CHAPTER FIVE

THE RESEARCH METHODOLOGY

5.1. Introduction

The objective of this chapter is to explain the methodology that we will adapt to investigate the impact public expenditure on social development index in Sudan. Following this introduction, in section (5.2) we explain the construction of a composite social development index. We describe the construction of health index using life expectancy at birth followed by construction of a composite education index using gross enrollment index and adult literacy index weighted averages. The research methodology and techniques adopted in measuring the impact of public expenditure on social development index well present in section (5.3) the section specifies and describes regression models used in examining the impact of public expenditure on health and education indices. Finally, section (5.4) concludes the chapter with brief summary.

5.2. Social Developments Index (SDI)

The social development index is defined by the most important indicators in social sector, mainly in health and education sectors. With regard to health sector, the indicators include: The number of hospitals, the number of beds, the number of dispensaries, the number of doctors, the number of specialists, the number of nurses, life expectancy at birth, infant mortality rate and under-five mortality rate. While the indicators of the education sector include: The numbers of educational institutions, teacher/pupils ratio, gross enrolment rate and adult literacy rate. Social development index is calculated using a simple methodology (weighted average). First, a sub index for each of the two components of the overall index is calculated. These two components are health and education indices. Performance in each dimension is expressed as a value between 0 and 1 by applying the following general formula:

$$\textbf{Dimension} = \frac{\textbf{Actual value} - \textbf{Minimum value}}{\textbf{Maximum value} - \textbf{Minimum value}} \ldots\ldots\ldots (5.1)$$

Among the reasons that composite indices have found such favor among development organizations and researchers in recent years are the following: first, a composite measure has the ability to summarize complex or multi-dimensional issues in a simple manner, making it possible for policymakers to get a tractable and representative sense of the situation in a given country as it stands in comparison with others. A measure such as GDP per capita, for example, provides a more intuitive understanding of the state of an economy, than a table of the output of different industries and sectors. Second, because they provide a single estimate, composite indices have substantial ease of interpretation over the use of multiple benchmarks, while quantification of a concept makes it possible to assess progress over time and to highlight cases where intervention may be needed. Third, the commitment to regularly produce and update quantitative ratings facilitates communication with ordinary citizens, including stakeholders in developing countries, showing both the commitment of an organization to a particular set of development challenges. Finally, composite indices are an important starting point for debate. Roberto Foa, Jeffery C. Tanner. (2006). therefore, these properties of composite indices made it a popular measure to be adopted in this respect.

Therefore, we analyze the social development index on the basis of health and education composite indices, as it presented in appendix (A.14). Health Index (HI) in health sector. While in education sector we construct the composite Education Index (EI) which comprised of the Gross Enrolment Index (GEI) and Adult Literacy Index (ALI). Table (5.1) explore the goalpost values that used in calculating the health and education indices.

Table (5.1): the Goalpost for Calculating Social Development Index.

Indicator	Maximum Value	Minimum Value
Life Expectancy at Birth	85	25
Gross Education enrollment rate	100	0
Adult literacy rate	100	0

In order to measure the degree of volatility of an indicator/index, we calculate the coefficient of variation (CV) for each indicator/ index. The coefficient of

variation is equal to standard deviation divided by the average (mean) multiplied by 100 as the following formula:

$$CV = \frac{S}{\bar{x}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.2)$$

Where: S is standard deviation and $\bar{x}$ is the mean of indicator/ index, multiplied by 100 to obtain the percentage.

Hence, following the same practice adopted in calculation of the Human Development Index (HDI), we have taken the simple arithmetic mean of the relevant achievement indicators for calculating the composite social development index.

5.2.1. The Health Index

In this subsection we calculate the health index using data set of life expectancy at birth which consists of annual time series spanning 1980 through 2009. Thus, the health index is calculated using the following formula:

$$HI = \frac{LEB_i - LEB_{Min}}{LEB_{Max} - LEB_{Min}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.3)$$

Where: HI: is health index, LEB_i : is the actual value of the life expectancy at birth in thr year i, LEB_{Max}: is maximum value of the life expectancy at birth, LEB_{Min} : is minimum value of the life expectancy at birth.

