THE COST MATERNAL MORTALITY ON GROSS DOMESTIC PRODUCT IN SUDAN, 2015

Adel Ali Ahmed Mohamed[(1)] Ahmed Mohamed Hamef Nory[(2)]

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ABSTRACT:

The study attempted to estimate impact indicators of maternal mortality on gross domestic product for Sudan. This is done in two different ways. First the study establishes the bidirectional correlation between reducing maternal mortality and the economic gain from such reduction. It also establishes the impact mechanism of such bidirectional relationship by clearly illustrating that maternal mortality have a particular impact as it affects the most active segment of female population upon whom the burden of maternal death mostly falls. It clearly illustrates how investment in safe motherhood can result in national economic benefits from individual through the economy wide levels. The study conceptualized the burden of MM on GDP through a schematic representation and then modeled this conceptual framework using statistical and econometric model. The study reviewed previous studies in the subject which are quite meager. Two estimates are provided: first by estimating the loss in Sudanese GDP attributable to maternal mortality through fitting a curve estimation technique using logit transformation of time series data on maternal mortality and gross domestic product for the period 1990 -2013. This model showed that If MMRs increases by 10 % GDP decreases by 6.5% and vise versa. The study also utilized Jose's M. Kirigia, 2012 results of loss in total GDP and annual GDP based on a double log econometric model applied to cross-sectional data for 45 of the 46 Member States in the WHO African Region. The results came out approximately similar to our logit result which shows that Sudan total GDP loss as a result of maternal mortality in is US$ 1133 and annual GDP loss as a result of annual number of maternal death as (US$2.81).

The conclusion that can be derived from this exercise is that investing in reproductive health; particularly on safe motherhood is smart economics

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(1) Professor, Sudan, University of Gezira, Faculty of Economic and Rural Development, Department of Applied Statistics and Demography.

(2): Associate Professor, Sudan, University of Gezira, Faculty of Economic and Rural Development, Department Applied Statistics and Demography.

Introduction

This study attempts to study the impact of maternal mortality (MM) on the Sudan economy. This can be used as a justification to prioritize MM in the development agenda. Economic impact is the effect that a certain indicator (for example, MM) has on the economy. The analysis of the economic impact of MM and interventions can be used to advocate for the necessity of spending more on safe motherhood initiatives interventions. It does this by illustrating the economic costs of not intervening, or by clarifying the direct link between reproductive ill-health or death and poverty[1]. Economic impact studies often use econometric or statistical correlation and regression models, which can produce confusing results that seem quite obscure for those unfamiliar with the methodology. However, the basic concepts and reasoning behind the models is rather straightforward and can prove helpful when arguing for more resources for MM.

First, the *macro* economic impact is the impact on the size and growth of economic variables that cover the economy as a whole. For example, the total volume of savings, investment and consumption by the different economic actors (households, companies, government, and the foreign sector) are key macroeconomic variables. As such, the macroeconomic impact follows the *micro* economy, the level at which the different economic actors are looked at individually. This covers, for example, the demand of consumers for certain products, such as drugs, the supply of those products by companies and the interaction between them, which determines the price of products. The most aggregated macroeconomic variable is the national income, which is the total value of goods and services produced in an economy. This is most often expressed in terms of the Gross Domestic Product (GDP) or the growth of GDP, also called

economic growth[2]. Another important measure of the macroeconomic impact is the income per capita (per person), which reflects the change in population growth compared to the change in economic growth. This measures, for example, how while MM might lead to a reduction in the total value of the economy (reduction in economic growth), there will also be fewer people to share this income with (reduction in population growth).

Impact mechanism of Maternal Mortality on the GDP:

Advocacy for public health interventions often refers to the macroeconomic impact with statements like "a 10 per cent reduction in MM is associated with 0.4 per cent higher growth of national income". However, this is only the tip of the iceberg. Given that the impact of illness and death are greatest at micro level, much of the effect will be diluted by the time it reaches the macro level. It is very difficult for economic modelers to forecast and combine all the interrelated effects over a longer time frame, especially since an economy will adapt the way it works to different circumstances, such as an increase in women death. For example, private companies will find ways to minimize the costs of death of employees, because they have to guard their profits[3]**.** They might decide to lower health care benefits or reduce the size of their workforce rather than suffer lower profits. So there may not be a visible economic impact caused by loss-making companies. Instead, there might be an economic impact caused by increased household poverty as a result of companies lowering health care benefits or reducing the size of their workforce. The way in which increased poverty subsequently interacts with the macro economy is less well understood[3].

In general, the health status of a population will have an economic impact. However, MM will have a particular economic impact because of the focus on 1) sexually active females, 2) mothers, and 3) family planning. First, the burden of maternal death falls mostly on *sexually active women*, which is also the age at which women are most active economically and have children. This is in contrast to most other diseases that hit hardest amongst the youngest or oldest females in a population, Women who are dependents rather than income earners or careers. A maternal death event in households, therefore, significantly lowers the productivity in households and in the

labor force, thus affecting the capacity of the economy as a whole. Second, WHO,2001[4] showed that reproductive health problems accounted for 32% of the global burden of diseases among women of reproductive ages. This is important even though it is not always acknowledged in official statistics. Women make a significant contribution to the production of goods and services in every country. This can be through formal or informal wage labor or unpaid work in the household. Moreover, women also contribute to the economy by providing care for dependants such as children and the elderly, though economists find it difficult to measure the monetary value of such work.

