Can the Sudan Reduce Poverty by Half by the Year 2015?

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ABSTRACT:

The paper investigates the feasibility of achieving the Millennium Development Goal of reducing poverty by half by the year 2015 in the context of Sudan. An analytical framework for the changes in poverty over time is presented. The framework allows an indirect method for the calculation of the relevant variables to be used for countries that do not have the required information. The indirect method is used for Sudan. Starting from 2001 as a base year it is shown that Sudan needs to attain, and sustain, a GDP growth rate of about 7 percent per annum to achieve the MDG on poverty. Alternatively, it is shown that it will take Sudan, growing at a per capita GDP rate of 2.2 per cent per annum (equivalent to a GDP growth rate of about 5 per cent per annum) about 28 years to achieve the MDG on poverty. On both counts the results show the infeasibility of achieving the MDG on poverty and suggest that the formulation of the time horizon for the MDG on poverty should be left free to be determined by country circumstances.

Key Words: Millennium Development Goals, poverty, head count ratio, Gini coefficient.

JEL Classification: I32.

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I. Introduction:

In their foreword to the report titled "A Better World for All" the representatives of the international community declared that poverty "in all its forms is the greatest challenge to the international community. Of special concern are 1.2 billion people living on less than $1 a day and the additional 1.6 billion living on less than $2 a day. Setting goals to reduce poverty is an essential part of the way forward". The "foreword" is signed by Mr. Kofi Annan, the Secretary-General of the United Nations (UN); Mr. Donald J. Johnston, the Secretary-General of the Organization for Economic Co-Operation and Development (OECD); Mr. Horst Kohler, the Managing Director of the International Monetary Fund (IMF); and Mr. James D. Wolfenson, the President of the World Bank Group (see the website: www.paris21.org/betterworld).

The international development goals (IDGs), described in the report, are based on the global UN conferences and summits held during the 1990s. As such it is no surprising that they were incorporated in the UN Millennium Declaration as the Millennium Development Goals (MDGs) in September 2000. According to the United Nations (UN(2002: 8)) the "development goals set out in the Millennium Declaration express the resolve of the world's political leaders to free their fellow men, women and children from the abject and dehumanizing conditions of extreme poverty, to make the right to development a reality for everyone, and to free the entire human race from want". In the UN analysis the world is divided in such a way that one sixth of humanity has achieved levels of well-being that are very affluent by any standard. At the other extreme, another one sixth of humanity "struggles for daily survival, in a life-and-death battle against disease, hunger and environmental catastrophe". An estimated four billion people live in between these two extremes of affluence and poverty, but their standards of living are judged to be relatively far below those enjoyed by the affluent group of countries.

The above distribution of the peoples of the world implicitly uses per capita consumption expenditure (or per capita GDP) as a measure of well-being, despite the various reservations about the appropriateness of such a measure. On the basis of such measure of well-being Sudan is unfortunate to belong to the one sixth of humanity that "struggles for daily survival, in a life-and-death battle against disease, hunger and environmental catastrophe". In this respect Sudan is not much different from a large number of Sub-Saharan African countries.

Eight MDGs have been identified. They include the original seven IDGs in addition to a goal on forging a "global partnership for development". The remaining seven MDGs are "eradication of extreme poverty and hunger", "achievement of universal primary education", "promotion of gender equality and empowerment of women", "reduction of child mortality", "improvement of maternal health", "combating HIV/AIDS, malaria and other diseases", and "ensuring environmental sustainability". For each goal a number of targets were specified and for each target a number of quantitative indicators were identified. For most indicators precise quantitative targets are set to be achieved by the year 2015 starting from their initial values in 1990.

The first Millennium Development Goal (MDG) is to eradicate extreme poverty and hunger. Two major targets under this goal have been specified. The first target is to halve the proportion of people living in extreme poverty (living on less than US$1.08 per person per day) by the year 2015. As is well known, the proportion of people living in extreme poverty is the head count ratio while the income level of US$ 1.08 per person per day is the poverty line. Three indicators have been selected to reflect progress in achieving this target. These include the head-count ratio itself, the poverty gap ratio and the share of the poorest 20 percent of the population in national consumption (i.e. the share of the poorest quintile). All three indicators are considered consumption-based poverty indicators. In section (II), dealing with a proposed analytical framework for the analysis of feasibility of achieving the MDG on poverty, issues on the measurement of poverty will be addressed.

