KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

KUMASI

THE ECONOMIC IMPACT OF HEPATITIS B ON LABOUR AND CAPITAL IN THE TECHIMAN MUNICIPALITY

By

MOHAMMED SEIDU

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CERTIFICATION

I herein certify that, this work was carried out solely by Mohammed Seidu (PG3015509) in the department of Mathematics, Institute of Distance Learning, in partial fulfilment of the requirement for the award of Master of Science Degree in Industrial Mathematics.

..... 19/10/11
Mohammed Seidu Date
(Student)

....
Prof. I.K. Dontwi Date
(Supervisor)

DECLARATION

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

MOHAMMED SEIDU .... 19/10/11.....

Student Name (PG3015509) Signature Date

Certify by:

....

Supervisor's Name Signature Date

Certify by:

....

Head of Dept. Name Signature Date

DEDICATION

I dedicate this thesis to my loving mother who laid the solid foundation for my informal and formal education and all other family members for their prayers and support during the course of my studies.

Lastly, to my two boys Obed Akwasi Agyeman and Agyeman Yaw Kuffour.

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CHAPTER 1

1.0 INTRODUCTION

The chapter focuses on the background of the study, statement of the research problem objectives of the study, methodology, significance, research questions / hypothesis, research limitations and organization of study,

1.1BACKGROUND OF STUDY

Infectious diseases constitute a tenacious and a major public -health problem all over the world. Although some, such as smallpox and poliomyelitis, have been eradicated from nature or almost nipped out, many diseases persist with little or no hope of getting them under control. In addition, new diseases are emerging and old ones that were thought to be under control are gaining lost ground. According to the U.S Natural Institute of health (NIH; Bethesda, MD, USA), 16 new infectious diseases have been identified in the past two decades. NIH, (2008); Fauci et al (2005); five others have been identified as re-emerging. In fact, we are witnessing a slow realization among public – health experts and the general public that infectious diseases are back with vengeance.

The impact of these diseases is immense and is felt across the world. In addition to affecting the health of individuals directly, infectious diseases are also having an impact on whole societies, economies and political systems. In the developing world in particular, crucial sectors, for sustained development such as health and education have been a marketed loss of qualified personnel, most notably to human immunodeficiency virus (HIV)/ acquired immune deficiency Syndrome (AIDS), tuberculosis (TB), Hepatitis B and malaria. These and other infectious agents not only take an enormous physical toll on humanity but also cause significant economic

losses both directly in the developing world and less directly in the developed world. It is therefore a matter not only of public health, but also of economic interest to invest in and organize an international co-coordinated strategy to fight the major infectious diseases, or at least to bring them control.

The burden of infectious diseases is therefore likely to aggravate, and in some cases even provoke further economic decay, social fragmentation and political destabilization, especially in the developing countries like Ghana. According to World Health Organization (WHO) infectious diseases caused 32% of deaths in the world, 68% of deaths in Africa and 37 % of deaths in South East Asia WHO (1999). These diseases account for 90% of the health problems worldwide and kill about 14 million annually, 90% of whom are from the developing world. They have killed more people than famine war, accidents and crimes together. AIDS, TB, Hepatitis B and malaria are increasingly being acknowledged as important factors in the political and economic disability of the developing world.

There is bound to be rise in health expenditure and lower income generating potential and savings among households, private firms, and business may also suffer from lower productivity on account of higher personnel costs due to health – related expenses on absenteeism, sickness, death , and recruitments, as well as organizational disruptions. These constitute an additional burden and deterrent both to expanding domestic investment and fostering, direct investment World Economic Forum (2004). Similar effect can be seen in the public sector, where significant pressure on budget is created by the decline in the revenue side, given the reduction in working age labour force, and increase in the expenditure side resulting from higher health and welfare cost.

These infectious diseases are deepening poverty, reversing human development achievements , worsening gender inequalities , eroding the ability of government to maintain economic growth Collins & Ran (2001) . The epidemics are changing the contours and dynamics of poverty through its demographic and socio economic impacts, which may create inter - gen erational poverty by improvising surviving orphans (often forcing them out of school, thus limiting their livelihood options), by fragmenting or dissolving household and by decimating the fragile asset base of the poor.

Agriculture is the largest and most dependable sector in most African economies, making up the majority of employment, but it is coming under increasing pressure from these infectious diseases like AIDS/ HIV, Hepatitis B , etc. If just a few workers are lost at crucial times of the year then this can even have a disproportionate effect on harvest and income.

In Ghana, Agriculture constitutes 34 percent of the gross domestic product (GDP) GSS (2008) and it employs about 50 percent of the people GSS (2002). Between 2003 and 2008 however, there was a slight decline in the growth rate of the agriculture sector, from 6 to 5 percent which can be attributed to loss of labour productivity GSS, (2008).

According to Todaro and Smith (2004), Health is a prerequisite for increase in productivity. Health is one of the most important assets a human being has. It permits us to fully develop our capabilities. Life cycle models have explained how one's health status can determine future income, wealth and consumption (Lilliard and Weiss (1997); Smith (1999). Barron (1996) comments health is a capital productive asset and an engine of economic growth. Using this argument, we can

consider health as a determination of human capital. Likewise, Mushkin (1962) indicates human capital formation, with the help of health services, and education are based on the argument that people develop themselves when they invest in these assets and will earn a future return with them. Haacker (2004).

In developing countries in particular, manual works make up a large proportion of output, and physical endurance and strength rely crucially on sound health, this increase the level of productivity in the economy. Healthier population due to lower health related expenditure and higher likelihood of future survivals are more likely to save and invest for the future and their savings are invested in the infrastructure and factories that are essential for economic prosperity or expansion Haacker (2004).

Over the years the government of Ghana has embarked on various economic and poverty reduction programmes with the aim of improving the living conditions of the citizenry. In 2007 the Livelihood Empowerment against Poverty Programme (LEAP) was introduced, and in 2008 individuals identified as poor, started receiving monthly allowances GSS (2008).

Sickness also contributes to the scarcity of labour because of both the incapacity of workers and time others have to devote to looking after them. The effect of these losses is that such households rarely recover even their initial level of living, since their capacity is eroded De Waal and Asea (2003). There are, therefore several reasons to include health as an input or a determinant of the macroeconomic production process. Consideration of Paul A Samuelson's (1987) production function, which is of the form; $f(y) = -0.16y^2 + 1.6y$ can help. In this model, the labour force of size **y** can be reduced if skilled labour supply shrinks due to any health hazard. Poverty and infectious diseases are closely related; poverty often predisposes

individual to infectious diseases and moreover, infectious diseases may lead to deterioration in individual and community socioeconomic status. McIntyre (2006).

A common methodology used by health economist to assess the total indirect costs of premature deaths is the human capital approach. The human capital approach typically estimated the value of productivity cost by computing the present value of the stricken individual's future earnings under certain assumptions about his or her life style, wage profile, and future participation in labour force. The earnings stream is discounted to the time of death or initial illness.

Another approach proposed by Cuddington (1993) is the growth model. Here, the classic Solow (1956) growth model is extended to incorporate the key macroeconomic approach which focuses on estimating the cost of individual cases of the diseases in terms of present value. The mortality effect infectious diseases have two impacts, first is to lower population growth rates. The second impact is to change the demographic composition of the population, because a combination of death and illness associated with infectious diseases outstrips all other causes of staff turnover Mankiw and Romer (1992).

In the context of population growth, it can be stated that; $\frac{dp}{dt} = kp$, where K (the

Relative growth rate) $= \frac{1}{p}\frac{dp}{dt}$. The significance of the K, is that, it increases the percentage growth rate. The prevalence of AIDS for example impacts negatively on the relative growth rate **k** of the population. Perhaps the most important point to note is that the causality between HIV/ AIDS prevalence and macroeconomic devastation work both ways. Just as the epidemic places severe strain on the functioning of the

economy, the economic impact foster an environment in which the epidemic proliferates Haacker (2004).

1.2 THE STATEMENT OF THE PROBLEM

The effects of emerging disease on the quality of life and economic growth and development in sub- Saharan Africa have recently received international attention. It is against this background that the researcher would like to find out the economic impact of Hepatitis B in the Techiman Municipality.

Hepatitis B is an infectious illness caused by Hepatitis B virus (HBV) which infects the liver of hominoidea, including humans, and causes and inflammation called hepatitis originally known as "serum hepatitis Barker, et al (1996). The disease has called epidemics in parts of Asia and Africa, and it is endemic in China. William , (2006). About a third of the world's population, more then 2 billions people has been infected with the Hepatitis B virus. This includes 400 million people chronically infected. It is also estimated that 10-30 million people will become infected each year. An estimated one million people die each year from hepatitis B and its complications. Approximately 2 people die each minute from hepatitis B HBF (2009). Hepatitis B is 100 times more infectious than AIDS Virus, yet it can be prevented with a safe and effective vaccine.

The virus is transmitted through blood and infected body fluid. This can occur through direct blood – to blood contact, unprotected sex, use of unsterile needles, and from an infected woman to her newborn during delivery process. Nearly 70% of the individuals who have acquired this disease never show any sign or symptoms of the virus.

In order to fully appreciate the disease burdens, and enormity of the crises unleashed by the Hepatitis B epidemic in Africa, as elsewhere, it is important not only to understand the impact on the growth of economies. The present study therefore seeks to find, and shed light on the economic impact of hepatitis B on labour and capital in the Techiman Municipality.

1.3 OBJECTIVES

Objectives for this study are;

1. To model the economic impact of Hepatitis B, using a system of ordinary differential equations.
2. To obtain solutions of the differential equations, and interpret them in relation to the study.
3. To discuss the stability of each equilibrium point
4. To analyse and interpret solution to inform policy makers, stakeholders and the general public.

1.4 METHODOLOGY

The research design used in carrying out this study is a simple descriptive research, because secondary data will be collected to describe the relation between health and economic growth. The population for the study will include individual households, communities and firms in the Municipality that are affected by the Hepatitis B pandemic. The sample includes all those who were tested Hepatitis B positive during 2008 – 2010 survey periods. The data will be analyzed using Matlab software.

1.5 SIGNIFICANCE OF THE STUDY

The findings of this study would help individuals and households to appreciate the long terms devastating effect of the Hepatitis B pandemic on human, community and national development, so as to take the necessary precautions towards limiting the effects of this pandemic.

The solution of this problem can help policy makers and the government to come out with economic measures or programmes which give best value for money.