Thus, using this formula, we obtained the value of health index presented in. See appendix table (A.6). Hence, this index will influenced by many indicators such as health infrastructures indicators which are comprise of (physical and manpower indicators) as we will see in the following subsections.

5.2.1.1. Health Infrastructure in Sudan

Among others indicators that have substantial effects on health index are the health infrastructure, that have a magnitude importance in strengthen or/and weakening this index according to health institutions performance, thus, the variables that the, number of hospitals per1000000 population denoted by (Ho), the number of beds per100000 population (Be) and the number of dispensaries per 100000 population (Di), were considered to compute health physical indicator. However, we suppose that, this indicator has positive sign on health

index. In other side, the variables that the, number of doctors per100000 population (Do), the number of specialist per100000 population (Sp), the number of nurses per a doctor (Nu) were calculated to construct health manpower indicator. To examine the effects of the two components of health infrastructure (physical and human) we were scheduled them into two sub-indicators these are the health physical infrastructure indicator and the heath manpower indicator. Appendix tables (A.7) and (A.8) show the values of the variables that are used in constructing of these two health's infrastructure (physical and human) indicators.

5.2.1.2. Health Attainment in Sudan

The major variables that used to examining the potential impact on health index are the life expectancy at birth (Le), infant mortality rate (In) and under-five mortality rate (M). These three variables summarize the final outcome and the ultimate progress in the health sector. Life expectancy at birth is defined as the number of years a newborn infant would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life. In other words, it is the theoretical number of years a newborn will live if the age-specific mortality rates in the year of birth are taken as constant. Thus, life expectancy at birth was calculated using the following formula:

$$Le_0 = \frac{T_0}{I_0} \quad \text{(5..4)}$$

Where: Le_0 denoted to life expectancy at birth. T_0 is a total number of person year lived by population of life table to exact age 0 and I_0 denoted to radix of life table.

Hicks (1980) and Mazumdar (1996) said that, it seems appropriate to use life expectancy at birth as one as basic measure of the efficacy of a country's success in providing for basic needs. These single indicators directly reflect the level of health, nutrition, sanitation improvements, clean water and income, and thus indirectly link employment and shelter. Infant mortality rate is defined as the probability of dying between birth and exactly one year of age, expressed per1000 live births. In addition to performing a significant role in interpreting life expectancy in a country, infant mortality is a good indicator of the availability of the sanitation and clean water facilities that are crucial because of

the susceptibility of infants to water-borne diseases. Infant mortality has also been characterized as an outcome variable summarizing the degree of existence of contagious disease in a country, as infants are more susceptible to these problems. In addition, this indicator demonstrates rapid response to many health policies. Thus, a high figure would show that there are many people living in conditions under which basic health needs are not met (Mazumdar 1996; Goldstein 1985).however infant mortality rate was calculated by the following formula:

$$IMR = \frac{\text{death under age 1 in year}}{\text{livebirth in the same year}} X\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.5)$$

Under-five mortality rate is the probability of dying between birth and exactly five years of age, expressed per 1000 live births. It is widely documented as the most appropriate indicator of the cumulative exposure to the risk of death because it provides the best means of capturing mortality risks during the most vulnerable years of childhood, the first five years of life. It has several advantages over the infant mortality rate as a composite measure of health risks at childhood. Specifically, the risk of death from several of the diseases that are primary causes of infant mortality remains high in the early years of childhood. Consequently, it is also a suitable outcome measure in assessing the impact of various intervention programs intended at improving child survival (Ahmad and others 2000). Appendix (A.9) show the values of life expectancy at birth indicator that were used in calculating the health index and the values of infant mortality rate and under-five mortality rate which are expected to have negative effects (negative sign) on health index. However we suppose that, the impact of infant mortality rate and under-five mortality rate would take a negative sign with respect to health index.