It has been shown that Sub-Saharan Africa, as a distinct group among developing countries, will not be able to achieve the MDG on poverty judging by its historical growth performance (see, for example, Ali (2001) and Collier and Dollar (2001), and ECA (1999)). In this chapter focus is placed on Sudan as a country belonging to the Sub-Saharan group. Using the proposed framework section (III) addresses the question of the feasibility of achieving the MDG on poverty for Sudan. Section (IV) presents concluding remarks.

II. Analytical Framework:

The study of the feasibility of achieving the Millennium Development Goal (MDG) on poverty in developing countries has so far been conducted in the context of an analytical framework based on various approaches to the measurement of poverty. In this respect three broad approaches to the measurement, and study, of poverty can be distinguished. The most widely used approach is the quantitative, money metric, approach. This approach looks at the issue of poverty in the context of welfare comparisons where welfare is defined on income or

consumption expenditure as reflecting the standard of living enjoyed by individuals. The second approach is that of capability which broadens the concept of the welfare of an individual to include fundamental freedoms in addition to the commodity dimension of welfare (see, for example, Sen (1981 and 1999) and Ravallion (1998)). The third approach is one that searches for the meaning of poverty by asking the poor themselves and is known as the participatory poverty assessment approach (see, for example, Chambers (1994 and 1997), Blackburn and Holland (1998-a and b), Narayan (2000), Narayan et al (2000-a and b), and Nararyan et al (1999)) .

Despite the richness of the "capability" and the "participatory" approaches the analytical framework that follows is based on the money metric approach to the measurement of poverty in view of the fact that the MDG on poverty is formulated in terms of this approach. As is probably well known a huge technical literature has accumulated on the measurement of poverty under this approach[2].

Under the money metric approach, the first step taken towards measurement is to agree on a relevant measure for the standard of living. A relevant standard of living for developing countries is per capita consumption expenditure (including the consumption of own production). In advanced countries it is income that is taken as the relevant measure of the standard of living. Given agreement on the measure of the standard of living, there are a number of methods to determine the threshold of deprivation below which a person can be identified as poor. This threshold is commonly known as the poverty line.

While there are a number of methods for determining poverty lines, the most widely used, and preferred, method for developing countries is that of the cost of basic needs (CBN). This method involves identifying a typical diet for the poor that is necessary for leading a healthy life. Healthy life is defined in terms of nutritional requirements using WHO and FAO nutritional recommendations (recommended daily allowances e.g. 2500 calories per adult per day). Required quantities of the goods supplying the required calories are appropriately priced to arrive at a monetary value defining a food poverty line. By adding to this amount

[2] Sen (1976) pioneered the theory of poverty measurement by identifying a set of axioms that need to be satisfied by poverty measures. The literature that followed is indeed extensive as reviewed by Zheng (1997 and 2000). In Zheng (2000) seventeen axioms and sixteen poverty measures are identified. Of the sixteen poverty measures four are found to satisfy all seventeen axioms (these are the Foster-Greer-Thorbecke (1984), Watts (1968), and Hagenaars-Dalton measure and Hagenaars (1987)); two are found to satisfy sixteen out of the seventeen axioms (these are the Chakravarty (1983) ethical measure and the Clark, Hemming and Ulph (1981) sub-group consistent measure). At the other extreme, the head-count ratio is found to satisfy eight axioms while the poverty-gap ratio is found to satisfy eleven axioms.

the cost of other requirements needed by individuals to live in a social context (e.g. the cost of clothing, shelter, education and medicine) an overall poverty line can be estimated[3].

In historical context it needs to be noted that the international debate on poverty has been conducted in terms of a fixed poverty line (e.g. $1 dollar per day) applied to all countries and over time. However, there is now increasing realization that poverty lines should vary among countries depending on the level of development. This is tantamount to saying that, in general, the poverty line will be expected to be a function of the standard of living. Indeed, allowing the poverty line to change with the standard of living has been the practice in Europe in contrast to the practice in the US where the poverty line was held fixed for a long period of time[4].