Again, the findings of this research study would help the government to assess the overall impact of Hepatitis B on the efficiency of public services, the fiscal policies and government revenue.

1.6 RESEARCH LIMITATIONS

The researcher intended to consider the economic effects of several emerging diseases on the economies of individuals, households, firms and countries in sub Saharan Africa. But, due to limited time, financial constraints and scarcity of data the researcher has limited his study to the economic impact of Hepatitis B in the Techiman Municipality of Ghana.

1. 7 HYPOTHESES

In order to achieve the aim of this study, the following hypotheses have been formulated.

1. Has Hepatitis B any economic effect on the determinants of economic growth in the long term?

2. Has Hepatitis B any impact on the quality of labour force to both formal and informal sectors in Ghanaian economy?
3. Has Hepatitis B any effect or impact in the gross poverty reduction efforts in the municipality and Ghana as a whole?

1.8. ORGANIZATION OF THE STUDY

This work consists of five chapters. Chapter 1 is the introduction, which talks about background of the study, statement of the problem, objectives of the study, research limitations, hypotheses and organization of the study.

Chapter 2 comprises the review of the related literature. Chapter 3 concerns with the methodology used in carrying out this research. Chapter 4 talks about the results, obtaining solution for the model, interpretation of results and other findings. Lastly, Chapter 5 presents the summary of the research finding, implications of the study, conclusions and recommendation.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter talks about studies other scholars have also done in relation to the topic under study.

More resent research has begun to establish that the apparent correlation between health and wealth operations through a number of channels including the effects of improved health on demography, education, the labour market production and investment.

2.2: ESTIMATING THE ECONOMIC IMPACT

Recent studies by Gallup and Sachs (2000) have shown that high malaria prevalence correlated with low rates of economic grow with particular reference to Hepatitis B, it is fair to say that, the initial orientation of academic and policy research was to see the epidemic as a public health problem not a development one as such. However, there is now general agreement that the pandemic has a trenchant effect on the economy.

A number of studies, Hall et al (1993); Aggarwal and Naik (1994); Miller

And Kane (2000) And Aggarwal et al (2002) have shown that the economic costs of Hepatitis B is colossal. They come in the form of reduced growth, decline in Savings and investment rates, huge health care costs. These and other studies have come in their wake, have been extremely valuable in improving or sharpening our understanding of the threat posed by the epidemic.

2.3 THE ECONOMIC IMPACT OF HEPATITIS B ON DETERMINANTS OF ECONOMIC GROWTH IN THE LONG TERM.

Economists draw a distinction between short term economic stabilization and long term economic growth. Economic growth refers to only quantity of goods and services produced. It is often measured as the rate of change in G D P. So economic growth is primary concerned with long-run. If Hepatitis B hits a household or community, economic activity begins to shrink.

Therefore estimating the combined impact of these various interdependent effects on the performance of an economy is a complex task. So, to simplify measurement of the "economic performance" Economists have tended to focus on the average income or gross domestic product (G D P) and per capital income.

While poverty reduction might be thought to reduce hepatitis B rates and other infectious diseases, in some cases the development process may itself strengthen epidemics. Development is associated with infrastructure development, urbanization, increases in disposable income, the growing importance of cash agriculture and growing mobility. Further more, inequality often grows in the early stages of an epidemic Francis Nelson (1994), creating increasing internal migration (as workers migrated to centres of wealth and development) ,a significant risk factor as men travel away to work, but seasonally return to their families in their village of origin. Development is likely to bring greater opportunities for multiple partnering and growth in the commercial Sex industry Jean – Claude D. et al (1998) .There are many mechanisms through which Hepatitis B may have a potential impact on the economy. Unlike most other deadly illnesses, HBV'S target is people of working age. The

result is a potential reduction in savings rates and disposable income, which may have an economic impact Daly and Kieren (2000). New staff must be trained and recruited, a cost that could not be otherwise have been borne. Firms may also suffer a loss of valuable know how. Moreover, a chronic Hepatitis B infection is debilitating, particularly in the final two years of death and absenteeism for both those infected and those caring for them may have and impact on Business and other working organization. Increase in health spending could mean cuts in investment in other growth – enhancing areas, education and in fracture, for example.

The impact on productivity may also decrease an economy's attractiveness to foreign investors, and diminish tax revenue.

2. 4 THE ECONOMIC IMPACT OF HEPATITIS B ON THE QUALITY AND SUPPLY OF LABOUR FORCE

Hepatitis B has the potential for a devastating impact on economic growth because of its impact on the labour market growth in the labour input; labour hours worked in a given week reduces. So illness and mortality from the epidemic reduce services provided by labour in the course of production. The composition or quality of labour force also changes, and there is a new mix of skilled and unskilled, with falling number of experienced workers in all sector of the economic activity. The young people in their most productive years are more at risk of HIV/HBV infection than other demographic group Cladwell (2006). In these societies that experience rising adult mortality, the passing on of acquired skills and knowledge, which has been such a major factor in the growth of labour productivity diminishing. Demographic change

therefore seems to have played a significant role in enhancing development and subsequently influenced economic growth and poverty reduction Dixon (2002).

The concern is not only with reduction in the size of labour force, but also is quality. Many of these infected with Hepatitis B are experienced and skilled workers in their productive prime, representing considerable human capital losses. It can, therefore, be said that the loss of skilled workers and the changing structures of labour force means a reduction of capacity for the transfer of technical skills from worker to worker, and between generations.

Labour – intensive firms on the one hand, are primarily faced with the problem of higher turnover in the labour force, capital intensive companies on the other hand , typically rely more on the experience and knowledge of a few personal Isaken et al (2002). The long period of illness, absenteeism (from work by infected workers and death of colleagues associated with HBV reduces labour productivity and hence revenue fall.

Beyond the disruptions to public services associated with increased attrition rates, Hepatitis B also affects the composition of government employees in various dimension and level of human capital available to the government. The effects are said to be catastrophic not just on workers and their families, but on business and the overall national economy. This may also decrease the economy's attractiveness to investors, and diminish tax revenue.

Loss of staff members has consequently led to under – staffing of certain facilities slowed down provision of services, De Waa (2003)

2.5 THE ECONOMIC IMPACT OF HBV ON GROSS POVERTY REDUCTION

Many governments have been pursuing human development objectives with a focus on the elimination of poverty, disease and ignorance. The approaches to meet the millennium development goals (MDGs) on eliminating hunger, jobs creation and increase in incomes, have been however hampered by limitations in capacity, financing and governance problems. Ghana is not an exception, so in the year 2000, the government of Ghana, with the aim of ensuring effective management and unified response to the HBV epidemic, adopted a multi- sectoral approach to address the developmental challenges of the epidemic GSS (2008).

The persistence of extreme poverty is often solely attributed to in adequate political and economic institutions, which fail to provide the critical foundations for functioning market economies Barro (1997).

But there are important correlates of global poverty that fall within the, realm of the biological sciences and epidemiology, such as high prevalence of infectious diseases (such as HIV/AIDS and Hepatitis B) low life expectancies , and high rates of reproduction WHO, and UN Millennium project (2007). The most conversional explanation for these correlates is that poverty is an underlying cause of disease and mortality rates derive high rates of reproduction.

The increase in mortality and morbidity as a result of Hepatitis B, reduce living standards directly and have repercussions that affects the economy. The loss of; people of working age, households production and income, drastically increases the dependency ratio. This in turn means that surviving children are less likely to be educated or well- nourished has been argued that, without mitigation, this will make it impossible for governments to reduce poverty Haacker (2004).

The epidemic also strikes the poor who can least afford treatment and care, thereby increasing problems of property Haacker (2004). The treatment of Hepatitis is, according to a report by Ghanaian Times, not covered by the National Health Insurance Scheme (NHIS). Accordingly a physician at the Korle – Bu Teaching Hospital "under scored the need to widen the NHIS to cover Hepatitis B treatment in order to encourage people to know their status and seek treatment "Ghanaian Times (2007).

The Ghana Hepatitis B foundation (GHBF) which mainly focuses on information dissemination on preventive measures and immunization was formed a month prior to the physicians appeal. It also made its aim to get hepatitis B on the lost of illness covered by the NHIS GHBF (2008).

CHAPTER 3

METHODOLOGY

INTRODUCTION

This chapter talks about the research design, the area of study, source of data, the impact of the disease on the quality and supply of labour and the impact on the determinant of economic growth in the long term.

3.0 RESEARCH DESIGN

The method chosen for this study is a simple descriptive research, because, the writer only wants to by means of data; establish the association between health hazards and economic growth of individuals, communities, firms and a nation as a whole.

3.1 STUDY AREAS

The areas under study are the individuals, households, communities and firms in the Municipality. Subjects for this study were all HbsAg patients aged 15-55 years. The sample size for this study is 2,360, total number of people tested positive within the study period.

The choice of this population was made in order to know the prevalence rate, assess, understand the economic cost associated with sickness and reduced productivity, estimate, or predict the overwhelming and impoverishing effects of HBV deaths on households' income, and even the gross domestic product (GDP), per capita income, and the economic growth in the municipality. It is believed that the epidemic has the potential for a devastation impact on economic growth because of its impact on the labour market.

3.2 SOURCE OF DATA

The data for this analysis were secondary data obtained from the major health institutions in the Techiman Municipality. These include the Holy Family Hospital, Ahmadiyya Muslim Hospital, Opoku Agyeman Hospital and MEDILAB Diagnostic Ltd. Analysis was done on the data to build an appropriate model for determining or predicting the devastating impact of the HBV epidemic on the development of the municipality, base on the following parameters.

I. The economic impact of Hepatitis B on the quality and supply of labour force to both formal and informal sector.

II. The economic impact of the epidemic on the gross poverty reduction efforts in Ghana.

III. The economic impact of the epidemic on the determinants of economic growth in the long term.

3.3 THE ECONOMIC IMPACT ON THE QUALITY AND SUPPLY OF LABOUR FORCE.

Infectious diseases continue to be most significant in poor or developing countries where birth rates and transmission rates are systematically high, Mclean and Anderson, (1998).

Patterns of morbidity, fertility and mortality in particular age groups that supply labour to formal and informal sectors is determined by interaction between infectious diseases and systematic human socioeconomic process. It is becoming increasingly clear that many infectious diseases such as hepatitis B and HIV/AIDS are themselves

causes of poverty, owing to their effects on labour productivity Bonds and Rohani (2009).