According to UNFPA, the unmet need for contraceptive services in developing countries (about 200 million women in 2003) would avert 52 million unintended pregnancies annually and this would prevent the death of more than 1.5 million women. Clearly the loss of 1.5 million women will have an economic impact, not only through the loss of their productivity as workers and careers. There will also be longer-term economic implications of 505,000 children losing their mothers, in addition to the short-term costs to governments for the provision of social care.[5] For example, orphans have a high risk of missing out on education. This increases levels of unemployment and poverty over the long term, because these orphans might be less employable. Therefore, in countries with a large number of orphans, the economy as a whole will suffer from reduced productivity. Third, maternity services also have an impact on the economy through enabling *family planning*. These services enable people to plan their family and chose whether and/or when to have children. This enables them to make more optimal use of their income, for example by having more financial resources for the education of each child. Moreover, by enabling women to delay childbearing, these services can improve women's social and economic position, which will increase the productive capacity of the economy as a whole**.**

Modeling Impact mechanism of Maternal Mortality on the GDP:

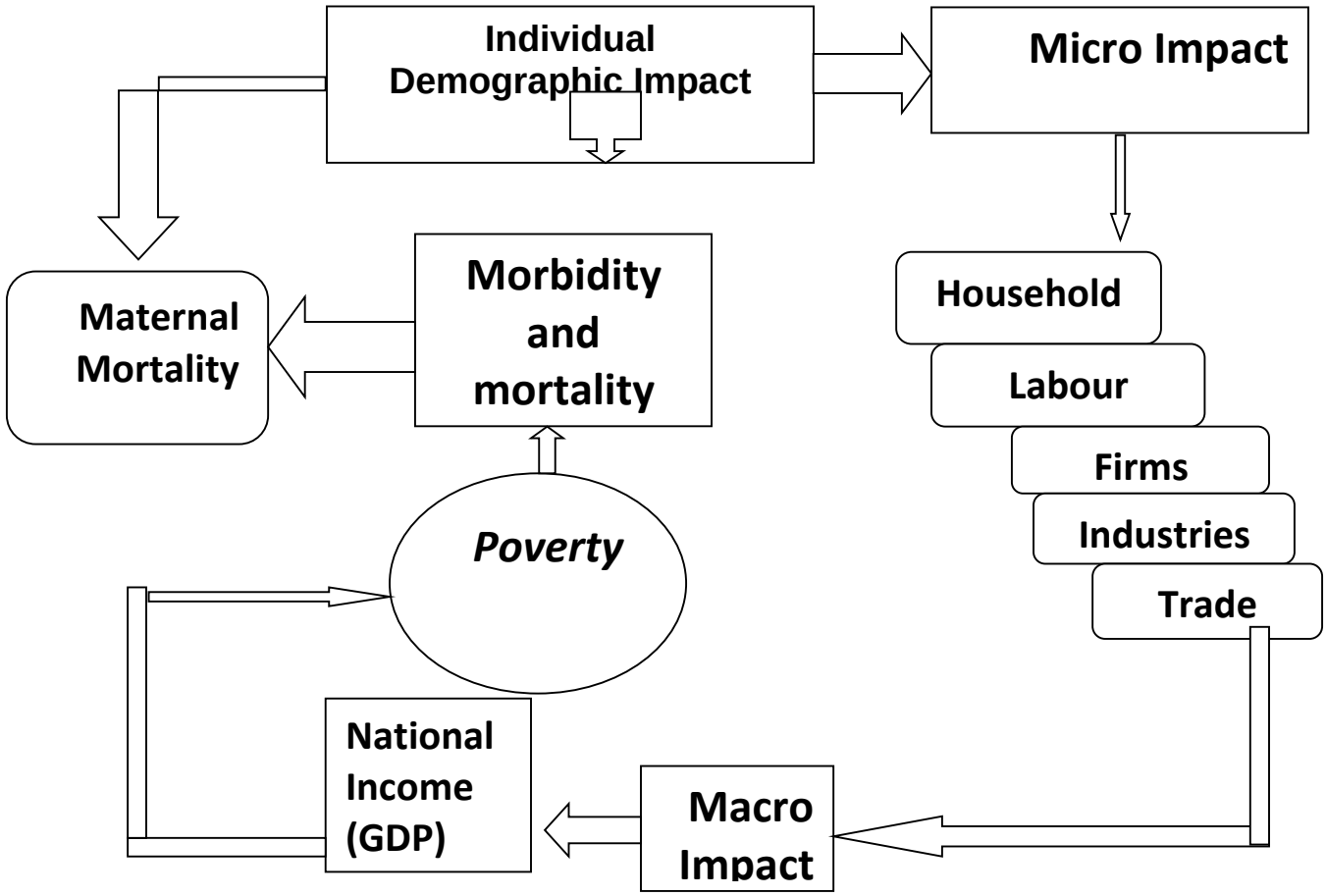
Econometric models are models that apply mathematical and statistical techniques to economics for the analysis of problems and forecasting. These models are simplified representations of the way in which economic actors – such as consumers, producers,

and government – interact with each other and react to changes in economic variables, such as an increase in interest rates. Models that incorporate MM focus on the reaction of the economic actors in a particular country to the effect on the economy due to maternal death. The main channels through which maternal death affects the economy are: The reduction in life expectancy and the higher risk of a woman death will affect household decision-making, for example about the need for savings and longer-term investments. Also at the *household level*, MM puts strain on other household members, who have to become family breadwinners when heads of households die. Maternal death also leads people to divert resources and time towards health care instead of other essentials. Especially worrying is the increased death rate among the careers and breadwinners relative to the dependents (elderly and young women). Orphaned children often suffer ill health and receive less education than other children. This can reduce the productivity of an economy in the future. As such, MM can lead to an increase in household poverty and subsequently to an increase in income inequality, depending on how affected households cope socially and economically.