Having obtained a poverty line, an immediate measure of poverty is the ratio of the poor thus identified to the total population in a given society. This is the well-known head-count ratio. It is the most widely used, and easily understood, measure of poverty. Thus, for example, the Millennium Development Goal on poverty is to reduce the head count ratio to half its level of 1990 by the year 2015. The head-count ratio measures the spread, or incidence, of poverty in a given society. Another useful poverty measure is the poverty-gap ratio, which takes into account the extent to which consumption of the poor falls below the poverty line. It measures the depth of poverty in a society. Using the head-count ratio and the poverty-gap ratio together one can immediately obtain the average income of the poor. As is well known these two measures are special cases of a general class of additively separable poverty measures. The Foster-Greer-Thorbecke, FGT, measure is given by[5]:

(1) $P_\alpha = 1/n \sum [(z - y_i)/z]^\alpha$;

[3] Note that this method was applied rigorously since the turn of the 20th century in the famous contribution of Rowntree (1901), but the concept itself would be as old as when people started worrying about poverty.

[4] See Atkinson (1998) for the practice in Europe, and Citro and Robert (1995) for the debate on the desirability of allowing the poverty line to change with the standard of living in the US . In a recent comment Streeten (2001: 89) notes that poverty lines "are dynamically defined and rise with rising average incomes". Moreover, he argues that it is important to "note that not all poverty resulting from rising average incomes is relative; absolute poverty can also result from higher average incomes". Ravallion (1998) provides a microeconomic foundation for a poverty line that changes with income where the utility function of a representative agent is defined on own income and the ratio of own income relative to mean income. Also see Foster (1998).

[5] See Foster, Greer and Thorbecke (1994).

In the above equation the summation is over q poor people, n is total population, z is the poverty line, y_i is the consumption expenditure of the i^{th} poor person, and α is a non-negative poverty aversion parameter. When $\alpha=0$ the equation gives the head-count ratio denoted by P_0 or H and is given by:

(2) $P_0 = H = q/n$

When $\alpha=1$, equation (1) gives the poverty-gap ratio, denoted by P_1 and is given by:

(3) $P_1 = H (1 - y_p/z)$

Where y_p is the mean consumption expenditure of the poor. Note that with equations (2) and (3) the average consumption expenditure of the poor can easily be calculated as:

(4) $y_p = z (1 - P_1/ H)$

The average consumption expenditure of the poor can also be used as an alternative measure of the depth of poverty.

To be able to identify the poor, information on the distribution of consumption expenditure, or income, in the society is needed. This information is usually obtained from household budget, or expenditure, surveys. Such surveys, like population censuses, are very expensive to conduct in a rigorous fashion and as a result such information is usually lacking in developing countries, especially on a time series basis (but India is an exception in this regard). For Africa such information has only recently been made available for a limited number of countries (see the website of the World Bank for details on household budget surveys conducted in developing countries: www.worldbank.org).

Given the above, it should be noted that, in general, any poverty measure (call it P) could be expressed as depending on mean consumption expenditure in society, the poverty line and on a measure of the underlying inequality in the distribution of consumption. Thus, in general form any poverty measures can be expressed in the following form:

(5) $P = P(\mu/z, \theta)$

where μ is mean consumption expenditure, z is the poverty line and θ is a measure of the inequality in the distribution of consumption expenditure usually taken as the Gini coefficient[6]. The theoretical restrictions on the above general form are such that as per capita consumption increases (poverty line declines), other things remaining the same, poverty declines. Similarly, as inequality in the distribution of consumption expenditure declines, other things remaining the same, poverty declines. Note that in this general formulation if the poverty line changes by the same rate of change as mean consumption expenditure, other things remaining the same, poverty does not change[7]. Note also that if the poverty line is set as a constant proportion of mean consumption expenditure, then poverty changes will only depend on the change in the distribution of consumption expenditure[8].

