internal movement of the population. In agreement to the issue of ecology, the study done in Vietnam showed that an increase in government expenditure on malaria control and treatment lacked uniform effect in diverse places as a result of the difference in ecological characteristics of each place. In conclusion, Laxminarayan points out that without clear evidence that there will be improvement in household living standards by a measure greater than the cost of investing in malaria control, malaria may be unable to attract sustained commitment from policymakers to eradicate the disease. (Laxminarayan, 2004)

Finally, in a review of the evidence on the link between malaria and poverty, Worrall, Basu, and Hanson (2004) found mixed evidence on malaria incidence as some studies show a correlation between socio-economic status and malaria, and a few did not. They do, however, support that important socio-economic differentials exist in access to malaria interventions which increases the vulnerability of the poorest. They also criticize the different methods used to measure socio-economic status in different studies that have been done on the topic. (Worrall, Basu, Hanson, 2005). Savigny and Binka (2004) argue that monitoring the future impact of malaria burden in sub-Saharan Africa will require investment in information systems and their ability to monitor change of impact indications. They mention an important point that given the inadequate resources, in order to attain successful malaria eradication, strategies, plans and decisions of how to utilize these resources will need to be ‘smart’. On the other hand, Hanson (2004) discusses the role of public and private expenditures in malaria control using economic analysis to determine the optimal forms of malaria control policies.

III. Data and the Model

After careful analysis of the literature relating malaria to poverty, it seems appropriate to introduce the model. The empirical work done in most of the reviewed literature relating malaria to poverty is similar to that of this paper. However, one variable present in most studies that is omitted from this one is on geography. It seems logical that they would include geographical variables as most of the other studies have been done on the economic effect of malaria globally. This paper focuses on only countries in sub-Saharan Africa and follows an underlying assumption that the geographic differences are not as adverse between the countries within sub-Saharan Africa as they are between countries globally.

As a result of unavailability of data in some African countries, this paper uses data collected from forty-two countries[2] in the sub-Saharan African region. These forty-two countries

[2] Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Angola, Comoros, Democratic Republic of Congo, Republic of Congo, Cote d’Ivoire, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea-Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger,

may sometimes be referred to as observations. Unlike Gallup and Sachs (2001) that use the malaria index derived from malaria maps and falciparum prevalence as a malaria variable rather than the cases of malaria reported by the WHO because they feel the national reporting systems are systematically different between countries with high or low levels of malaria, this paper does use the cases of malaria reported by the WHO. Other than the fact that the data from WHO is more readily available, just as with the geography variables, there is an underlying assumption that if any, the systematic difference that exists in the national reporting systems within the forty-two countries does not significantly affect the model. However, the cases reported in these countries are for the most recent years reported and they fall between 1998 and 2003.

Before going into further details about the variables in the model, it is perhaps appropriate to now present the model. The model is as follows:

$$In(GDP\ per\ capita)_i = \beta_0 + \beta_1\ ln(Malaria\ Cases)_i + \beta_2\ ln(Physical\ Capital)_i + \beta_3(Labor\ Growth)_i + \beta_4\ (Trade\ Openness)_i + \beta_5\ ln(Corruption\ Index)_i + error\ term \quad \textbf{(1)}$$

The dependent variable in this model is the logarithm (log) of Gross Domestic Product (GDP) per capita, which is used as a measure of the standing of living in the various countries in this paper. It is taken from *The World Development Indicators 1999 CD-ROM* and is measured as GDP at market prices in constant 2000 US dollars divided by the population. Because of the differences in years of the malaria cases reported and in order to capture, if any, the effect of the malaria cases on standard of living, it seemed inappropriate to use the GDP per capita of just any given base year. Therefore, the GDP per capita for each observation was taken from the year that the malaria cases were reported for that particular observation. For example, the malaria cases reported in Nigeria is for the year 2003 and so the GDP per capita used for that observation was

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Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

the GDP per capita reported for 2003. This is done with the belief that occurrences of malaria in a given year, would affect the standard of living in that year. It may be argued and perhaps proven that malaria occurrences affect the standard of living in a given country for years after, but for the intent of this paper, the model is focusing on the effect in a given year. It could be referred to as a ‘short-term’ effect.