Certain industrial *sectors* – such as mining, agriculture, the health sector and financial services – can be more affected than others. This depends on the extent of maternal morbidity risk of the employees and gender employment level. It will also depends on the vulnerability of the production process to the increased levels of maternal related death among both the workforce and the consumers of the products. These changes will have an impact on the long-term capacity of a country to produce goods and services.

Apart from the effects of MM on the civil service workforce, *governments* will need to deal with increased demand for their services, especially if the public sector is gender dominant, not only in the health sector but also in other affected sectors, such as social welfare, education, trade and industry. As such, given budget constraints, governments must make hard choices about how to handle the increasing costs and reduced income. Options are to reduce other expenditure (’crowding out’ of non-RH expenditures), increase taxation or increase government debt, all of which will have a different impact on the economy.

Furthermore, the economic impact of MM does not confine itself to a particular country, but will also have an impact on the *regional and international* environment. For example, in most cases, drugs will need to be imported from abroad. Also, the anticipation of the economic impact of MM, if closely related to Sexually Transmitted Diseases, Such as AIDs , could reduce foreign investment in an affected country.



Source: Adapted from Resource Book : The Economic of sexual and RH , Royal *Tropical Institute Kit, February 2008*

Fig.(1) Schematic Representation of the conceptual framework of MM impact on GDP

As illustrated in figure (1), these impacts and the way in which the different actors react to them, will affect the total amount and value of goods and services produced in a country, now and in the future (GDP and GDP growth). Moreover, it clearly shows

how dynamic the interaction is: while MM will have an impact on the economy, the changes this causes in the economy will also have an impact on MM.

Related Works:

The literature in the field is quite meager. Our enormous effort searching the literature has resulted in only four related researches all over the globe. These researches attempts are described below.

Compernolle etal (2008)[2] drafted a resource book titled the "Economy of Sexual and Reproductive Health" This booklet provides an overview of how Sexual and Reproductive Health (SRH) has an impact on the economy and especially on poverty. This can be used as a justification to prioritize SRH in the development agenda. The example of AIDS was used to illustrate how economists have modelled this economic impact. However, it is also possible to undertake a similar analysis of the economic impact of other SRH issues, such as unwanted pregnancy or maternal health. This booklet answers questions such as:

· What does economic impact mean?

· What are the most important ways in which AIDS and other SRH problems affect? the economy?

· What are the limitations of the models that economists use to determine the economic impact?

· Why is it more useful to look at the economic impact at household, company or government level than at the economy as a whole?

Aresha and Gerdtham (2013)[1] in their study Impact of Maternal and Child Health on Economic Growth: New Evidence Based Granger Causality and DEA Analysis examined whether there are relationships between maternal and child health outcomes and economic growth in different countries at different income levels, and, given such relationships, (ii) they estimated the direction and magnitude of these relationships. As

measures of maternal and child health, they used the under-five mortality rate (the number of deaths of children under five per 1,000 live births) and the maternal mortality ratio (the number of deaths per 100,000 live births). Data on mortality in 1990-2010 was taken from the WHO global data repository (http://apps.who.int/ghodata/) including 180 countries for under-five mortality and 170 countries for maternal mortality. As a measure of economic growth they used per capita GDP in 1990-2010 in 2000 US$ from the World Bank's World Development Indicators 2012:http://devdata.worldbank.org/wdi2011.htm.

To examine whether there are relationships between maternal and child mortality and economic growth they used international country-level panel data and Granger causality analysis to identify the direction of the relationships between GDP and maternal and child mortality and to estimate the rough magnitude of the effects involved. In 105 of 180 (58%) countries, they found bi-directional relationships. This indicates that in the majority of countries, changes in under-five mortality have an impact on GDP and vice versa.

In 49 countries (27%) they found one-way relationships from under-five mortality to GDP. In 14 countries (8%) they found one-way relationships from GDP to under-five mortality. For the remaining 12 countries (7%), no relationships are found. In 68 of 170 (40%) countries they found bi-directional relationships. One-way relationships from maternal mortality to GDP are found in 50 countries (29%) and one-way relationships from GDP to maternal mortality are found in 19 countries (11%). No relationships are found in 33 countries (19%).

They concluded that in general the relationships between maternal and child health outcomes and GDP run in both directions, with the majority running from maternal and child health to GDP. They found evidence that the causal effects of GDP on maternal and child health outcomes are stronger, especially in low income countries. They thought that this may reflect that the effect of marginal health investments on health outcomes is higher at low levels of GDP, i.e. in countries where the level of health investments is generally lower.

David Canning and Paul Schultz (2012)[3] considered the evidence for the effect of access to reproductive health services on the achievement of Millennium Development Goals 1, 2, and 3, which aim to eradicate extreme poverty and hunger, achieve universal primary education, and promote gender equality and empower women. At the household level, controlled trials in Matlab, Bangladesh, and Navrongo, Ghana, have shown that increasing access to family planning services reduces fertility and improves birth spacing. In the Matlab study, findings from long-term follow-up showed that women's earnings, assets, and body-mass indexes, and children's schooling and body mass indexes, substantially improved in areas with improved access to family planning services compared with outcomes in control areas. At the macroeconomic level, reductions in fertility enhance economic growth as a result of reduced youth dependency and an increased number of women participating in paid labour.

Kirigia, etal (2006)[5] estimated the loss in GDP attributable to maternal mortality in the WHO African Region. The burden of maternal mortality on GDP was estimated using a double log econometric model. The analysis is based on cross-sectional data for 45 of the 46 Member States in the WHO African Region. Data were obtained from UNDP and the World Bank publications. All the explanatory variables included in the double log model were found to have statistically significant effect on per capita gross domestic product (GDP) at 5% level in a t-distribution test. The coefficients for land (D), capital (K), educational enrolment (EN) and exports (X) had a positive sign; while labor (L), imports (M) and maternal mortality rate (MMR) were found to impact negatively on GDP. Maternal mortality of a single person was found to reduce per capita GDP by US$ 0.36 per year. The study has demonstrated that maternal mortality has a statistically significant negative effect on GDP. Thus, as policy-makers strive to increase GDP through land reform programs, capital investments, export promotion and increase in educational enrolment, they should always remember that investments in maternal mortality reducing interventions promises significant economic returns.