Percentage changes in poverty over time, G(P), can be obtained from equation (6) by direct differentiation with respect to time, where $G(\mu)$ and $G(\theta)$ are the percentage changes in per capita consumption expenditure and the Gini coefficient respectively:

$$(6) \quad (dP/dt)(1/P) = G(P) = \eta\, G(\mu) + \nu\, G(\theta)$$

where η and ν are the elasticities of the poverty measure with respect to consumption expenditure (inclusive of the elasticity of the poverty line with respect to consumption expenditure), which is negative, and with respect to the Gini coefficient respectively, which is positive. The first term on the right hand side of equation (6) is the growth component, meaning changes in poverty due to changes in per capita consumption expenditure holding the distribution of consumption expenditure constant. The second term is the distribution component, meaning the changes in poverty due to changes in the degree of inequality in the distribution of consumption expenditure holding per capita consumption expenditure constant. As is clear from equation (6) these components depend on the two elasticity magnitudes.

[6] As is well known the most widely used measure of inequality in the distribution of income is the Gini coefficient. The measure varies from zero for the case of perfect equality (where every one in society gets the mean income) to unity for the case of perfect inequality (where one person gets all the income and the rest receive nothing, indicating the presence of complete inequality). In addition to the Gini coefficient the shares of total income received by various population groups can also be used as measures of inequality.

[7] This is the property of zero homogeneity of the poverty measure with respect to mean consumption expenditure and the poverty line. This property is thought to hold for most of widely used poverty measures.

[8] This can easily be established by direct substitution in equation (5). Suppose that $z = \beta\mu$, then according to equation (5) in the text $P = P(1/\beta, \theta) = P(\theta)$.

It should also be noted that if it is believed that the inequality in the distribution of consumption expenditure, and the poverty line, depend on mean consumption expenditure in society, then a powerful, yet simple, relationship between poverty and economic growth can be established. To appreciate the result in question note that in this case the poverty measure will be given by:

(7) $P = P(\mu/z, \theta) = P(\mu/z(\mu), \theta(\mu)) = P(\mu)$

This relationship says that changes in poverty over time can always be calculated as a product of the elasticity of poverty with respect to mean consumption expenditure, after taking into consideration changes in the distribution of consumption expenditure, and the rate of change in mean consumption expenditure. The percentage change in poverty over time is given by, where t is time:

(8) $(dP/dt)(1/P) = G(P) = \gamma\,(d\mu/dt)(1/\mu) = \gamma\, G(\mu)$

The elasticity involved, γ, is the "growth elasticity of poverty" and it can be estimated or calculated. Such a relationship is important for the purposes of looking at the goal of poverty reduction over time[9].

One possible justification for the assumption that the inequality in the distribution is a function of mean consumption expenditure is the presence of a Kuznets relationship between inequality and development. Formulated on the basis of a dual economy, the hypothesis asserts that as development proceeds (i.e. per capita income increases) inequality in the distribution of income will increase at the early stages and then declines. The basic reasoning for the result relies on the characterization of the rural sector as being a low productivity, low inequality sector and the urban sector as a high productivity and high inequality sector. As development proceeds, labour migrates from the low productivity, low inequality sector to the urban sector thus increasing the weight of the high inequality sector in the overall economy. This development process increases overall inequality up until a time when the rural sector achieves the characteristics of the urban sector in the sense of the model economy ceasing to be dual[10].

[9] Note that the "growth elasticity of poverty" is a total elasticity which is equal to the sum of two partial ealsticities: the elasticity of the poverty measure with respect to consumption expenditure, appropriately adjusted for changes in the poverty line with respect to consumption expenditure, and the elasticity of the poverty measure with respect to the Gini coefficient.

[10] For theoretical, and empirical, analysis of the Kuznets' hypothesis see Anand and Kanbur (1993-a and b).

Formulated for empirical purposes as a relationship between a measure of inequality in the distribution of income (e.g. the Gini coefficient) and mean income of society, the hypothesis is usually referred to as the inverted u-shaped curve of inequality and development. Interpreted from a policy perspective the hypothesis could be taken as asserting the existence of a fundamental trade-off between growth and equity during the process of development. Moreover, it has also been interpreted as representing a critique to the trickle down view of a growth process in the context of a dual economy. This critique to the trickle down thesis was articulated, from a policy perspective, in a famous volume in 1974 with the title of "Redistribution with Growth", and more recently in a volume in 2001 with the title of "The Quality of Growth".