Other than the malaria variable, there are four other explanatory variables that are intended to represent variables that would usually explain economic growth as presented by Farr, Lord, and Wolfenbarger (2000). Although in their paper the variables are intended to explain economic growth, this paper assumes that because GDP per capita is also a macroeconomic variable, these variables may also be used to explain it. With the exception of the measure of trade openness and corruption index, the other variables are calculated using data from *The World Development Indicators 1999 CD-ROM* and are explained below.

The first of these explanatory variables is the fraction of income invested in physical capital. It is measured by gross domestic fixed investment as a percentage of GDP and is presented for each country for various years. In the regression, it is used in its logarithmic form. In order to capture an effect of this variable in the model and as observed in papers that use data from developing countries, the figures used in this model are an average of the annual figures given from 1999 to 2004. Farr et al (2000) employ the same averaging technique in their study stating that ‘it helps eliminate “noise” that is common in annual data’.

The second of the non-malaria variables is a measure of the rate of labor growth. It is proxied by taking the percentage changes in the total labor force for the various observations. To maintain conformity to the averaging of annual figures, the percentage change is calculated by using 1999 as the base year and 2004 as the current year. Between those years three countries have a negative labor growth rate. As a result, the variable on labor growth is not put in its logarithmic form as the logarithm of a negative number does not exist.

Another non-malaria variable is a measurement of trade openness. Trade openness here is proxied using net exports[3]. Data to calculate this measure is acquired from the Central Intelligence Agency (CIA) World Fact Book. The gross exports give the total US dollar amount of merchandise exports on a free on board (f.o.b.) basis and are calculated on an exchange rate basis rather than in purchasing power parity (PPP) terms. The gross imports give the total US dollar amount of merchandise imports on a cost, insurance, and freight (c.i.f.) or free on board (f.o.b.) basis and are calculated on an exchange rate basis rather than in purchasing power parity (PPP) terms. The two components- exports and imports are the given 2006 estimates. There was little surprise that the net exports for most of the observations were negative as it is observed that developing countries tend to import more goods than is exported. That however, is beyond the scope of this paper. As a result of the negative figures, again, the logarithm cannot be taken for reasons previously explained. It is therefore put in the model as is (some figures being negative, others positive). It is important to take note of this as when analyzing the results in the next section, the interpretation of the coefficients for the explanatory variables in the logarithmic form will be different than that which is not in the logarithmic form.

The last explanatory variable is a measure of economic freedom which is proxied using data that measures corruption perception index in 2006 in the various observations. The score relates to perceptions of the degree of corruption as seen by business people and country analysts and originally is given in a range of 0-10 with 10 being highly ‘clean’ and 0 being highly corrupt. Before being ran in the model presented in this paper, the figures were subtracted from 10 thereby switching the interpretation of the end points of the range. It thus became that 10

[3]Gross Exports – Gross Imports

indicated highly corrupt and 0 highly ‘clean’. The reason for doing this will be explained in more details in the next section.

IV. Results

After careful explanation of the data and the variables used in the model, the regression results will now be presented. The model was run using Ordinary Least Squares (OLS) regression analysis. Table (1) shows the regression results of the model equation (1) presented in section III.

Table 1. Regression Results (Dependent variable= log (GDP per capita))

Variable	Coefficient	t statistic
Constant	13.19852	6.175643
Log (Malaria Cases)	-0.124487*	-3.029237
Log (Physical Capital)	0.445680	1.404416
Labor Growth	-0.126183	-1.993900
Trade Openness	3.55E-11**	2.317939
Log (Corruption Index)	-3.375347*	-3.787602

*significant at the 0.01 level or better
**significant at the 0.05 level or better