The Hepatitis B virus (HBV) reveals its developmental effects on its impact on economic and social system by reducing both the quantity and quality of labour available to produce output. A model is presented here to show how the epidemic affects factors like; the level of net savings, investment rates economic growth rate, the level of Gross National Product (GNP), per capita income, and on the size of labour supply by skill or education, which has critical implications for what can be produced, and under what conditions of production.

After all, economic activity requires human resources- specifically, human capital and therefore relies on biological processes in the form of physical labour and cognition which are often compromised by infectious diseases ;Nokes et al (1992).

Indeed, fertility, poverty, and diseases are not only signatures to each other, but they also interact with each other in an important and predictable ways that can be built into traditional disease ecology model, can be useful for the analysis of demographic transitions Sachs (2005).

In Ghana, for instance, the government is now set to transform the rural economy in order to ensure sustained and even economic growth. Substantial investment in agriculture would be the driving force behind the transformation of rural economy. It is therefore incumbent on the youth to access credit to undertake productive ventures. The Ghana government has re-introduced the youth-in-Agriculture programme to encourage the youth to venture into farming. So hard work is much needed to transform the economy. Duffour (2010).

Undoubtedly, the prevalence of any infectious disease in such a time frame, that impact heavily on physical strength and endurance will be detrimental to the growth of the economy at present, and for decades to come.

Economists say that, a worker who is well-fed and free from disease will be more productive than one who is weak and ill. So in order to deepen our understanding of how the supply of labour affects the growth of an economy, a model is presented in this section ,which appropriately relies on the principles of predator-pray model Lotka (1925); Volterra (1926); Anderson and May (1992).

Assume the following facts about the model;

I. There is no Hepatitis B outbreak or prevalence

II. The rate of increase of labour supply to produce output is proportional to the size of the labour available.

This can be express mathematically as

$\dot{y}$=ky y≥0 where k is positive constant.

Since k, is a positive constant, it implies that the rate of increase of labour supply is an increasing function of time. The analytical solution of the model gives;

$Y=Ae^{kt}$ which is an exponential function, and it models the supply of labour not affected by the prevalence of any epidemic. It is seen that the supply of labour will grow or increase exponentially. The solution $Y=Ae^{kt}$ is one parameter family of solutions of the equation $\dot{y}$=ky on the interval $[-\infty, \infty]$. The solution varies as the parameter changes, depending on initial conditions.

However, to give a more realistic description or impression of the supply of labour which has been adversely affected by the prevalence of Hepatitis B, the rate of effective labour supply will decline sharply through illness and absenteeism; this leads directly to the model shown here.

$$\dot{y}=-ky \quad \text{where } y\geq 0$$

The analytical solution of this equation will yield a solution curve of the form $Y=A_1e^{-kt}$ which means the much needed skilled labour, the variable input to ensure sustainable output and economic growth is now declining slowly or showing negative growth.

All other things being equal, if the size of the labour supply in any firm or organization is so low in proportion to capital as a result of health hazards such as Hepatitis B, then production or output will decrease.

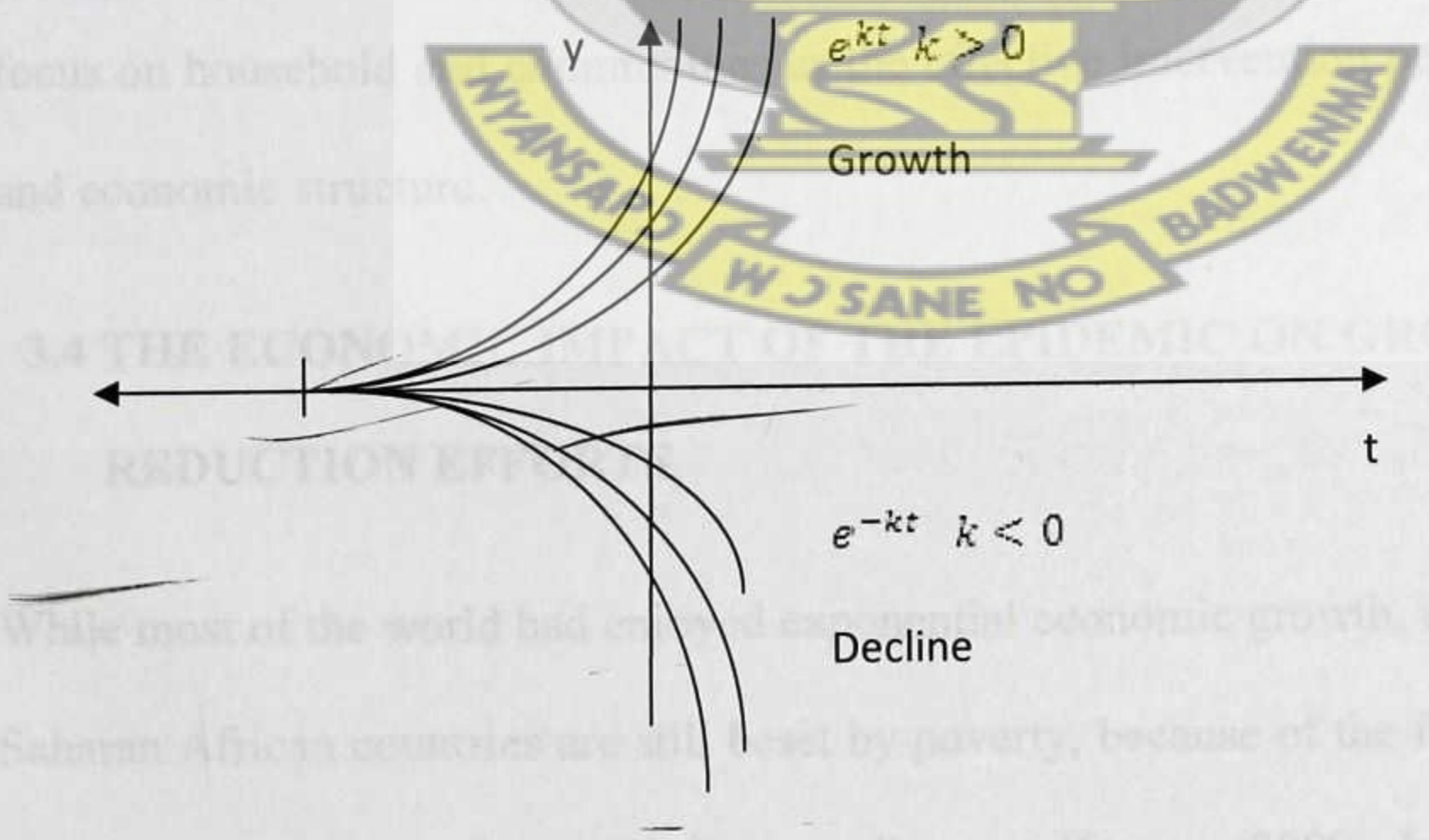

Fig 3.1 Supply of labour force against time.

This simple graph which shows the supply of labour against time, allows one to study the dynamics of labour supply as time increases. The rate of growth or decline of labour supply is as a result of health condition.

Good health ensures growth as shown on Figure 3.1 whilst health hazard such as Hepatitis B causes a decline of labour supply as depicted by the curves in Figure 3.1. With the help of this graph, the harmful or devastating effects of Hepatitis B pandemic on the size of labour supply, and for that matter the growth of the economy of any nation or municipality can easily be appreciated. This should, therefore, call for effective, expanded and integrated policy response or descriptions to combat the spread of the epidemic. This is important because the disease is a major threat to production and development in the Municipality and the country at large. Man y people who are infected with the disease will be exchanging their productive time for medical care. Resources that could be invested to increase productivity would be used by individuals to pay medical bills. The government would have to direct resources for production to good health care delivery and most policy interventions will have to focus on household and communities as the effective intervention points in the social and economic structure.

3.4 THE ECONOMIC IMPACT OF THE EPIDEMIC ON GROSS POVERTY REDUCTION EFFORTS.

While most of the world had enjoyed exponential economic growth, undeveloped sub-Saharan African countries are still beset by poverty, because of the feedback between economies and the ecology of infectious diseases, Keenan (2009). In fact, the burden of infectious diseases is likely to be a cause of poverty and has been implicated as an underlying barrier to economic development, Strauss and Thomas (1998).

The profit theory holds that the amount of investment spending depends on the amount of profit that firms are making. This theory therefore suggests that output depends on supply of inputs, for all variable inputs, particularly labour available, will find employment when there is increase in production.

Essentially, economies can grow only if they can produce enough so that there is a little bit left over for saving, after the needs of the people have been met. The ability to save is crucial to growth, because it increases the potential to produce in the future, Haughton (1992). It is therefore clear that, the amount of production, and hence revenue or income will fall with a decline in labour supply, due to Hepatitis B and its associated illness and absenteeism. Once income reduces, savings is likely to reduce, which has the potential to cripple economic expansion of a household, a firm, or a nation.

It is, however, the case that most direct impact of hepatitis B mortality and morbidity is at the household level the very base of the economy. The impact on households with HBV normally the same pattern: loss of income, if a breadwinner stops work due to the sickness or death, or breadwinner stops work to look after a sick family member. So much, is the impact on a house hold, labour supply, and for that reason reduces the household's daily, monthly, and annual income. Decline in the household savings is further stretched by the cost of health care and funerals, De Waal (2003).

Households typically used up much of their savings to meet their health care and funeral costs. They may also sell assets to meet urgent expenditure needs.

Assuming a household is affected by Hepatitis B , then its income, savings and investments, altogether considered as capital, x and the size of labour supply represented as y, will reduce this is the true picture ,of the devastating impact of the

epidemic ,because many people are not aware of the disease. The burden, enormity and severity of the disease can be portrayed by the dynamics of the models shown below;

$$x = -kx \quad \text{and} \quad y = -ky \quad x \geq 0 \quad y \geq 0$$

The negative sign in the first equation means, the rate of growth of capital x , will be decreasing with time because of loss of income through the death of a breadwinner, due to Hepatitis B. In the second equation, the negative sign means that the rate of growth y of a labour supply is decreasing, or being lost to Hepatitis B pandemic.

Among other things, healthy agricultural development , for instance, can reduce poverty , release labour to other productive sectors and earn foreign exchange, as well as supply of food, Haughton (1992).