Empirical work on the Kuznets' hypothesis reports a large, and largely conflicting, body of results depending on the data sets, and methodologies, used. One major bottleneck to conclusive empirical results has been the absence of comparable time series data on income inequality for individual countries (the few exceptions would include India and Japan). Despite this, however, there exists some evidence supporting the hypothesis[11]. The latest evidence is based on what is known as an augmented Kuznets' relationship where variations in the Gini coefficient across countries is explained not only by variations in per capita income (reflecting the stage of development) but also by other factors deemed relevant to such explanation. These other factors include education (proxied by primary and secondary and higher school enrolments), the rule of law, democracy, and openness to trade. Moreover, regional dummies for Africa and Latin America have also been included to capture the extent to which the behavior of inequality in these regions differs from the average. An augmented Kuznets' relationship that controls for education and the regions is shown to exist such that inequality increases up to a per capita income level of US$3320 in 1985 PPP.

On the basis of such evidence, and depending on the level of real per capita income beyond which inequality starts to decline, a relationship between per capita income (and the corresponding per capita consumption) and the Gini coefficient can be postulated. For countries below the threshold income level inequality in the distribution of income can be assumed to be increasing with the increase in per capita income. Thus, the required rate of per capita income (or per capita consumption) for reducing poverty by a given target would be determined by the difference between the pure growth elasticity of poverty (i.e. prior to

[11] An early empirical analysis establishing the Kuznets' relationship is Ahluwalia (1976). For recent results see, for example, Fishlow (1996), Jha (1996), Sarel (1997), Bluir (1998), Hayami (1998), Ali and Elbadawi (1999), Milanovic (1999) and Barro (2000).

taking into consideration the distributional impact of growth) and the distribution elasticity of poverty (i.e. the elasticity of the poverty measure with respect to the Gini coefficient and the Kuznets' elasticity). The higher the distribution elasticity of poverty, and hence the lower the net growth elasticity of poverty, the higher would be the required rate of per capita income growth.

The implication of the Kuznets' hypothesis is that the inequality measure has a functional form as follows:

(9) $\theta = \theta(\mu)$, with $\partial\theta/\partial\mu \geq 0$ for $\mu \leq \mu^*$ and < 0 for $\mu > \mu^*$;

where μ^* is the per capita consumption expenditure at which poverty is stationary. If the relationship exists then a Kuznets' elasticity can be estimated, $\kappa = [d \log \theta / d \log \mu]$. Under such specification the growth elasticity of poverty in equation (8) can easily be seen to be a composite elasticity taking the value $[\gamma = \eta + \nu \kappa]$. This means that equation (8) will take the general form:

(8') $G(P) = \gamma\, G(\mu) = [\eta + \nu \kappa]\, G(\mu)$

The growth elasticity of poverty measures can be estimated in a direct fashion (as done by Ravallion (1995)) or calculated on the basis of indirect methods as will become clear in the following section.

III. The Feasibility of Achieving the MDG on Poverty:

As noted earlier the international agreement on considering the reduction of poverty as the overarching objective of development is expressed in the context of the UN MDG of reducing poverty by half by the year 2015. By poverty in the context of the MDGs is meant the head-count ratio calculated on the basis of the global benchmark poverty line of $1 a day per person in 1985 purchasing power parity.

To study the feasibility of achieving the MDG on poverty recall the definition of the headcount ratio, H, in general format as depending on mean consumption expenditure, a poverty line and a measure of the inequality in the distribution of consumption which is given by:

(10) $H = H(\mu/z, \theta)$

The percentage change in poverty over time, G(H), takes the following format:

(11) $[dH/dt][1/H] = G(H) = \eta_H G(\mu) + \nu_H G(\theta)$

where η_H and ν_H are the elasticities of the head count ratio with respect to consumption expenditure (inclusive of the elasticity of the poverty line with respect to consumption expenditure), which is negative, and with respect to the Gini coefficient respectively, which is positive.

To undertake the feasibility analysis all that needs to be done is to further specify some behavioral assumptions. Two such behavioral assumptions are: (a) the behavior of the poverty line with respect to mean consumption expenditure where the standard assumption in the literature is that the real poverty line should be held constant over time as in the MDGs; and (b) the behavior of inequality in the distribution of consumption expenditure over time. Once again, a convenience assumption adopted in the literature is that the distribution of expenditure does not change substantially over long periods of time (e.g. a constant Gini coefficient).