Looking at the results, beginning with the malaria variable, the negative and statistically significant coefficient of the variable supports the suspected relationship between the malaria cases and GDP per capita. It is important to note that although earlier mentioned that the paper is interested in the causal relationship between malaria and standard of living with the cause being the former and the latter the effect, regression does not necessarily imply causation. Causality must be justified, or inferred, from the theory that underlies the observable fact that is tested empirically (Gujarati 2006, p. 134). Because the logarithm of malaria cases is run on the logarithm of GDP per capita, the coefficient on the logarithm of malaria cases gives a proportional change in GDP per capita given a proportional change in malaria cases (holding all other variables constant). Put in another way, it measures the partial elasticity of GDP per capita with respect to malaria cases (holding all other variables constant). The negative relationship therefore implies that in the forty-two observations included in the model, one percent increase in malaria cases will result to a 0.124487 percent decrease in GDP per capita holding other variables constant.

Although the purpose of this paper is to analyze the economic impact of malaria, and the other variables were added to prevent under-specification of the model, they each have results that are worth discussing. Firstly, the coefficient of the logarithm of physical capital is positive, although only slightly statistically significant. This shows a positive proportional relationship between investment on physical capital and GDP per capita. This relationship is expected as the observations are based on developing countries that have more allowance for capital development. The coefficient on the rate of labor growth variable is negative and statistically significant at the 10% level of confidence. Again, this is not surprising as it is expected that an increase in labor growth may indicate an increase in population thereby leading to a proportional decrease in GDP per capita. The coefficient on the trade openness variable is positive and statistically significant. This goes along with the Gallup and Sachs (2001) results that a positive relationship exists between GDP per capita and the openness to the economy. Put in another way, greater openness of the economy will result in increased economic growth. The measure of economic freedom variable which is the corruption index is also negative and statistically significant. This is expected as a large amount of empirical evidence now exists that show the impact of economic freedoms on economic growth and the standard of living, including that shown in the paper by Farr, Lord, and Wolfenbarger (2000). In section III, it had been mentioned that the corruption index data was put in a form whereby the higher the figure, the more the corruption. The original data acquired from the Transparency International organization indicated a higher figure meant less corruption. This resulted in a positive coefficient in the regression results that may create confusion at first glance. Thus the form was changed. So with the regression result presented, it is now clear to see a negative relationship occurring between corruption and GDP per capita while barely affecting the coefficients and the significance of the coefficients of the other variables .

Furthermore, the R^2 value of 0.63 indicates that the model explains approximately 63% of the variation in GDP per capita. Since the standard errors from the regression are not large, it is safe to assume that there is not a significant level of multicollinearity. To further support this assumption, there is also not a case of a large R^2 value with few significant *t* ratios in the results. As a result, the paper does not delve into trying to reduce multicollinearity as if it does exist, it more than likely would be in a relatively small degree. As the model uses cross sectional data rather than a time series data, there is little or no need to be concerned with autocorrelation.

IV. Conclusion

'Does malaria have a significant effect on the standard of living of the countries in sub-Saharan Africa?' This is the question asked in section I that this paper was interested in providing evidence to answer. After review of previous literature on the subject, a new model presented and its results analyzed, there is more evidence to support a possible answer to the question. From the regression results, there is a negative relationship between malaria cases and per capita GDP, which further adds to evidence that malaria has a significant effect on the standard of living of countries in sub-Saharan Africa. More evidence to support this argument may be gathered from the numerous empirical evidence that exist showing the negative relationship between malaria and GDP per capita, poverty, or standard of living and economic growth. A criticism of the model used in this paper is that the observations were only slightly large. In future, better research methods may be used to collect more data for the countries that were not included in the model for lack of data in order to increase the sample size. In addition, a panel data set, which uses data from each country over a period, may be more helpful in catching the effect of the malaria occurrences in these countries over time.