Economic growth declines as the population grows more slowly, national savings reduces and rising health care cost deter investment Haacker (2004). This subject the generation through vicious cycle of economic slow down, poverty and spread of Hepatitis B. This therefore hampers all efforts to reduce poverty. The short and long term effects of this situation can be described by the model shown here.

The following facts can be assumed;

I. A one year improvement in a population's life expectancy.

II. A stable population.

The rate of growth of output or income represented by $U(x, y)$ per unit capital is directly proportional to the difference between the rate of increase in the size of labour supply and the rate of increase in capital. This can be expressed mathematically as;

$U(x,y)=\alpha(y-x)$, where

y = rate of increase of in the size of labour supply.

x = rate of growth of capital

α = constant of proportionality or rate of growth of production or income.

This model depicts that , for any value of $\alpha \leq 1$ and for any value in which the rate of supply of skill labour begins to decline, as a result of health hazards to the extend that $x > y$, then the rate of growth of productivity $U(x,y)$ will be negative or experience a negative growth, and rate of return on capital will also be declining. Considered as investment, better health care can increase labour productivity and also lengthen the productive live span of nation's workers.

The graph below shows how production or output varies with the supply of labour. It also measures the output of a firm at a given level of input. This can be appropriately used to measure the output or income of a household. The production function is $f(y) = -ay^2 + by$, where a, and b, are constants

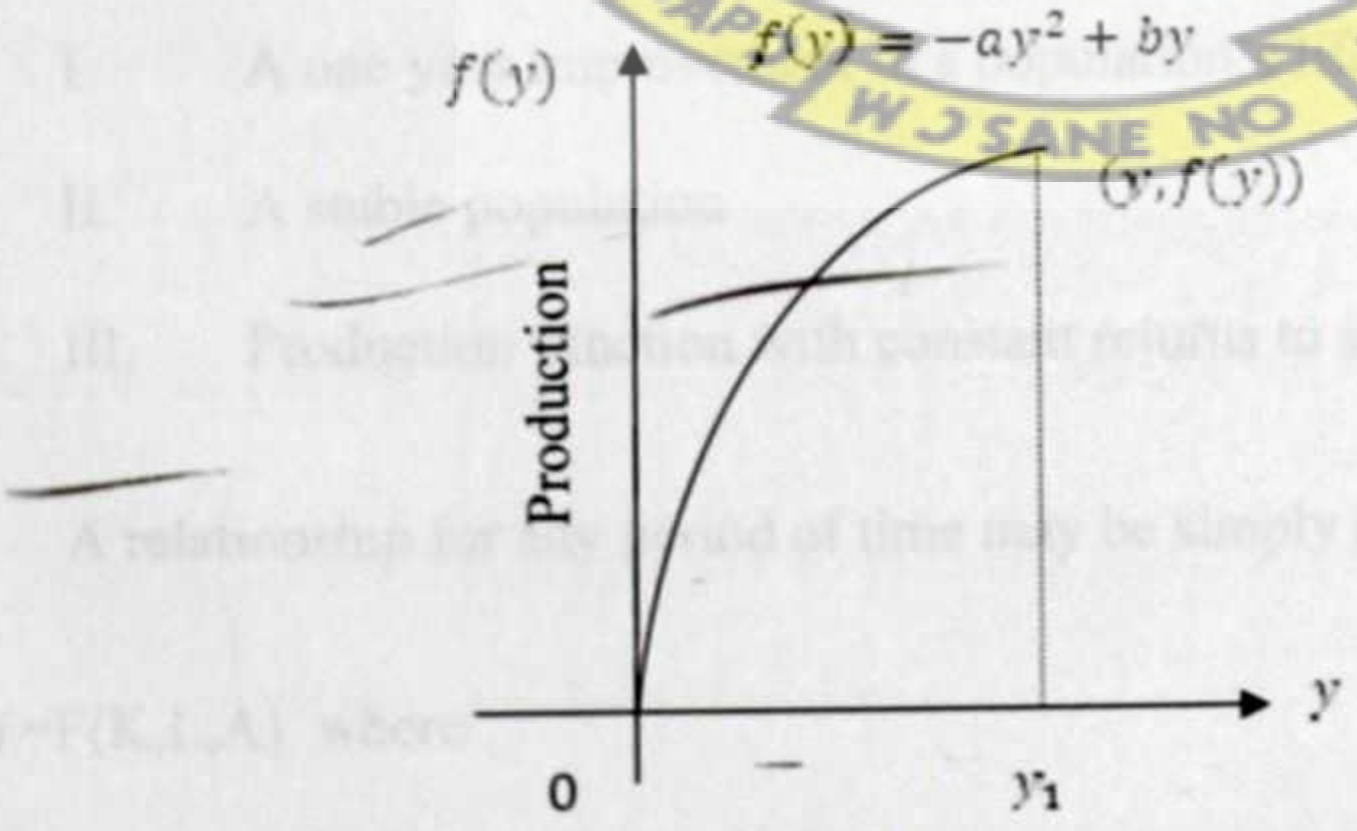

Fig. 3.2 Production function

The graph above indicates that any severe reduction in the supply of labour can adversely affect productivity. An important economic concept derived from here is marginal product which is the derivative of the production function, which measures the rate of change of output as input changes. The largest number of labour units available to the firm is y_1. This is valid only for the values of y in the interval $[0, y_1]$.

3.5 THE ECONOMIC IMPACT OF HEPATITIS B ON DETERMINANT OF ECONOMIC GROWTH IN THE LONG TERM

Studies have shown significant negative effects on the patient's capacity to engage in income-earning activities, Russell (2004).

In line with the neoclassical economic growth theory, the rate at which the output or income of the economy grows depend basically on; savings, and act of changing what is save into capital good, the rate at which its capital stock, labour force, and technological know-how grow over time, a production function can be used to assess the economic impact or effect of the Hepatitis B on output and economic growth.

Assuming the following facts;

I. A one year improvement in a population's life expectancy

II. A stable population

III. Production function with constant returns to scale

A relationship for any period of time may be simply expressed in the form:

$Y=F(K,L,A)$ where

K= capital stock

L= the size of labour force

A= an index of technological know-how

Let the production function stated above be replaced by a point $(x, y) = (x(t), y(t))$ in a plane, representing two determinants of production or economic growth, that is physical capital $x = x(t)$ and human capital or labour $y = y(t)$ at any time t. As t increases the point $(x, y) = (x(t), y(t))$ will trace a path that represents the variation of capital and labour with time. At a particular time t it is supposed that factors of production are $x(t)$ and $y(t)$. The evolution of the two determinants can be represented as a path as shown here;

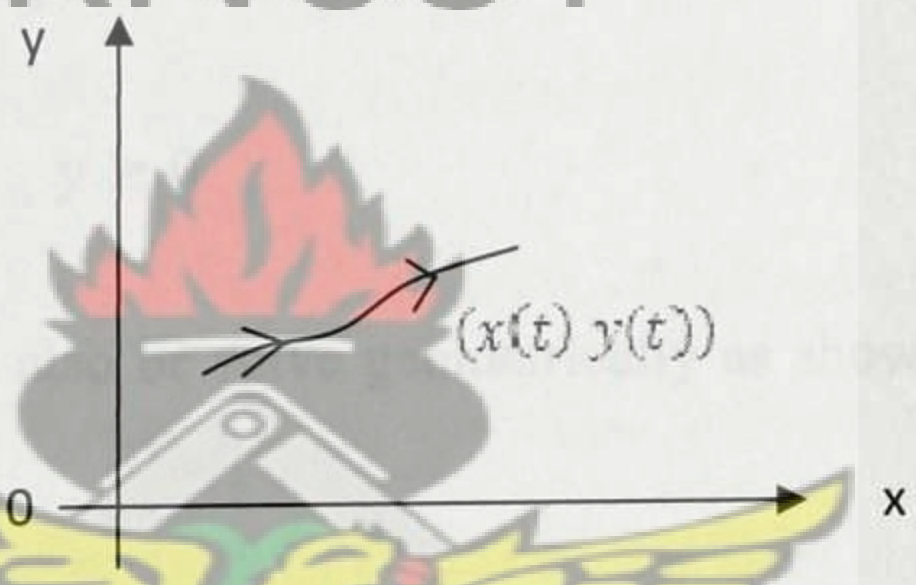

Fig. 3.3

The directions on the path indicate the directions in which the point$(x(t), y(t))$, moves.

Using vector notation, the pair of the determinants may be represented by the vector

$x=[x, y]^T$

Assuming the following facts about a household or the municipality;

I. There is no Hepatitis B epidemic; therefore, both capital and labour supply are evolving independently.

II. The rate of growth of capital is proportional to the current capital stock

III. The number and quality of labour supply increases in a rate proportional to the present size of labour.

This may be modelled by the pair of equations:

$\dot{x}=kx, \quad \dot{y}=hy, \quad x \geq 0 \quad , \quad y \geq 0$

Since k, and h, the proportionate growth rates, are positive constants, it means in ideal situation, when there are no serious health hazards, or outbreak of any infectious diseases such as Hepatitis B, the economy will be growing exponentially since k>0 and h>0.

Choosing a suitable value for the amount of capital x(t) and labour supply y(t) at time t=0, for example given the explicit solutions;

$X=x_0e^{kt}, \quad x \geq 0 \qquad y=y_0e^{ht}, y \geq 0$

These exponential functions can also be solve geometrically as shown in figures 3.4 and 3.5 for time $t \geq 0$.