Models and Specifications:

Models to be used here are statistical inference models based on correlation and econometric models. The specification of each model depends on the linearity of the data involved. In some instance log log or logit transformation was necessary. The

dependent variable is all through the MMR . MMR is defined as the maternal death per 100000 live birth. The independent variable is interchangeably the GDP and annual GDP**.** The gross domestic product (GDP) is one of the main national output measures. GDP is the sum of total value of consumption expenditure; total value of investment expenditure; government purchases of goods and services; and net exports (i.e. exports minus imports) of goods and services. Alternatively, it can be viewed as the total value of consumption expenditure; gross private saving (business saving + personal saving + depreciation); net tax revenues (tax revenue minus domestic transfer payments, net interest paid, and net subsidies); and total private transfer payments to foreigners. Intuitively, maternal mortality can impact on the production of GDP in a number of ways.[5]

Data

The difficulty inherent in this investigation is that it attempts to apply models for cross sectional data for one country. Such data is not available for Sudan. Kirigia, etal analysis was based on cross-sectional data for 45 of the 46 Member States in the WHO African Region.[5] Similar exercise could not be done here because Sudan belong to the Mediterranean, West Asia, and north Africa WHO region. Most of the countries in this region have MMRs less than 10 with high GDP. As such one has two alternatives; either to rerun the Kirigia model but include Sudan in the Cob-Douglass model, or to fit a model to Kirigia final result and use the fitted model to predict the economic loss in the Sudanese GDP impacted by its maternal mortality level.

The first choice would be better, but it needs data other than MMR for Sudan (Such as capital stock proxied by gross domestic investment (as a percentage of GDP , It consists of additions to fixed assets of the economy plus net changes in inventory) in addition to a production function for the measurement GDP elasticity.

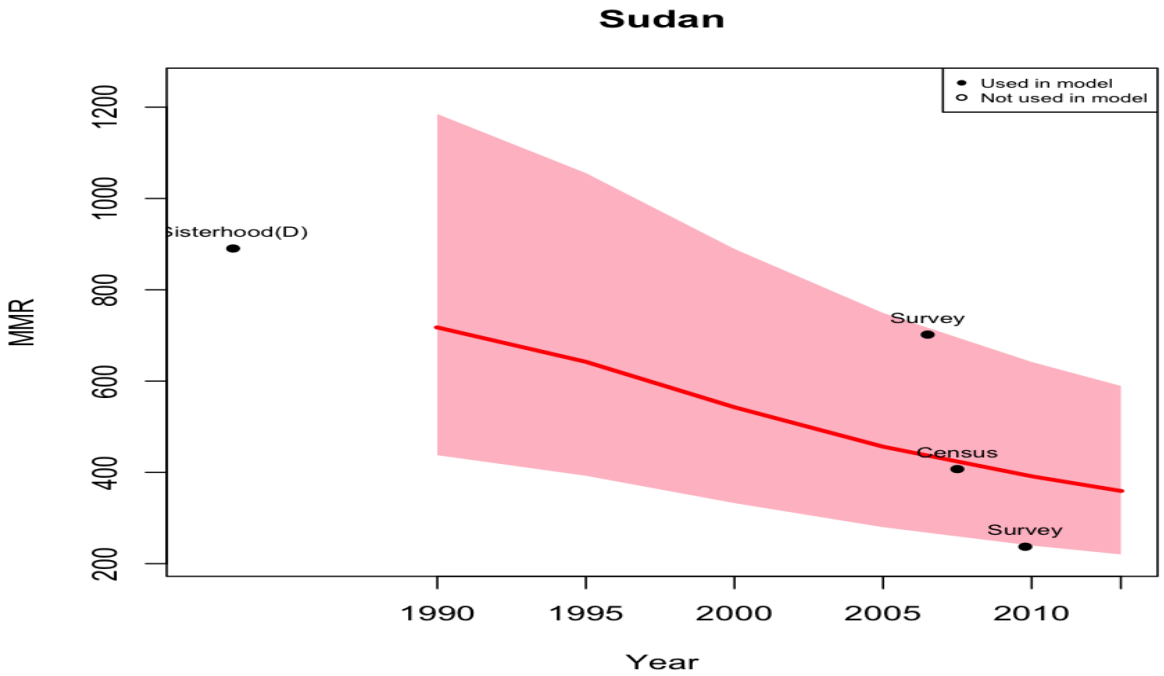
For this reason we chose the second alternative whereby we fitted a linearized bidirectional model and predicted Sudan GDP loss due to maternal death. But first we run correlational analysis with t-test to determine the direction and magnitude of the relationship between GDP as time series and the corresponding MMRs for the same period using available Sudan time series data.

The data for the correlation analysis was obtained from different sources: GDP values are from the CBS for the period 1990-2008[7], but for the period 2009-2013 we used World Bank Report 2014 estimates.[8] GDPs are calculated in American dollar at 2005 as base year. To obtain similar time series data for MMR for the same period was a complicated task. We have to extrapolate 24 point estimates from 6 observed points for 1990, 1999, 2000, 2006, 2008 and 2010. We utilized WHO, UNICEF, UNFPA, The World Bank and United Nations Population division maternal mortality estimation inter- agency group Sudan 1990-2013[9]. However, the resulting MMRs distribution estimates based on this estimation procedure was not robust, see fig(1).