With these two assumptions the head-count ratio changes over time in accordance with changes in per capita consumption expenditure as follows:

(12) $G(H) = \eta_H G(\mu)$,

where η is the elasticity of the head-count ratio with respect to mean consumption expenditure (exclusive of the change in the poverty line with respect to consumption expenditure; η is negative)

It is an easy matter to show that reducing poverty by half by the year 2015, starting in 2001 as a base year, would require a reduction in the head-count ratio by an annual rate of 4.83 per cent[12]. Given that both the poverty line and the Gini coefficient are assumed constant, it is

[12] Note that H in 2015 is required to be equal to half H in 2001. This can be formulated as $H_{15} = H_{01} \quad (1 + r)^{rt}$, where r is the rate of change of H and t is time. The MDG on poverty requires that $H15/H01 = 0.5 = (1 + r)^{14}$. Taking logs on both sides gives log 0.5 = 14log (1 + r) which gives (-0.30103) = 14 log (1 + r) which in turn gives (-0.0215) = log (1 + r). Taking anti-logs gives 0.9516 = (1 + r). Solving for r gives r = 0.9516 – 1 = -0.0483, as in the text. Following the same procedure the required rate of reduction of the head count ratio for the MDG original initial year of 1990 (implying a horizon of 25 years) is equal to 2.7345 percent per year.

also easy to show that such a rate of decline of the head-count ratio would require an increase in per capita consumption given by 0.0483 divided by the absolute value of the elasticity of the head-count ratio with respect to mean consumption expenditure. From equation (12) we have:

(13) $G(H) = [-0.04831] = \eta_H \, G(\mu)$

Thus, the required rate of increase in per capita consumption to reduce poverty by half by the year 2015 is given by:

(14) $G^*(\mu) = [-0.04831] / \eta_H$

For testing the feasibility of achieving the MDG on poverty, the required rate of growth of per capita consumption expenditure, given by equation (14), can be compared to the known growth record of the country. Note that in equation (14) the elasticity of the head count ratio with respect to per capita consumption expenditure, η_H, plays the role of the growth elasticity of poverty.

In general, however, the elasticities in question can be calculated in a direct fashion if the required distribution data is available[13]. In the case of Sudan such data is not available for a long time series. As a result resort can be made to indirect methods. One such method is to use estimates of poverty measures from Sub-Saharan Africa the requisite data for which is reported in the World Bank World Development Indicators. For a sample of 18 Sub-Saharan countries poverty measures were calculated based on a poverty line that changes with per capita consumption expenditure. A poverty equation is then estimated where the logarithm of the head count ratio is the dependent variables and per capita consumption expenditure and the Gini coefficient are the explanatory variables. The resulting estimated equation for the headcount ratio, with White heteroscedasticity adjusted absolute t-values in brackets, is given below:

(15) $\text{Ln } H = 4.1732 - 0.00163\ \mu + 0.0124\ \theta$; adjusted R-squared = 0.94;

(34.36) (15.96) (5.40)

[13] For grouped data the POVCAL program, developed in the World Bank and can be freely downloaded from its web site, automatically calculates these elasticities for the FGT measures of poverty.

where H is the head-count ratio, μ is real per capita consumption expenditure in 1985 purchasing power parity dollars, and θ is the Gini coefficient in percentage points. The relevant partial elasticities of the head-count ratio are readily obtainable from the above equation as $\eta_H = [-0.00163\mu]$ and $\nu_H = [0.0124\theta]$ and can be calculated once information for μ and θ is available.

Alternatively, the change in poverty over time can directly be obtained by differentiating equation (8) with respect to time to get:

(16) $G(H) = [-0.00163\mu]G(\mu) + [0.0124\theta]G(\theta)$

where $G(\mu)$ is the growth rate in per capita consumption expenditure and $G(\theta)$ is the percentage change in the Gini coefficient.