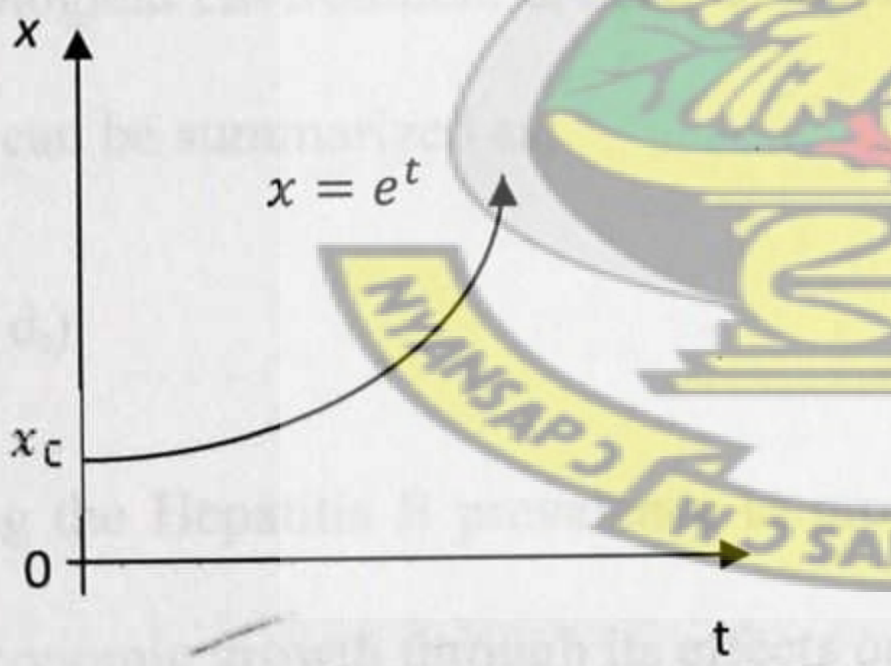

Fig. 3.4 Fiscal capital

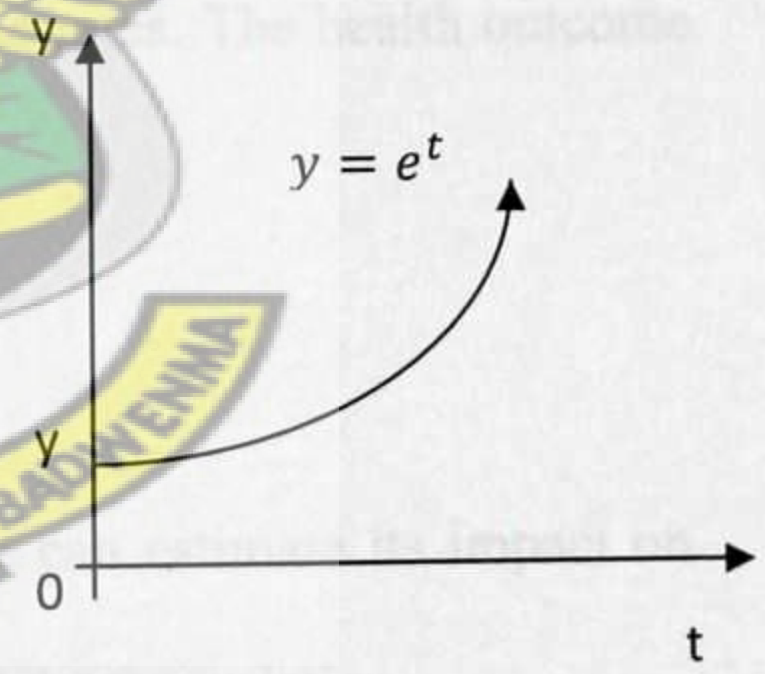

Fig. 3.5 Human capital

These two situations may be described as exponential growth in fiscal capital and human capital. This can be achieved through better health care, and well-being of people living in the Municipality.

Careful study of the dynamics of this model reveals that, Hepatitis B can affect output or total income through its economic impact on capital accumulation, due to low productivity that leads to low per capita income. It can also impact heavily on the supply of labour force –labour productivity, because, there is an apparent correlation between health, wealth, labour productivity, and level of GDP per capita. It is argued that "if a worker is healthier, less susceptible to disease, and more alert and more energetic, then he or she will be more productive and command higher earnings Thomas and Frankenberg (2002)". There is also positive effect of health on labour and productivity and argued that output growth brought through health improvements can generate capital accumulation. Bloom Canning and Sevilla (2004).

Health outcomes in a country are assumed to be a function of several inputs. These inputs z_t include factors such as health expenditure, education, infrastructure, and so forth. The health outcomes are also assumed to be functions of country's epidemiological environment d_t such as disease prevalence rates. The health outcome function can be summarized as;

$$H_t = f(z_t, d_t)$$

By taking the Hepatitis B prevalence to proxy for d_t one can estimate its impact on macro economic growth through its effects on health capital accumulation.

In a real Ghanaian society, and elsewhere, it is unlikely that capital investment and quality labour supply will increase harmoniously to ensure smooth growth of the economy, therefore, in the wake of Hepatitis B prevalence the following assumptions can be made;

I. the growth of capital will be decreased by a factor proportional to xy,

II. The decline growth rate of labour supply need to be increased by a factor proportional to xy.

III. Hepatitis B can affect top level personnel-those who own the capital

This requires that the first model $\dot{x}=kx$, and $\dot{y} = hy$, $x \geq 0$, $y \geq 0$ should be modified to include changes base on these assumptions. So the system of differential equation that models the impact of Hepatitis B on an economy is now given by;

$\dot{x} = kx - \beta xy$ and $\dot{y} = -hy + \mu xy$, for some positive constants β and μ. Together, this system of differential equations models the pair of factors of production or vital determinants of economic growth. The system is said to be coupled because the rate of change of capital and labour supply depend on both x and y

Let $\beta=\frac{k}{Y}$ for some positive constant Y and $\mu=\frac{h}{X}$, for some constant X so that the system of equations becomes

$$\dot{x}=kx\left(1-\frac{y}{Y}\right) \qquad \dot{y} = -hy\left(1-\frac{x}{x}\right)$$

Where k, X, and Y are positive constants. This can be written as $\dot{x} = u(x, y)$, and the vector field $u(x, y)$ is given by

$$U(x,y)=\left[kx\left(1-\frac{y}{Y}\right), -hy\left(1-\frac{x}{X}\right)\right]$$

Solving this non-linear differential equations will help one to appreciate the dynamics of provision of capital and size of labour supply depend on each other , or evolve in response to each other, to ensure economic growth or decline, which

partly depends on the prevailing health condition. Besides impoverishing effects of the Hepatitis B on the long term growing of economies can also be appreciated. The model seems to predict that both determinants x(t) and y(t) are periodic in time.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

This thesis has estimated the impact of hepatitis B on the growth and development of economies with particular reference to Techiman municipality using sample data from 2008 to 2010. The model will help capture the impact of the epidemic on growth since its effect can be felt through capital and labour supply, were the variables used. Despite data limitation, the study permits a number of conclusions. On the global scene, the epidemic had caused much devastation to many economies, demographic compositions and the structure of many work forces. A research conducted by Noguchi Memorial Institute for Medical Research indicated that the national prevalence rate of Hepatitis B is about 15% Ampofo , et al (2002).

4.2 ECONOMIC ANALYSIS

Economic analysis helps in evaluating; the impact of Hepatitis B, the cost and benefit of mitigation programs or activities, the impact on the capacity of the economic system to deliver improved standard of living in the future. Through such analysis, there has come, the paucity of information or evidence to indicate the importance of health to economic and social development. Bloom, Canning and Sevilla (2001) found that a one year improvement in a population's life expectancy (a standard measure of health status) contributes to a 4 percent increase in output.

In another study, the same authors estimated that, one percentage increase in adult survival rates boost labour productivity by about 2.8%. In a typical Ghanaian environment like Techiman where most of the workers are farmers and traders, their

output of work will increase if they are free from diseases because these manual workers depend primarily on physical work.

Formal analysis suggest that , a country can, on average , expect to see per capita incomes grow by an extra 0.3 to 0.5 percentage point a year, every five years it adds to its life expectancy Bloom and Malaney (2000) .

Moreover, studies that consider 'full income – which assigns economic value to changes in life expectancy, suggest that, falling mortality rates have a more substantial positive impact on economic development. For example, in an assessment of growth of real per capita in United States over the 20th century, Nordus Williams (2003) concluded that over half of the growth full income up to 1950 was attributed to mortality decline.

Bloom, Canning and Jamison (2004) suggest in a new review the literature on 'Value of a Statistical Life (VSL) indicators' that, the adverse economic impact of Hepatitis B in Sub-Saharan Africa has already been more significant than GDP per capita data indicate.

It is important to recognize that while measures of the impact economic aggregates – such as GDP or per capita GDP provide useful indications of the over all economic impact, they typically fail to capture a significant proportion of the economy's delivery of economic wellbeing to its people. This is because; lots of economic activities are often unmeasured. More importantly , measures such as production and consumption are only a partial indication of welfare , so that small changes in measured economic impact may not necessarily mean that welfare impact are small Allen (1997).

4.3 DATA

In order to appreciate the effect of the disease in the Municipality, the following information was obtained from the various health institutes

Table 4.1: 2008 cases in Holy Family Hospital- Techiman

Month	Number screened	Tested positive	Tested negative
January	300	47	253
February	257	36	221
March	333	42	291
April	195	25	170
May	261	32	229
June	343	51	292
July	348	41	307
August	324	38	286
September	261	23	238
October	245	27	218
November	254	33	221
December	287	30	257
Total	**3,408**	**425**	**2,983**

Table 4.2: 2009 cases in Holy Family Hospital- Techiman

Month	**Number screened**	**Tested positive**	**Tested negative**
January	287	33	254
February	273	36	237
March	385	45	340
April	287	36	251
May	287	45	242
June	347	39	308
July	446	45	401
August	284	47	237
September	300	49	251
October	511	49	462
November	269	32	237
December	357	52	305
Total	**3,533**	**508**	**3,025**

Table 4.3: 2010 cases in Holy Family Hospital- Techiman

Month	**Number screened**	**Tested positive**	**Tested negative**
January	356	19	337
February	155	17	138
March	231	40	191
April	200	29	171
May	309	43	266
June	241	27	214
July	265	38	227
August	310	27	283
September	324	41	283
October	284	29	255
November	322	42	280
December	229	27	202
Total	**3226**	**379**	**2847**

Table 4.4: 2008 cases in Ahmadiyya Muslim Hospital-Techiman

Month	**Number tested**	**Positive**	**Negative**
January	15	6	9
February	16	2	14
March	21	7	14
April	20	3	17
May	23	4	19
June	12	5	7
July	10	2	8
August	14	5	9
September	25	7	18
October	13	3	10
November	14	5	9
December	21	6	15
Total	**195**	**55**	**140**

Table 4.5: 2009 cases in Ahmadiyya Muslim Hospital-Techiman

Month	**Number tested**	**Positive**	**Negative**
January	13	4	9
February	10	3	7
March	16	1	15
April	11	0	11
May	8	3	5
June	17	6	11
July	23	9	14
August	8	3	5
September	4	1	3
October	12	4	8
November	11	5	6
December	11	3	8
Total	**143**	**42**	**101**