5.2.2. The Education Index

In this subsection we present the indicators used in constructing the composite education index in Sudan during the period1980 - 2009. These indicators include the gross enrolment rate and adult literacy rate. Adult literacy rate defined by the number of literate adults (persons aged 15 years or more) as a percentage of the adult populations. Alternatively, the youth literacy rate for those 15-24 years old is defined as the number of literate adults (persons

between 15-24 years of age) as a percentage of the adult populations. Thus, the education index is comprised of two sub-indices these are:

5.2.2.1. Education Attainment Index

To measures the overall level of educational attainment achieved by the adult population, we take into account the percentage of the population age twenty-five years and older who have earned at least a high school diploma or equivalent, at least a bachelor's degree, or an advanced degree (master's, professional, doctoral, etc). Each category represents the percentage of the adult population who have achieved at least that level of attainment, meaning that the percentage of the population twenty-five and over with a graduate degree necessarily includes those with a bachelor's degree and those with a high school diploma or its equivalent. To calculate the attainment index, first an attainment sum is determined by adding the percentage of the population twenty-five and older with at least a high school diploma or equivalent, the percentage with at least a bachelor's degree, and the percentage with an advanced degree to those who have earned an associate's degree or those who have completed some college without earning a degree are counted in the "at least higher school" category, Thus, using data in appendix (A.10) attainment index is calculated from the following formula:

$$EAI = \frac{ALR_i - ALR_{Min}}{ALR_{Max} - ALR_{Min}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5.6)$$

Where: EAI is education attainment index, ALR_i is adult literacy rate in the year i , ALR_{Max} is maximum adult literacy rate. ALR_{Min} is minimum adult literacy rate.

5.2.2.2. The Gross Enrollment Rate Index

As the composite education attainment index are calculated using the above formula, then, the gross enrollment rate is based on a gross enrollment calculation that takes into account the total number of students enrolled in school (of any age at any level) divided by the total school-aged population of 6 to 24 year-olds in basic and secondary schools taking the simple arithmetic mean of gross enrollment rate in basic and secondary schools using data in appendix (A.11) gross enrollment rate index are computed by applying the following formula:

$$EnI = \frac{GER_i - GER_{Min}}{GER_{Max} - GER_{Min}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.7)$$

Where: EnI is gross enrollment rate index. GER_i is gross enrollment rate in the year i. GER_{Max} is maximum gross enrollment. $GER_{Minimum}$ is minimum gross enrollment rate

Therefore, these two education indices are combined into one index called the education index. In order to reflect the relative ease of enrolling students in school compared to getting students through a meaningful course of education (signified by the attainment of degrees), a two-thirds weight is applied to the attainment index and a one-third weight to the enrollment index to calculate the final education index as follows:

$$EI = \frac{2}{3} EAI + \frac{1}{3} EnI \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5.8)$$

Where: EI denoted to Education Index .EAI denoted to Education Attainment Index. EnI denoted to Enrollment Index.

Thus, in appendix tables (A.10) and (A.11) we calculate the education index presented in appendix table (A.12).

5.2.2.3 Education Infrastructure

Here in this subsection we intended to compute the education infrastructure index, for this purpose we use the number of educational institutions per 100000 population denoted by (Y_1) and the number of teachers per 100000 population denoted by (Y_2). To calculate the number of educational institutions per 100000 population firstly, we constructed basic schools by merge the number of intermediate schools for the years 1980 up to 1993, (the year when the basic schools system begin), to the primary schools and then we add the number of basic schools to the number of secondary schools then divided by the population's size to the same year then multiplied by 100000. For constructing teacher/pupils ratio denoted by (Y3) we take the simple arithmetic mean of teacher/pupils ratio form basic and secondary schools then we were construct the education infrastructure in Sudan as it illustrated in the appendix table (A.13).