We had to smooth the data using 5-years moving average to attach some stationarity to the data. Table (1) shows GDP and maternal mortality ratios for the period 1990-2013.

The two sets of data are plotted in a scatter in fig(2). Unfortunately, the relationship between MMRs and GDP is not strictly linear though the directional pattern is negative and r^2 is around 0.6, which at least shows that MMRs has a negative impact on the GDP.

Maternal mortality in 1990-2013 WHO, UNICEF, UNFPA, The World Bank, and United Nations Population Division Maternal Mortality Estimation Inter-Agency Group.



Source: Copied from World population prospects: the 2012 revision. New York, Population Division, Department of Economic and Social Affairs, United Nations Secretariat, 2012.

Fig.(2): maternal mortality trend 1990-2013

Table (1): Distribution MMRs and GDP per capita Sudan (1990-2013)

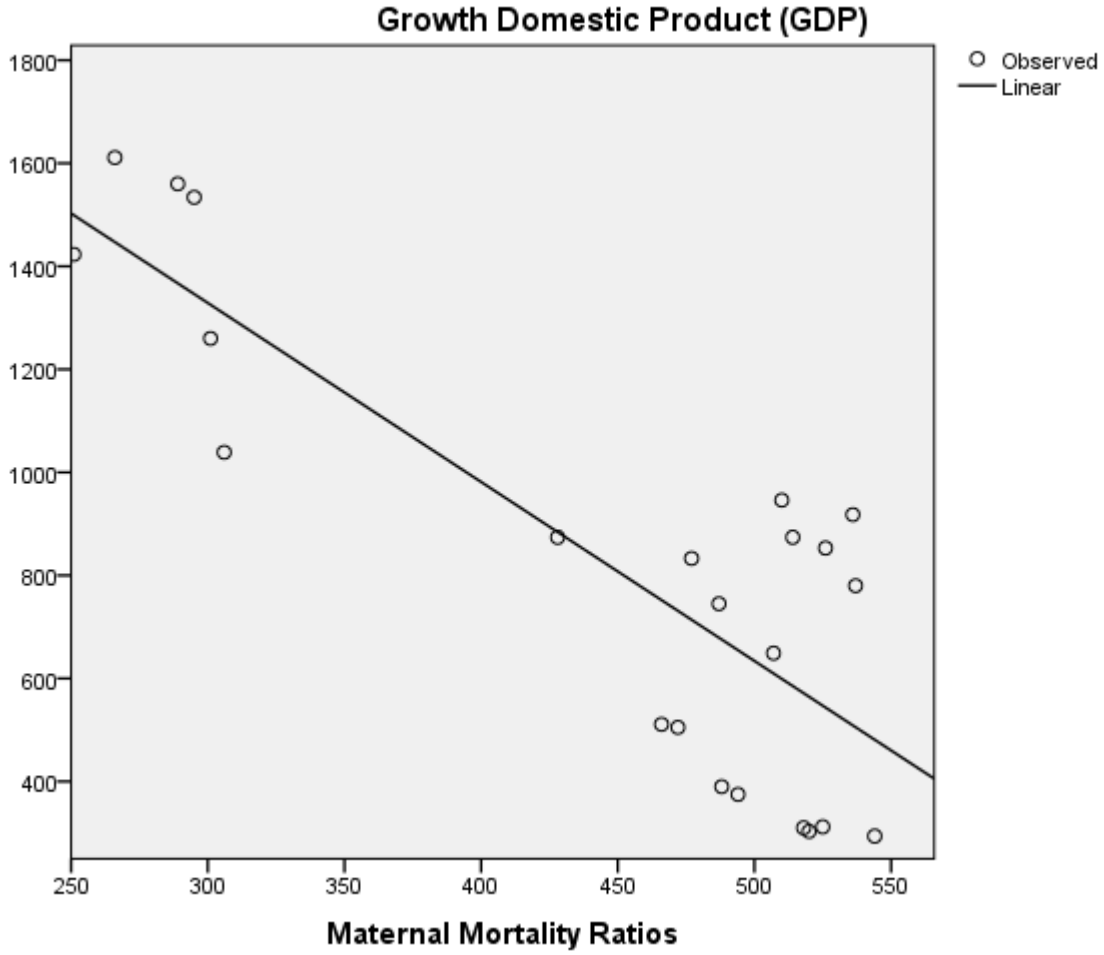
Year	Maternal Mortality Ratios (Maternal deaths per 100000 live births[a]	gross domestic product In US$ with 2005 as base year.[b]

1990	520	295
1991	518	303
1992	512	310
1993	494	375
1994	472	505
1995	466	511
1996	488	390
1997	487	745
1998	507	649
1999	525	312
2000	526	853
2001	510	946
2002	514	874
2003	536	918
2004	537	780
2005	477	833
2006	428	874
2007	306	1039
2008	301	1260
2009	295	1534
2010	289	1560
2012	266	1611
2013	251	1423

Source:[a] *Compiled from UNDP Human Development Reports (Various Issues) and Abdelmawla (2010).*[b]1. The World Bank Data Catalog, 2013 (http://datacatalog.worldbank.org/). 2. Penn World Tables 7.1. (https://pwt.sas.upenn.edu/) 3. World Health Organization. Country Profiles. MMRs were graduated by 5 – years moving average.