Table 4.6: 2010 cases in Ahmadiyya Muslim Hospital-Techiman

Month	**Number tested**	**Positive**	**Negative**
January	20	5	15
February	13	2	11
March	10	2	8
April	10	2	8
May	12	3	9
June	11	5	6
July	29	3	29
August	9	4	5
September	12	4	8
October	4	1	3
November	11	2	9
December	10	2	8
Total	**141**	**35**	**106**

Table 4.7: 2008 cases in Opoku Agyeman Hospital

Month	Number tested	Positive	Negative
January	16	3	16
February	8	1	7
March	21	2	19
April	14	2	12
May	31	7	24
June	30	6	24
July	28	5	23
August	19	2	17
September	27	3	24
October	35	6	29
November	18	3	15
December	20	4	16
Total	**270**	**44**	**226**

Table 4.8: 2009 cases in Opoku Agyeman Hospital

Month	Number tested	Positive	Negative
January	21	5	16
February	6	0	6
March	30	4	26
April	9	1	8
May	27	3	24
June	18	6	12
July	34	7	27
August	15	2	13
September	23	5	18
October	19	4	15
November	15	1	14
December	20	5	15
Total	**237**	**43**	**194**

Table 4.9: 2010 Cases in Opoku Agyeman Hospital

Month	**Number tested**	**Positive**	**Negative**
January	20	4	16
February	19	3	16
March	22	0	22
April	21	6	15
May	13	0	13
June	12	1	11
July	29	10	19
August	23	7	16
September	12	4	8
October	36	8	28
November	32	2	30
December	15	1	14
Total	**227**	**46**	**181**

Table 4.10: Cases at MEDILAB Diagnostic Services Ltd-Techiman

YEAR	**Number tested**	**Positive**	**Negative**
2008	407	107	300
2009	531	209	322
2010	1,027	467	560
Total	**1,965**	**783**	**1,182**

Table 4.11: Summary of all the information from the various health institutions in the Techiman Municipality.

Year	**2008**			**2009**			**2010**		
Health Institution	Number tested	Positive	Negative	Number tested	Positive	Negative	Number tested	Positive	Negative
Holy Family Hospital	3,408	425	2,983	3,533	508	3,025	3,226	379	2,847
Ahmadiyya Muslim Hospital	195	55	140	143	42	101	141	35	106
Opoku Agyeman Hospital	270	44	226	237	43	194	227	46	181
MEDILAB Diagnostic service LtD	407	107	300	531	209	322	1,027	467	560
TOTAL	**4,280**	**631**	**3,649**	**4,444**	**802**	**3,642**	**4,621**	**927**	**3,694**

Discussion: From the above Tables4.1-11 it can be seen that, the prevalence rate of the disease in the municipality is very significant. In Table 4.9 out of 4,280 people tested in 2008 in the various health institutions in the Municipality, 631 were positive cases representing 15%. In 2009, there were 802 positive cases out of 4,444 people

tested representing 18%. Again in the year 2010 out of 4,621people tested, 927 were positive representing 20%. The average prevalence rate in the Municipality is about 18%. Comparing this to the national rate of 15% shows that Hepatitis B is worrying the people in the Techiman Municipality.

It can be said that, if such number of people are infected with the disease in the Municipality, it will reduce accumulation of human capital, or labour supply. This has the potential to reduce house hold income, create pressures for the reallocation of expenditure and of internal resources to address the care needs. Adult sickness and death, and household response to cope with the resulting loss of income can lead to withdrawal of children from school to substitute for adult labour. This impact on labour supply and consumption patterns will be transmitted through to the enterprising and government sectors of the economy.

Table 4.12 OPD Cases and Deaths - Holy Family Hospital, Techiman

Year	OPD	Inpatient	Death
2008	91	48	28
2009	37	57	22
2010	57	72	12
TOTAL	**185**	**177**	**62**

Discussion: In the Techiman municipality, the major hospital is the Holy Family Hospital. This is where serious health cases in the other hospitals are referred. In the period under study, there were 62 death recorded as a result of Hepatitis B infection. This will certainly affect the quality of labour supply to both formal and informal sectors.

It is reported that, the economy of Ghana is dominated by the activities of enterprises in the informal sector. It is estimated that, in terms of economic activity, about 86.3 percent is carried out by the self-employed sector mostly operating informal structures, Ghana living standard survey, (2000) ,even though quite a significant number could easily be classified as earning below the taxable income of GH□120 liable to tax 5% . According to records at the Registrar General's Department, Ghana, there are 266,760 self-employed registered in the informal sector Amamoo , (2008) .

It is reasonable to say that, the 2,360 who were tested positive and the 62 people died through Hepatitis B in period under study are workers in the private-sector, and also from the public sector, which will adversely affect output; an impact that will be compounded by reductive in efficiency, associated with incidences of ill health and shortages of critical skills. It is also likely that, this incident can reduce savings rates as well as to increase poverty.

Table 4.13 Age distribution of those who were tested positive within the survey period.

	2008	2009	2010	Total
Children<15years	43	85	96	**224**
Ages>15yaers but<55years	556	666	761	**1,983**
55+	32	51	70	**153**

Discussion: In a total of 2,360 people tested positive, from Table 4.13 only 153 people were above age 55 and 224 were below 15 years the rest 1,983 representing 84% were between ages 15 and 55years which constitute the working age group. This shows that epidemic is directly affecting labour and indirectly affects capital stock.

Also the number of children who were tested positive is alarming since a child's health status is the key factor in determining his height, achievement in school, IQ, labour market productivity, reduced middle-and late –age mortality and delayed onset of many chronic health limitations which can be expected to impact labour force participation and productivity per hour worked or wage rates, as well as welfare (Schultz, 2007).

Major channels for economic impact of Hepatitis B

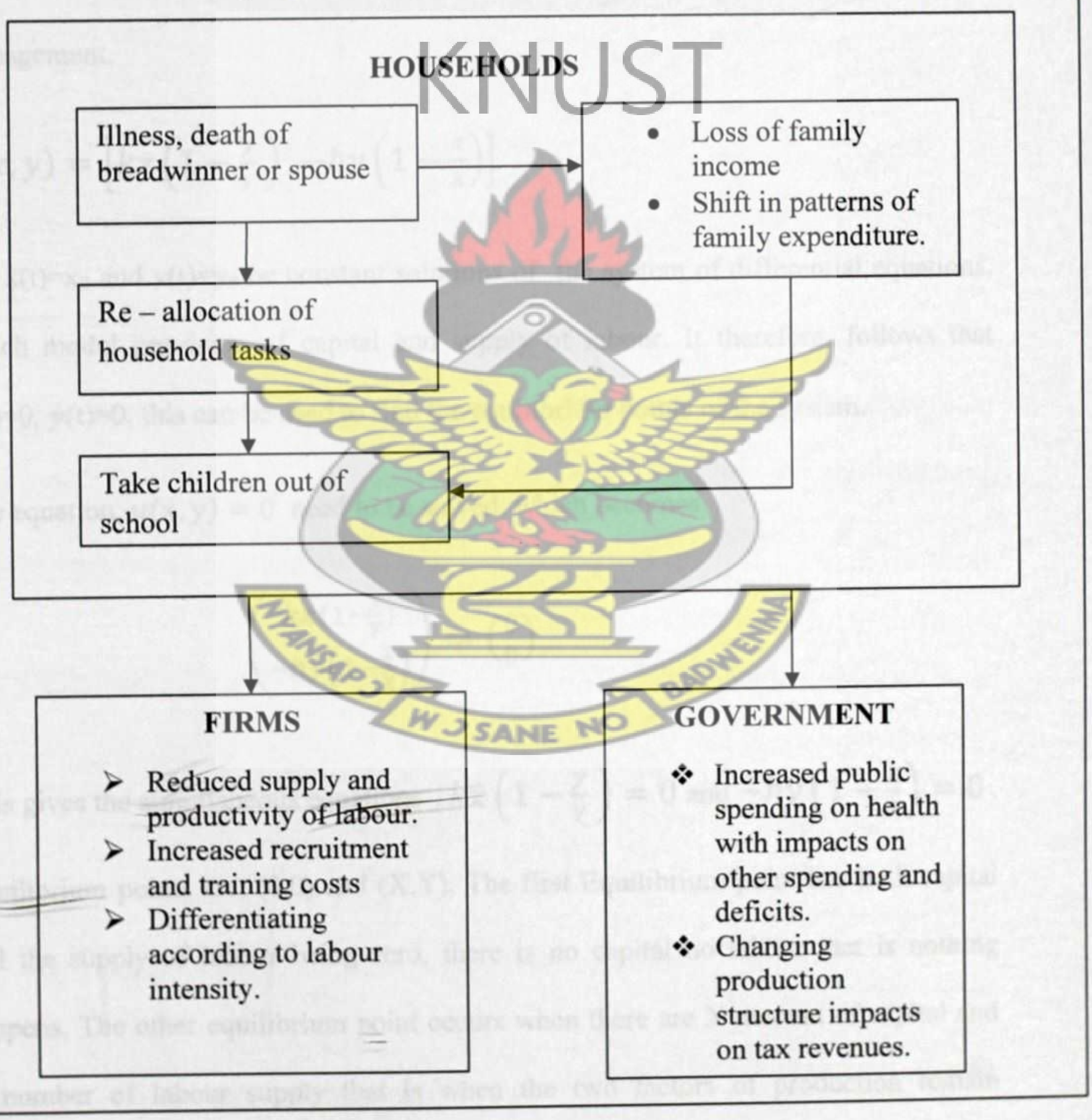

Chart 4.1: Major channels for economic impact of Hepatitis B

As the data reveals the tragedies being caused by Hepatitis B the municipality, it can naturally be fitted into the pair of equations which has been constructed in the model for the present analysis.

Consider together, this pair of equations is called first-order system (only first derivative, but more than one independent variable) of differential equations that models the impact of Hepatitis B on labour and capital the Techiman Municipality. It is assumed that Hepatitis B can also affect those who own capital –top level management.

$$u(x,y) = \left[kx\left(1-\frac{y}{Y}\right), -hy\left(1-\frac{x}{X}\right)\right]$$

Let $x(t)=x_0$ and $y(t)=y_0$ be constant solutions of the system of differential equations, which model provision of capital and supply of labour. It therefore, follows that $\dot{x}(t)=0$, $\dot{y}(t)=0$, this can be used to find the equilibrium points of the system.