5.3. The Research Methodology

One of the most popular methods to model the functional relationship between variables is OLS estimation procedure which is very simple and straightforward to apply, however, for OLS estimators to be ideal, some conditions are needed. One of these conditions is that, the error terms, are assumed to be independently distributed random variables whit zero mean and a constant variance. In this section we outline the research methodology that will be adopted in testing the impacts of public expenditure on health and education as the most important sectors on social development specifies regressions models that will be used in examining this impact. Thus, in this regards, Ordinary Least Squares technique (OLS) are adopted.

5.3.1. Regression Model

In this subsection we detailed the equations that are used for testing the impacts of our selected variables and indicators on social development indices in Sudan, thus our model consists of three equations as follows:

5.3.1.1. Health Index Equation

In view of the literature discussed in previous chapters, we note down that public expenditure influence health and education indices by wide range of factors, these includes, among others, all types of infrastructure and facilities related to health and education services, such as, hospitals, dispensaries, beds, schools. Therefore, in this subsection we identify factors that have direct effects on health and education services in Sudan. The health services function takes the following general form:

HI = F (HE, Re, M) ……..……..... (5.9)

Where the theoretical hypothesis to these variables is: $F_1 > 0, F_2 > 0 > 0, F_3 < 0$

HI= Health Index.

HE = public Health Expenditure as percentage of GDP.

Re = Real GDP per capita.

M = Under-Five Mortality Rate

Equation (5.9) suggest that, health index is function of public health expenditure as percentage of GDP, real GDP per capita and under-five mortality rate. Health index is a summarize of the whole health services output, for our analysis, we suppose that, all variables in equation (5.9) have positive sign except under-five mortality rate has negative sign on health index. From theoretical point of view, our considered variables in equation (5,9) affects health index by various diminutions, however, an increase in health expenditure as percentage of GDP has a major effect on boosting the health environment for facilitating delivery of health services, beside the provision of health sector by equipments and facilities needed in hospitals, clinics and health centers. Therefore, progress/ deterioration made in health infrastructure in its both side (physical and manpower) will be direct reflected directly on health index. In addition, the real GDP per capita variable plays positive significant role in enhancing family's affordability of health services, in view of public reduction policies that are implemented, where there is only a fraction of public expenditure available for funding health services, because of the structural adjustment programs (SAPs) and liberalization policies adopted in early1992. Thus, the excess burdens of public expenditure for these services lied exclusively on household budget.

In contrast to the effects of public expenditure as percentage of GDP and real GDP per capita on health index, under five mortality rates is expected to have a negative effect. Low mortality rate reflects the impact of various intervention programs intended at improving child survival, hence, the lower mortality rate indicates higher health index and the opposite is true. i.e, high mortality rate indicates bad living conditions and chronic situation health problems.

5.3.1.2. Education Index Equation

In this subsection, the education equation will present, thus, we are supposed that, education index is subordinate to the improvement and facilities made in the area of real GDP per capita, as well as the amount of the education expenditure as a percentage of GDP devoted to funding education services and infrastructure, we suppose that all of these variables has significant role in enhances the education index positively except pupils/ teacher ratio in which we

hypothesis to has a negative sign. Thus, the following equation summarizes the above relations as follows:

$EI = F(Re, EE, Y_1, Y_2, Y_3)$……..…..…..……(5.10)

Where the theoretical hypothesis to these variables is that: $F_1 > 0, F_2 > 0, F_3 > 0, F_4 > 0, F_5 < 0$

EI: is Education Index.

Re: is Real GDP per capita.

EE: is public Education Expenditure as percentage of GDP.

Y_1: is Education infrastructure.

Y_2: is Teachers per 100,000 Population.

Y_3: is Teacher /Pupils Ratio.