With the above methodological points noted the stage is set for applying the framework to Sudan. As in the framework the growth component of the change in poverty is addressed first. Table (1) presents estimates of real per capita consumption expenditure for a number of years with emphasis on the 1990s decade. As is usual in the literature use is made of the estimates of private consumption to GDP from national income accounts. To be appropriately used in the estimated equation for the head-count ratio real per capita consumption expenditure is estimated on the basis of 1985 PPP US dollars[14].

[14] See Karshenas (2001) for the appropriateness of using per capita consumption figures that are consistent with national income accounts.

Table (1):

Real Per Capita Consumption Expenditure and the Elasticity of the Head Count Ratio with respect to Consumption Expenditure in Sudan: 1968-1999

Year	GDP per Capita ($: 1985 PPP)	Private Consumption/GDP (%)	Per Capita Consumption Expenditure ($: 1985 PPP): μ	Annual Growth Rate of Per Capita Consumption $G(\mu)$ (%)	Elasticity of Head Count Ratio with Respect to Consumption Expenditure η_H
1968	798	0.679	542	-	-0.883
1978	962	0.815	784	3.76	-1.278
1987	817	0.778	636	-2.30	-1.037
1988	763	0.713	544	-14.47	-0.887
1989	808	0.890	719	32.17	-1.172
1990	773	0.833	644	-10.43	-1.050
1991	798	0.937	748	16.15	-1.219
1992	817	0.721	589	-21.26	-0.960
1993	815	0.932	760	29.03	-1.239
1994	820	0.933	765	0.66	-1.247
1995	833	0.782	651	-14.90	-1.061
1996	846	0.810	685	5.22	-1.117
1997	876	0.874	766	11.82	-1.249
1998	908	0.913	829	8.22	-1.351
1999	944	0.857	809	-2.41	-1.318

Source: GDN data base (see Easterly and Sewadeh (2002)). Figures for per capita GDP are appropriately adjusted using real GDP growth rates. Figures for private consumption as a ratio of GDP from 1988 onwards are from the Arab Monetary Fund et al (2000).

From the above information it is clear that per capita private consumption expenditure fluctuated widely over the period. As the table shows per capita consumption expenditure increased by an annual rate of 3.8 per cent during the period 1968-1978 and declined at an annual rate of 2.3 over the period 1978-1987. Despite the fluctuations during the period since the mid 1980s, per capita consumption expenditure recorded positive growth for the various sub-periods of the 1990s. The average annual growth rates of per capita consumption for the 1990s sub-periods are as follows: 2.21 percent for 1990-1999 (with a standard deviation

of 15.2 percentage points); 2.72 percent for 1990-1998 (with a standard deviation of 16 percentage points); 2.88 percent for 1990-1994 (with a standard deviation of 20.24 percentage points); and, 1.59 percent (with a standard deviation of 10.6 percentage points) for 1995-1998.

The table also shows that with the fluctuations in real per capita consumption expenditure the elasticity of the head count ratio also fluctuated in view of the estimating equation used to derive it. The average absolute elasticity for the 1990s decade is 1.1811 implying that an increase in per capita consumption of one percentage point would have resulted in a reduction in the head count ratio by approximately 1.12 percentage points, after allowing for the change in the poverty line in response to the increase in consumption expenditure.

Having noted the above on the elements in the growth component of the poverty change it is now time to turn to the distribution component. As is well known high quality data for Sudan is available only for 1968 in international data sets such as that of Deininger and Squire (1996). In view of this an indirect method is invoked to generate estimates for the Gini coefficient for various years and as such to generate the relevant elasticity. The method depends on an estimation of a Kuznets' equation reported in Ali (1998) and Ali and Elbadawi (1999). The estimation is based on a sample of 50 countries: 33 developing countries (12 Latin American, 9 Asian and 11 African) in addition to 17 advanced countries. Instead of the usual quadratic form, the functional form proposed by Anand and Kanbur (1993) was estimated where the Gini coefficient (measured as a ratio) is regressed on mean income and its reciprocal.

The result of the estimation, with an African dummy (Afdum), is reported in equation (17) below where figures between brackets are t-values:

$$(17)\quad \text{Gini} = 0.5121 - 0.0000203\mu - 49.8037(1/\mu) + 0.06927\,(\text{Afdum}); \quad R^2 = 0.329$$

$$(13.41)\quad (-3.625)\quad (-2.199)\quad (2.078)$$

Given the existence of a Kuznets' relationship according to equation (17) the implied turning point for the Kuznets' relationship is $1566 per person per year in 1985 PPP. Looking at the information in table (1) it is perhaps not surprising to find Sudan at the increasing phase of inequality in the distribution of income and expenditure.