In order to be able to determine the magnitude of the negative directional correlation we resorted to a logit transformation[10] after converting both variables into proportions (p) upon dividing by 1000 and 10000 respectively and using the logit formula:

$$\textbf{Logit (p) = 0.5 log}_e \textbf{ (1-p/p)}$$



Source: SPSS data sheet based on table (1)

Fig.(2): MMRs and GDP, Sudan (1990-2013)

The transformation has some properties:-

When p = 0 then logit p = 0.5 $\log_e$ (1/0) = + infinity

When p = 1 then logit p = 0.5 $\log_e$ (0/1) = - infinity

When p = 0.5 then logit p = 0.5 $\log_e$ (0.5/0.5) = 0.0

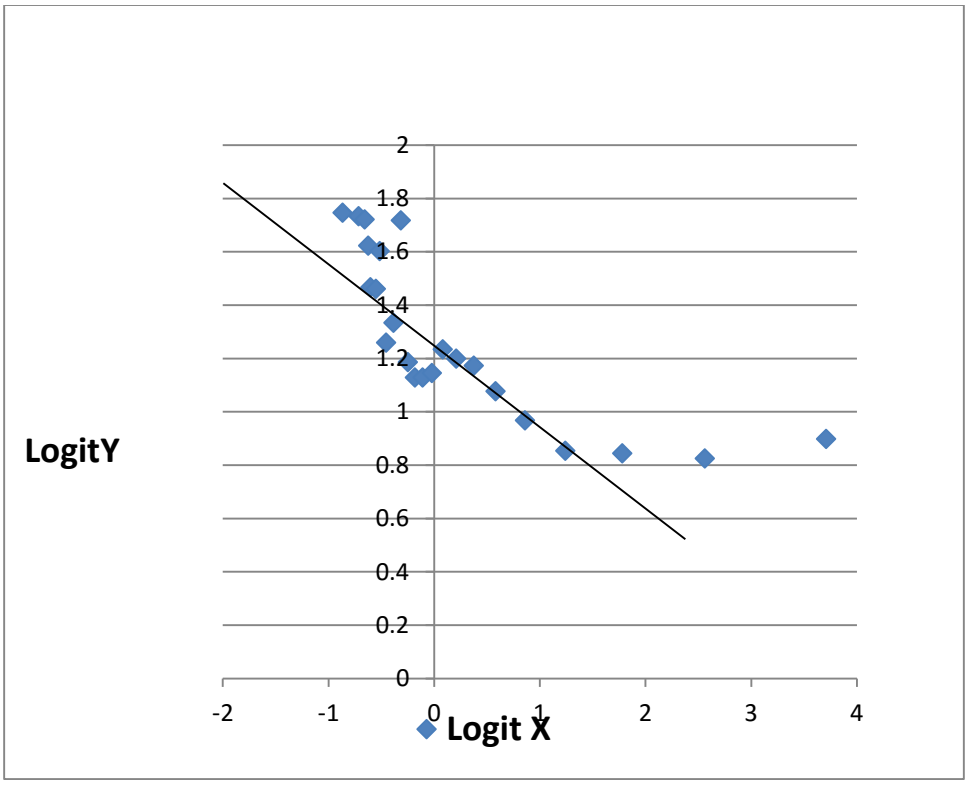
The table and the graph of the logit transformation is given in table (2) and figure (3) it can be seen that possible range of the transformed values is from minus infinity to plus infinity , whereas, of course, the range of the original proportion is from 0.0 to 1.0.

Table (2) Logits of

MMR and

Per capita GDP

Logit X	LogitY
-0.7153	1.73292
-0.6553	1.721139
-0.6218	1.622597
-0.6016	1.466981
-0.5498	1.460759
-0.5131	1.602206
-0.4551	1.259768
-0.3829	1.333903
-0.315	1.71782
-0.2469	1.186211
-0.1817	1.12936
-0.1073	1.12936
-0.0212	1.145926
0.0832	1.234918
0.21	1.199166
0.3746	1.172901
0.5818	1.077312
0.8611	0.968399
1.2433	0.85409
1.781	0.844148
2.5634	0.825033
3.709	0.898158



Fig(3) Scatter plot of the logit transformation

A strait line is fitted to the data in table (2) by using the group average method instead of ordinary least square method. This simply involves dividing MMR points into two groups and taking their average points and the same is done for the GDP points ,then drawing a line between the two by finding the gradient (β) of the line from these averages and then find the value of α .

It is clear that the transformation gives a better linearization between MMR and GDP. This is evident from the curve estimation model in table (3). The value of r^2 is 0.809 compared with 0.6 in the non transformed data. All model parameters suggest that there is a strong inverse correlation between MMR and GDP per capita. Person correlation coefficient is around 0.8 with very small variance and covariance (0.129) and (0.093) respectively.

Table (3)

Model Summary and Parameter Estimates

Dependent Variable: Logit Y

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.809	32.739	1	21	.000	2.459	-.065

The independent variable is Logit X.

Source: SPSS result sheet based on table 2.

The fitted line is:

$$\mathbf{MMR\ (x) = \alpha + \beta^{*}\ GDP\ (x)}$$

$$\mathbf{MMR(x)= 2.459 - 0.065\ (GDP)}$$

Given the value of β that tilts the relationship between the dependent and independent variables. If MMRs increases by 10 % GDP per capita decreases by 6.5% and vise versa. For example, if MMR in 2013 which is 251 increased in 2014 by 10% to become 276, the GDP per capita will decline from US$ 1423 to US$1331. Instead, if MMR decreased to 226 , GDP will rise to US$ 1516.

Estimating Sudan GDP loss Attributable to MMR using Kirigia Results for 45 African Countries.