Furthermore, education index is influenced by public education expenditure as percentage of GDP devoted to this sector to enhance and facilitates various educational operations and activates the physical and manpower infrastructure. The government uses this sort of expenditure to make and/or provide the initial and basic education services available for common population, but the structural adjustment programs (SAPs) and liberalization policies adopted in Sudan since 1992, reduced public spending on social services significantly, consequently, we add the real GDP per capita as private source to enhance people's access and to meet the expense of educational services. For education infrastructure variable (Y_1) as it presented in the equation (5.10) we assume that it plays a significant role in improving education index. Moreover, the number of schools per 100000 is a good indicator of availability of schools (basic and secondary) for the residents, in addition to that, the number of teachers (Y_2) which considered as a manpower variable. The two indicators (Y_1) and (Y_2) enhance education index positively. When there is enough teachers, then the teacher/pupils ratio will fall i.e, the number of pupils under supervision of one teacher decreases which improve the educational quality. For this assumption, teacher /pupils ratio takes a negative sign meaning that lower teacher /pupils ratio is the higher education index.

5.2.1.3 Social Development Index Equation

In this subsection, we specify the social development index equation, and as we declared in the previous subsections; social development index is affected by many variables and indicators. We simplify these variables in the following equation:

SDI = F (Re, HE, EE, HPI, HMp, Y_1, Y_2)……..……..(5.11)

Where the theoretical hypothesis to these variables is that: $F_1 > 0$, $F_2 > 0$, $F_3 > 0$, $F_4 > 0$, $F_5 > 0$, $F_6 > 0$, $F_7 > 0$

Where SDI: is social development index

Re: is Real GDP Per capita.

HE: is public Health Expenditure as percentage of GDP.

EE: is public Education Expenditure as percentage of GDP.

HPI: is Health physical infrastructure.

HMp: is Health Manpower.

Y_1: is Education infrastructure.

Y_2: is Number of teachers per 100,000 populations.

Equation (5.11) suggest that, social development index is a function of real GDP per capita, public health and education expenditure as percentage of GDP, health (physical and manpower infrastructure), education (physical and manpower infrastructure). All of these variables and indicators determine and/or facilitate the social development index level. However, if people can earn higher rates of real GDP per capita then, they can be able to access and afford to enjoy any service that they want, and avoid any deficiency of services.

Hence, real GDP per capita is an important variable in determining the level of social development index. At the same time, public expenditure as percentage of GDP can play a substantial role in providing social services and one of the major factors that determine the level of social welfare, especially in the less development countries like Sudan. Thus, we assumed that, the level of public

expenditure as percentage of GDP devoted to health and education in Sudan plays significant role in enhancing social development index, especially in the first decade of our study period or just before the structural adjustment programs (SAPs) and liberalization policies adopted in Sudan since 1992, which reduced public spending on social services significantly.

Also, the level of infrastructure in health and education sectors is considered to play a central role in the level of social development index. Therefore, we assume that health and education infrastructure (physical and manpower) plays significant role in this index, because they provide a good environment for delivering services. For health infrastructure variables both (physical and manpower) infrastructure are expected to influence the index positively. Further, the promotions and development made in hospitals, beds health centers and dispensers (per 100000 population), over the past three decades is expected to enhance social development index significantly. In addition to health physical infrastructure, health manpower, constitutes especial importance for providing health services, such as, the availability of doctors and specialist in health institutions this, will boosts health services and improve health situation of people and thereby improve, their incomes, education levels and their social welfare.

However, medical health care subordinate to progress made in the area of health physical and manpower infrastructure, so if there is good infrastructure accommodations, there will be healthy educated people, therefore, equation (5.11) is used to examine the importance of infrastructure in health and education.

5.4. Summary

The chapter explained the construction of composite social development index, The components of this index was specified and described, also specified the methodology and techniques adopted in investigating the impact of public expenditure on social development index in Sudan during the period (1980-2009). The next chapter discusses the empirical results.