The equation, $u(x,y) = 0$ need to be solved, which becomes

$$\begin{pmatrix} kx(1-\frac{y}{Y}) \\ -hy(1-\frac{x}{X}) \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

This gives the simultaneous equations $kx\left(1-\frac{y}{Y}\right) = 0$ and $-hy\left(1-\frac{x}{X}\right) = 0$.

Equilibrium points are; (0,0) and (X,Y). The first Equilibrium point has both capital and the supply of labour being zero, there is no capital no labour that is nothing happens. The other equilibrium point occurs when there are X amount of capital and Y number of labour supply that is when the two factors of production remain constant.

In order to find the linear approximation of this non- linear system, each component of the vector u(x,y) should be written as a function of two variables, x and y

$$U(x,y)=[u(x,y),\ v(x,y)]^T$$

This can be represented in a matrix form as;

$$\begin{pmatrix} u(x,y) \\ v(x,y) \end{pmatrix} = \begin{pmatrix} \frac{\partial u}{\partial x}(x,y), \frac{\partial u}{\partial y}(x,y) \\ \frac{\partial v}{\partial x}(x,y), \frac{\partial v}{\partial y}(x,y) \end{pmatrix} \begin{pmatrix} p \\ q \end{pmatrix}$$

Where $x(t)=x_e+p(t)$ $y(t)=y_e+p(t)$

It is also true that $\dot{x}=\dot{p}$ and $\dot{y}=\dot{q}$

The linear approximations to the non-linear system for the perturbation (changes in the factors of production caused by severe health hazard, Hepatitis B in this situation), p and q from the equilibrium point (X,Y) is $\dot{p}=\frac{-kX}{Y}q$ and $\dot{q}=\frac{hY}{X}p$

The matrix coefficient that arise from the linear approximation is

$$\begin{pmatrix} 0 & \frac{-kX}{Y}q \\ \frac{hY}{X}p & 0 \end{pmatrix}$$

The matrix equation that results from this is as shown below;

$$\begin{pmatrix} p \\ q \end{pmatrix} = \begin{pmatrix} 0 & \frac{-kX}{Y} \\ \frac{hY}{X} & 0 \end{pmatrix} \begin{pmatrix} p \\ q \end{pmatrix}$$

Using the eigenvalue, eigenvector, method for solving the equation gives;

$$\begin{pmatrix} p \\ q \end{pmatrix} = \begin{pmatrix} -\lambda & \frac{-kX}{Y} \\ \frac{hY}{X} & -\lambda \end{pmatrix} \begin{pmatrix} p \\ q \end{pmatrix}$$

The det. $(A-\lambda I) = 0$, from which the characteristic equation

$\lambda^2 + hk = 0$, where h=0.18 and k=0.05

$\lambda^2 + 0.009 = 0$, $\lambda = \pm 0.09i$

When $\lambda = 0.09i$, the corresponding eigenvector is $\begin{pmatrix} 1 \\ -0.09i \end{pmatrix}$, but when $\lambda = -0.09i$ the corresponding eigenvector is $\begin{pmatrix} 1 \\ 0.09i \end{pmatrix}$. The general solution becomes;

$$\begin{pmatrix} p(t) \\ q(t) \end{pmatrix} = A \begin{pmatrix} 1 \\ -0.09i \end{pmatrix} e^{0.09it} + B \begin{pmatrix} 1 \\ 0.09i \end{pmatrix} e^{-0.09it}$$

Further still the general solution becomes;

$$\begin{pmatrix} p(t) \\ q(t) \end{pmatrix} = C \begin{pmatrix} \cos 0.09t \\ 0.09 \sin 0.09t \end{pmatrix} + D \begin{pmatrix} \sin 0.09t \\ -0.09 \cos 0.09t \end{pmatrix}$$

Since the eigenvalues of the matrix of coefficients are purely imaginary, the equation of the trajectories is $K=C^2+D^2$, so the paths are approximately circular, or elliptical. An equilibrium point which has the behaviour in its neighbourhood is called a stable centre. So the equilibrium point (X, Y)=(1000,100) of the original non-linear system of the model is a stable centre.

It assumed that Hepatitis B directly affect labour supply, and indirectly affect capital invested

The phase portrait of this behaviour together with the time history are shown here.