As mentioned earlier, Kirigia, etal analysis was based on cross-sectional data for 45 of the 46 Member States in the WHO African Region. It is important to describe the econometric model structure use by Kirigia. He estimated a Cobb-Douglas production function of the following form:

$$GDP = aD^{\beta 1} L^{\beta 2} K^{\beta 3} HK^{\beta 4} EA^{\beta 5} OE^{\beta 6} MMR^{\beta 7} \varepsilon$$

Taking logarithms of both sides of the above equation, we obtain the following log-log (or double-log, log-linear or constant elasticity model):

$$\log GDP = \log a + \beta 1 \log D + \beta 2 \log L + \beta 3 \log K$$
$$+ \beta 4 \log HK + \beta 5 \log EA + \beta 6 \log OE + \beta 7 \log MMR + \varepsilon$$

where: log is the natural log (i.e., log to the base *e*, where is *e* equals 2.718); *a* is the intercept term; *β's* are the coefficients of elasticity (CoE), i.e. responsiveness; and ∈ is a random (stochastic) error term capturing all factors that affect gross domestic product but are not taken into account explicitly. CoE is the ratio of the percentage change in quantity of output produced (GDP) to the percentage change in a specific independent (explanatory) variable such as MMR. Mathematically, the absolute value of the CoE

ranges from zero (perfectly inelastic GDP) to infinity (perfectly elastic GDP). Unitary elastic output depicts a scenario in which the percentage change in quantity of GDP is exactly equal to the percentage change in an independent variable, i.e. CoE=1. Inelastic output refers to a situation where GDP is relatively unresponsive to a change in an independent variable, i.e. CoE > 0 < 1. Similarly, elastic output implies that GDP is relatively responsive to a change in an independent variable, i.e. CoE > 1. Thus, in simple terms, elasticity is a measure of the degree of responsiveness of a dependent variable (GDP in our case) to changes in an independent variable, such as MMR.[5]

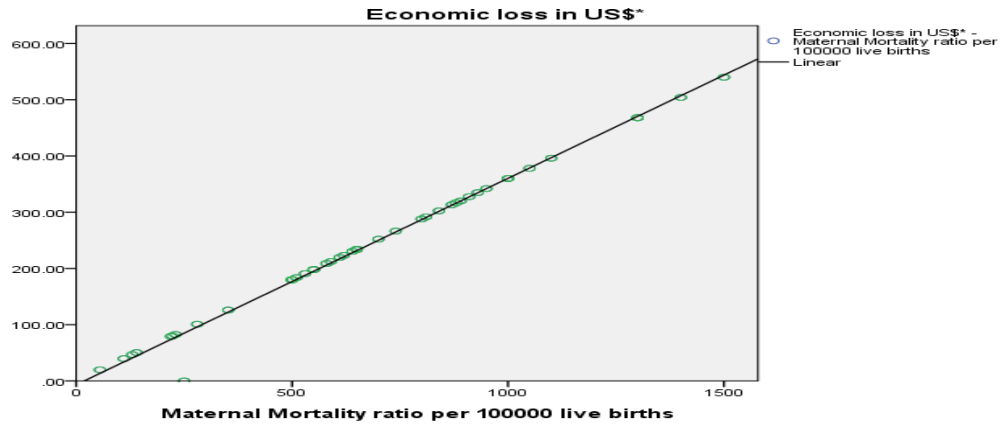
Two results are produced by Kirigia: one estimate represents GDP loss attributable to Maternal Mortality Ratio Per 100,000 live births. The second represents total annual economic loss due to annual maternal deaths. We used these results to estimate GDP loss for Sudan. (The two results are shown in tables 6 and 7 in the appendix) But before presenting our results, we have some important reservations about Kirigia results. First coefficients of elasticity are held constant and this is unacceptable in Cobb-Douglas production function. Second some of data points used in the analysis are incorrect, for example, The maternal mortality ratio for Kenya is used as annual number of death for Sierra Leone .Also there are a number of data points which are either inaccurate or inconsistent. In addition there is no location time for data points for all countries and the curves estimation we plotted these results in fig. (4) and fig. (5), they are incredibly linear. They are too linear to be true. Despite these limitations, Kirigia results are extremely useful as they give bench mark statistics for unknown parameters for the first time in global literature relating to the economic cost of maternal mortality.

Model Summary and Parameter Estimates

Dependent Variable: Economic loss in US$*

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.990	4030.203	1	42	.000	-6.801	.367

The independent variable is Maternal Mortality ratio per 100000 live births.



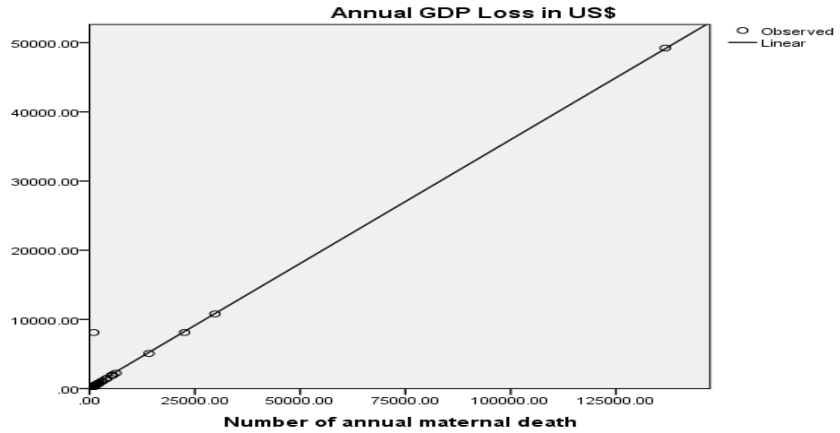
Fig(4) Curve Estimation for MMR and Per capita GDP

Model Summary and Parameter Estimates

Dependent Variable: Annual GDP Loss in US$

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.976	1768.699	1	43	.000	185.993	.358

The independent variable is Number of annual maternal death.