Suffice to say, the more evidence presented creates relevance to debates concerning governmental policy. In recent years more countries within and outside the sub-Saharan African region have started paying more attention to the prevalence of malaria. The majority of policies focus on malaria prevention more than on treatment. The commonly known efficient prevention tools are treated bed nets, indoor spraying of insecticides, and the use of dichlorodiphenyltrichloroethane (DDT). All three have proven effective and fairly inexpensive, although not to the poor victims of malaria in these sub-Saharan African countries. As a result, funding from national and international levels are required. Unfortunately, funding from these sources only started to come through recently. The most controversial of these treatments has been DDT. Although there is evidence as discussed by Bates and Lorenzo (2007) that the use of DDT eradicated malaria in Europe and U.S. in 1940s and 1950s without any known harm to humans, DDT was banned in 1972 as a result of pressure from environmentalists who argued that the chemical damaged the environment and posed a threat to human health. According to The Herald (2006), opponents of DDT argue that potential effects of indoor spraying include reproductive health, neurological effects, effect on breast milk and increased risk of breast cancer and the possibility of resistance of mosquitoes to DDT. Some African countries had previously banned DDT following pressure by western countries that feared the contamination of beef and vegetables exported from countries that used DDT. Fortunately, the WHO and the U.S. Agency for International Development (USAID) are now endorsing the use of DDT and other insecticides for indoor spraying and encouraging world powers to get more involved.

Organizations such as WHO argue that policies that support the lack of DDT will endanger more lives than the concentration of the chemical needed.

Finally, with continuing research and empirical studies done on this issue, more attention may be brought to policy makers so that in time sub-Saharan Africa may experience drastic reduction in malaria cases and subsequently reduction in loss of lives to malaria. In future research, more advanced research tools may have to be developed to better capture the effect of malaria on productivity, economic growth and standard of living. Ultimately, with more funding directed towards the prevention and elimination of malaria, keeping other factors constant, there should be an observable increase in the economic growth of sub-Saharan African countries and subsequently an improved standard of living.

Bibliography

Bate, R., De Lorenzo, M. 2007. Rwanda; Re-Consider DDT against malaria. *The New Times*, January 10. Accessed on April 23, 2007 from Galileo Virtual Library

Farr, K.W., Lord, R.A., Wolfenbarger, J.L. 2004. Additional evidence of the linkages between economic growth and the institutions of economic freedom, political rights, and civil liberties. (Working paper)

Gallup, J.L., Sachs, J.D. 2001. The Economic Burden of Malaria. *The American Journal of Tropical Medicine and Hygiene* 64(1,2): 85-96

Gujarati, N. 2006. Essentials of Econometrics, 3e. New York, NY: McGraw-Hill/Irwin

Hanson, K. 2004. Public and private roles in malaria control: the contributions of economic analysis. *The American Journal of Tropical Medicine and Hygiene* 71(2): 168-173.

Laxminarayan, R. 2004. Does reducing malaria improve household living standards? *Tropical Medicine and International Health* 9(2): 267-272.

Malaney, P., Spielman, A., Sachs J. 2004. The malaria gap. *The American Journal of Tropical Medicine and Hygiene* 71(2): 141-146.

Sachs, J.D., Mellinger, A.D., Gallup, J.L. 2000. The geography of poverty and wealth. Scientific America (16 September)

Sachs, J.D. 2005. *The End of Poverty*, 1ed. New York, NY: The Penguin Press.

Savigny, D., Binka, F. 2004. Monitoring future impact on malaria burden in sub-Saharan Africa. *The American Journal of Tropical Medicine and Hygiene* 71(2): 224-231.

The Herald. 2006. Malaria; DDT- Panacea to malaria scourge. *The Herald*, October 12. Accessed on January 26, 2007 from Galileo Virtual Library

The World Development Indicators (1999), International Bank for Reconstruction and Development, CD-Rom, Win*Stars version 4.2.

The World Factbook. www.cia.gov (Accessed March 15, 2007)

World Malaria Report 2005. www.rbm.who.int/wmr2005/ (Accessed February 18, 2007)

Worrall, E., Basu, S., Hanson, K. 2005. Is malaria a disease of poverty? A review of the literature. *Tropical Medicine and International Health* 10(10): 1047-1059.

www.who.org. (Accessed February 18, 2007) www.worldbank.org. (Accessed February 18, 2007)