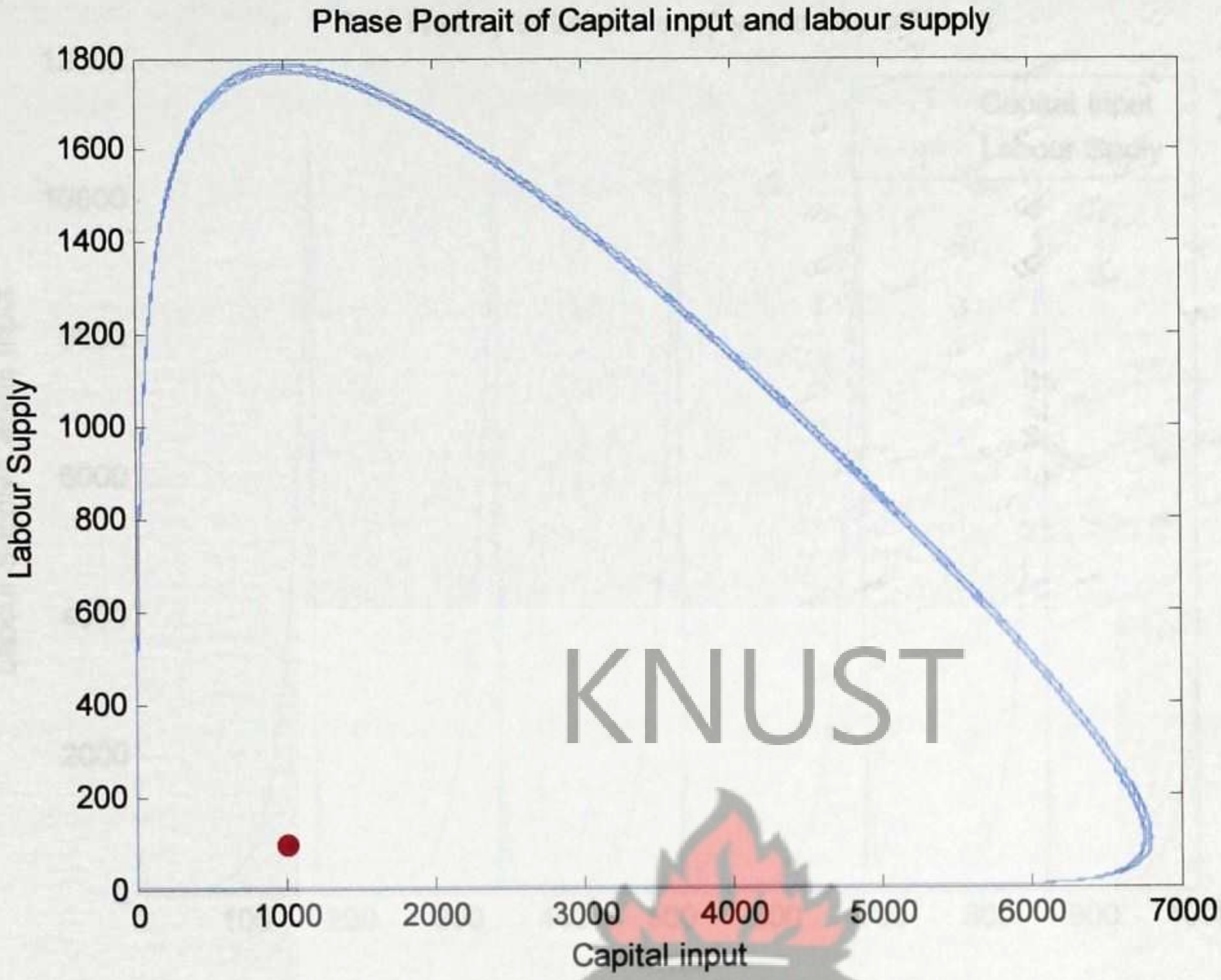

Fig.4.1: Phase Portrait of Capital Input and Labour Supply

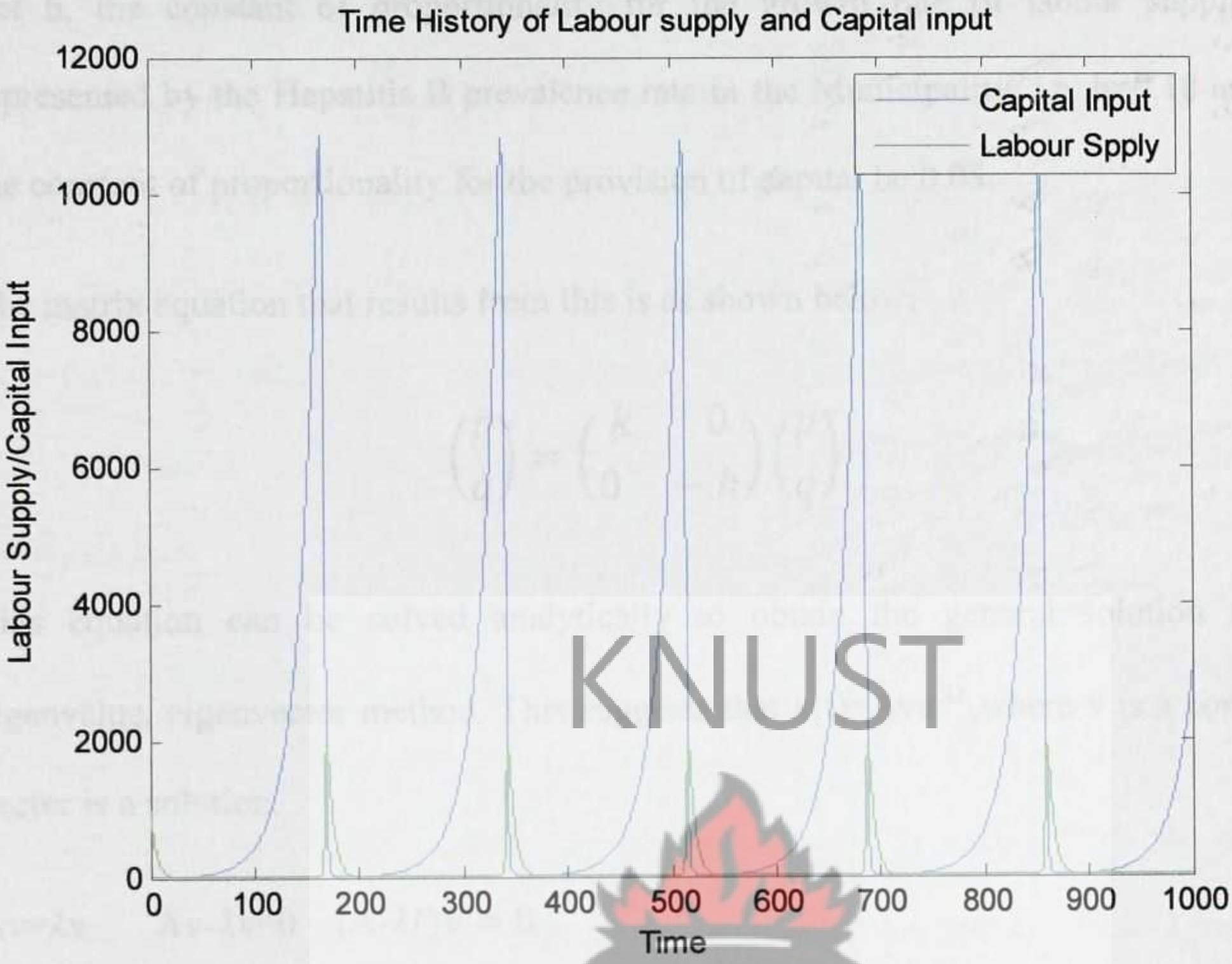

Fig.4.2: Time History of Labour Supply and Capital Input

Interpretations

We consider the phase portrait in Figure 4.1. Suppose initially both labour and capital are above the equilibrium point (1000, 100). In this circumstance, the labour increases at the expense of capital since there be more money for expansion in the economy. This will continue until there is no enough money to pay and cater for the health needs of workers and the labour population will also decrease until it drops below the equilibrium point. Now capital will recover since there would be fewer workers to be catered for and it will eventually increase above its steady-state and labour will pick up again and the cycle repeated. Figure 4.2 also shows that both capital and labour vary periodically.

Let h, the constant of proportionality for the growth rate of labour supply be represented by the Hepatitis B prevalence rate in the Municipality, i.e. h=0.18 and k, the constant of proportionality for the provision of capital be 0.05.

The matrix equation that results from this is as shown below;

$$\begin{pmatrix}\dot{p}\\ \dot{q}\end{pmatrix} = \begin{pmatrix}k & 0\\ 0 & -h\end{pmatrix}\begin{pmatrix}p\\ q\end{pmatrix}$$

This equation can be solved analytically to obtain the general solution using eigenvalue, eigenvector method. This suggests that $x(t)=Ave^{\lambda t}$,where v is a constant vector is a solution.

$Av=\lambda v$ $\quad Av-\lambda v=0$ $\quad (A-\lambda I)v = 0$

$$\begin{pmatrix}\dot{p}\\ \dot{q}\end{pmatrix} = \begin{pmatrix}0.05 & 0\\ 0 & -0.18\end{pmatrix}\begin{pmatrix}p\\ q\end{pmatrix} \quad \det.(A-\lambda I) = 0$$

$$\begin{pmatrix}0.05-\lambda & 0\\ 0 & -0.18-\lambda\end{pmatrix}$$

The determinant is; $(0.05-\lambda)(-0.18-\lambda)=0$

The roots of this equation are; $\lambda = 0.05, \quad \lambda = -0.18$

The corresponding eigenvectors are; $\begin{pmatrix}1\\ 0\end{pmatrix}$ and $\begin{pmatrix}0\\ 1\end{pmatrix}$ the general solution can be written as;

$$\begin{pmatrix}p(t)\\ q(t)\end{pmatrix} = A\begin{pmatrix}1\\ 0\end{pmatrix}e^{-0.18t} + B\begin{pmatrix}0\\ 1\end{pmatrix}e^{0.05t}$$

The interest is in the behaviour of the phase path near the equilibrium point at p=0 and q=0. When B=0 and A≠ 0, on these paths are the solutions $p(t)=A\ e^{-0.18t}$,

q(t)=0 so the point (p(t),q(t)) moves towards the origin along the p-axis as t increases. On the other hand, the paths A=0 and B≠0, the solution gives p(t)=0, q(t)= $Be^{0.05t}$, so the point (p(t),q(t)) moves away from the origin along q-axis as t increases. Clearly, when these behaviours are plotted on a phase plane ,non stable phase paths or portraits will be seen, which therefore mean that ,the original non linear system also have an unstable saddle equilibrium point at (0,0). This behaviour will continue indefinitely.

But, this does not happen in real life economic situation, and is of no interest to the research. Results indicate a negative (though insignificant) effect of Hepatitis B on economic growth through capital. The negative impact of capital from the model could be as a result of capital spent in treatment and prevention of the epidemic, which now does not allow capital to have enough grip on the aggregate output in the Municipality.

Treatment of minor and major illness, temporary and permanent disabilities can throw labour households into the vortex of poverty. Substantial wage and productivity loss could be incurred during illness. Major illness can cause catastrophic expenditure to households, rendering them vulnerable by liquidating assets, borrowing heavily and pulling further into deep poverty. Moreover, unlike the households with fairly secured/permanent source of income, households depending on income from manual casual labour face double burden of health care expenditure in case of illness of working members, direct payment as well as loss of income. Lack of social security and low levels of income often compel these households to compromise on required duration of treatment. This has long-term consequences not only on worker's health and poverty but also on labour productivity, economic growth, and social welfare.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 OVERVIEW

This chapter consists of the summary, of the study, conclusion, and recommendations for stake holders, policy makers, and for further studies.

5.2 SUMMARY

The study was designed to find out the economic impact of Hepatitis B on labour and capital in the Techiman Municipality. The national Hepatitis B prevalence is 15% but the prevalence rate for the Techiman Municipality is 18% which is higher than the national rate.

The research design was simple descriptive research. It was found out that, the Hepatitis B infection in the Municipality is concentrated in the working age that is between 15 and 55 years (Table 4.13). One of the peculiarly vicious tragedies of Hepatitis B is that just as it is demanding that we do more in treatment and prevention of the epidemic, it is undermining capacity even to maintain what we are doing. There is an increase in mortality and morbidity as a result of Hepatitis B; living standards are being reduced directly. It is also changing the age structure of the population and labour forces, which can adversely affect economic output. The most obvious patterns of mortality and morbidity around the globe are found among the poor, who lack the basic resources for disease prevention and treatment. This agrees with the finding of Ogum and Ikechukwu (2004) that poverty is a fertile ground for the spread of epidemics.

An understanding of global development over the short and long term, therefore, requires a broader scientific understanding of the complex interactions between infectious diseases and human reproductive and economic behaviour. Clearly, reductions in the disease burdens can be achieved through lower fertility.

The data for this study were secondary data obtained from the various health institutions in the Techiman Municipality. In the survey period 13,345 people were tested and out of this number 2,360 people were positive and there were 62 deaths.

A model which appropriately relies on the principles of predator-pray was developed to study the dynamics of interaction between the growth of capital, effective labour supply, and health hazard such as Hepatitis B prevalence, and its repercussions on the economic growth of the Municipality.

A pair of first order system of differential equations was constructed. The pair of equations was solved analytically to obtain the general solution, using eigenvalue, eigenvector method. Two equilibrium points (0, 0) and (X, Y) were obtained from the linearized differential equations which approximated the original non-linear system. The stability of the equilibrium point (0, 0) was found to be unstable saddle point. But the stability of (X, Y) was found to be stable centre, since the eigenvalues were purely imaginary. The interest of research was in the behaviour of the face path near the equilibrium point (X, Y). The interpretation is that if there is no infectious disease in the economy labour will be more active and increase output which will directly increase capital. On the other hand, when there is epidemic like Hepatitis B, labour will be less active and indirectly capital will also fall. Therefore, for a better growth in the economy adequate measures should be taken to curb the disease.

5.3 CONCLUSION

From the findings, the following conclusions could be made on the problem set for investigation. There is high prevalence rate of the disease in the Techiman Municpallity ,a rate of 18% as against the national prevalence rate of 15%. The rate is also high in the working age (i.e15-55years) constituting 84% of the number tested positive. The epidemic has direct adverse impact on households' labour supply and indirectly on capital accumulation or investments.

It appears one vicious tragedy of the Hepatitis B is the long term macro-economic challenges it poses on the affected or infected individuals, and the nation as a whole. The epidemic is deepening poverty and reversing human development achievements in the Municipality.

5.4 RECOMMENDATIONS FOR POLICY MAKERS

It is herein recommended that for the municipal economy to grow, and citizens getting to develop themselves, then an integrated well-structured multidisciplinary approach to prevention and treatment of Hepatitis B, should be carried out continuously to mitigate the socioeconomic and psychological effects of the epidemic on individuals, communities and the nation as a whole.

There should be an increased awareness of the risk associated with the Hepatitis B in the Municipality. Again, there should be a free screening and immunization of the disease in the municipality and if possible the treatment and immunization of Hepatitis B should be included the National Health Insurance Schemes.

5.5 RECOMMENDATIONS FOR FURTHER STUDIES

The results of this research require further exploration with more consistent database, especially on labour force. More information is also needed on the social and economic cost of the Hepatitis B epidemic. Much further work is required to improve the availability and quality of data on Hepatitis B prevalence and aspect of labour force in regard to the informal and formal economies, persons in part time and temporary employment, women and men, workers of different ages, occupation groups, labour productivity and sources of income. This would make it possible to shed light on the relationship between and economic growth.

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APPENDIX

The matlab code used for the phase portrait is given below,

```
function phase_plot(tspan,y0)

%y0 - initial capital input and labour supply;tspan is the time range

X=1000; Y=100; %equilibrium point

[tout,yout]=ode45('sysma',tspan,y0)

%tout - a vector of time returned by the solver ode45

%yout - labour supply and capital input values calculated at each time point in the

%vector tout


capital_input=yout(:,1)

labour_supply=yout(:,2)

n=length(tout); N=ones(n,1);

x=X*N; y=Y*N;


%Phase portrait


figure(1)

plot(capital_input,labour_supply)

title('Phase Portrait of Capital input and labour supply')

xlabel('Capital input')

ylabel('Labour Supply')


%Labour supply and capital input plot over time
```

```
figure(2)
plot(tout,capital_input,tout,labour_supply)
title('Time History of  Labour supply and Capital input')
xlabel('Time')
ylabel('Labour Supply/Capital Input')
legend('Capital Input','Labour Spply')
```