Fig(4) Curve Estimation for Annual Number of Death and Annual loss in Per capita GDP

Because of the apparent linearity of the two sets of data, we fitted an Ordinary Least Square (OLS) regression directly. The scatter plots and regression parameters are shown in tables 4 and 5 and figures 4 and 5 respectively. The OLS equations shown in

tables 4 and 5 give GDP loss attributable to maternal mortality is Sudan as (US$1133) and annual GDP loss as a result of annual number of maternal death as (US$281). The conclusion that can be derived from this exercise is that investing in reproductive health, particularly on safe motherhood is smart economics.

Policy Recommendations

The study has clearly shown that reducing maternal mortality by 10% results in a rise of gross domestic product by around 6% a result that urgently calls the government to integrate investment of maternal mortality reduction in her national economic plan. policy-makers should strive to increase GDP through land reform programs capital investments, export promotion and increase in educational enrolment, they should always remember that investments in maternal mortality-reducing interventions if integrated in development planning promises significant economic returns. The evidence provided in this study underscores the fact that maternal mortality is both an indicator and a cause of underdevelopment. However, such integration would require various background activities by the Federal Ministry of Health in the following areas:-

- Update Sudan MNMR Resource Mobilization Plan 2012-2015, including recommendations identifying strategies and interventions on how to mobilize future national resources.
- FMoH should conduct a national maternal mortality study that provides a bench mark estimate of maternal mortality before the integration takes place, information on the main socio-cultural causes, and avoidable factors contributing to maternal and infant deaths can be used as an important tool in the management of safe motherhood programs.
- Safe motherhood committees (supported by ministerial decrees) established at all levels can help ensure sustainability of plan.
- Investing in the development of a strong national maternal mortality surveillance system can yield timely maternal mortality data to enhance planning.
- Assess the donor environment with the potential to fund the MNMR roadmap, in the context of the current political situation and the changing aid environment

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APENDIX1

Table 6: GDP Loss Attributable to Maternal Mortality Ratio Per 100,000 Live Births

Country	MMR per100000 live birth	Economic loss in US$*
Algeria	**140**	**50.4**
Angola	**1500**	**540**
Benin	**500**	**180**
Botswana	**250**	**0**
Burkina Faso	**930**	**334.8**
Burundi	**1300**	**468**
Cameroon	**550**	**198**
Cape - Verde	**55**	**19.8**
Central African (Rep.)	**700**	**252**
Chad	**840**	**302.4**
Comoros	**950**	**342**
Congo	**890**	**320**
Democratic Republic of Congo	**870**	**313.2**
Cote D'ivoire	**810**	**291.6**
Equatorial Guinea	**352**	**126**

Eritrea	**1000**	**360**
Ethiopia	**1400**	**504**
Gabon	**500**	**180**
Gambia	**1050**	**378**
Ghana	**740**	**266.4**
Guinea	**880**	**316.8**
Guinea Bissau	**910**	**327.6**
Kenya	**650**	**234**
Lesotho	**610**	**219.6**
Madagascar	**500**	**180**
Malawi	**620**	**223.2**
Mali	**580**	**208.8**
Mauritania	**800**	**288**
Mauritius	**110**	**39.6**
Mozambique	**1100**	**396**
Namibia	**220**	**79.2**
Niger	**590**	**212.4**
Nigeria	**1000**	**360**
Rwanda	**1300**	**468**
Sao Tome & Principe	**130**	**46.8**
Senegal	**510**	**183.6**
Sierra Leone	**230**	**82.6**
South Africa	**650**	**234**
Swaziland	**222**	**79.92**
Tanzania	**530**	**190.8**
Togo	**640**	**230.4**
Uganda	**550**	**198**
Zambia	**650**	**234**
Zimbabwe	**280**	**100.8**

*This is only the loss attributable to maternal deaths per 100,000 live births.

APENDIX2

Table 7: Total annual economic loss due to maternal mortality

countries	**MMR per1000 live birth**	**Economic loss in US$***
Algeria	**1179**	**425**
Angola	**5441**	**1959**
Benin	**809**	**291**
Botswana	**250**	**90**
Burkina Faso	**2839**	**1022**
Burundi	**2099**	**755**
Cameroon	**2203**	**793**

Cape - Verde	**55**	**20**
Central African (Rep.)	**700**	**252**
Chad	**1588**	**572**
Comoros	**950**	**320**
Congo	**890**	**320**
Democratic Republic of Congo	**14108**	**5074**
Cote D'ivoire	**3820**	**1375**
Equatorial Guinea	**352**	**127**
Eritrea	**1000**	**8117**
Ethiopia	**22547**	**8117**
Gabon	**500**	**180**
Gambia	**1050**	**378**
Ghana	**4112**	**1480**
Guinea	**1485**	**535**
Guinea Bissau	**910**	**328**
Kenya	**6222**	**2240**
Lesotho	**610**	**222**
Madagascar	**2138**	**786**
Malawi	**1924**	**693**
Mali	**1489**	**536**
Mauritania	**800**	**289**
Mauritius	**110**	**40**
Mozambique	**5400**	**1944**
Namibia	**220**	**79**
Niger	**1962**	**706**
Nigeria	**29795**	**10796**
Rwanda	**1545**	**556**
Sao Tome & Principe	**130**	**47**
Senegal	**1286**	**463**
Sierra Leone	**650**	**234**
South Africa	**1810**	**652**
Swaziland	**220**	**80**
Tanzania	**5274**	**1899**
Togo	**816**	**294**
Uganda	**3052**	**1099**
Zambia	**1484**	**534**
Zimbabwe	**860**	**310**
Total	**136732**	**49224**

This is annual economic loss (deaths x US$0.36) and not lifetime economic loss.