From equation (17) it is an easy matter to show that the Kuznets' elasticity is given by the following expression:

(18) $[d \log Gini/d \log \mu] = \kappa = [- 0.0000203\mu+49.8037(1/\mu)]/Gini$

Where the Gini in the formula is the predicted Gini. Using the information in table (1) the results of applying equations (17) and (18) to Sudan are given in table (2).

Table (2):

The Gini Coefficient, the Elasticity of the Head Count Ratio with respect to Gini and the Kuznets' Elasticity in Sudan: 1968-1999

Year	GDP per Capita Consumption Expenditure ($: 1985 PPP)	Predicted Gini Coefficient: θ	Annual Change in Gini (%): $G(\theta)$	Elasticity of the Head Count Ratio with Respect to Gini: ν_H	Kuznets' Elasticity : κ
1968	542	0.4785		0.5933	0.1690
1978	784	0.5019	0.47	0.6224	0.0949
1987	636	0.4902	-0.26	0.6079	0.1334
1988	544	0.4788	-2.33	0.5937	0.1682
1989	719	0.4975	3.91	0.6169	0.1099
1990	644	0.4910	-1.31	0.6088	0.1309
1991	748	0.4996	1.75	0.6195	0.1029
1992	589	0.4849	-2.94	0.6013	0.1497
1993	760	0.5004	3.20	0.6205	0.1001
1994	765	0.5007	0.06	0.6209	0.0990
1995	651	0.4917	-0.17	0.6097	0.1287
1996	685	0.4948	0.63	0.6136	0.1469
1997	766	0.5008	1.21	0.6210	0.0988
1998	829	0.5045	0.74	0.6256	0.0857
1999	809	0.5034	-0.22	0.6242	0.0897

Source: own calculations.

As is expected, the table shows that the Gini coefficient of the distribution of consumption expenditure fluctuated over the period with the changes in per capita consumption expenditure. The overall trend, using end points, is one of increase as implied by the Kuznets' estimated relationship. For the 1990s decade the Gini coefficient increased at an annual rate of 0.27 per cent (using end points). Over the period the magnitude of the expenditure Gini in Sudan seems to approximate the average for Sub-Saharan Africa, with a fairly high degree of inequality with a Gini coefficient approaching 0.5. The elasticity of the head count ratio with respect to the Gini coefficient also fluctuated with the fluctuations in the Gini coefficient. The average elasticity for the 1990s decade is 0.6165, which is lower that the average absolute value of the elasticity of the head count ratio with respect to per capita expenditure of 1.18, and means that an increase in the Gini coefficient of one percent would have resulted in an increase in the head count ratio by about 0.62 percent, holding per capita consumption constant.

The table also reports the results for the Kuznets' elasticity. Once again not surprisingly the behavior of this elasticity is consistent with the Kuznets' relationship on which it is based. Like per capita consumption expenditure, and the Gini coefficient, the time profile is one of fluctuations but the general trend is one of decline as is expected. The relatively low magnitudes of the elasticity reflect the fact that changes in the distribution of consumption expenditure are expected to be small over time due to structural factors. For the 1990s decade the average Kuznets' elasticity is 0.1132.

Tables (1) and (2) provide the results needed to compute the growth elasticity of poverty for Sudan, albeit in an indirect fashion. Table (3) assembles the essential results for the 1990s decade and reports the computed growth elasticity. Ultimately it is average for the period that will be used to address the issue of feasibility. Despite this, however, the required annual rate of growth of per capita consumption expenditure will be reported for each year of the decade. In the table the growth elasticity of poverty ranges, in absolute value, from a low of 0.9703 for 1990 to a high of 1.2974 for 1998, with the average for the decade being 1.112.

Table (3):

The Growth Elasticity of Poverty and the Required Rate of Growth of Per Capita Consumption Expenditure for Sudan in the 1990s

Year	Elasticity of Head Count Ratio with Respect to Consumption Expenditure η_H	Elasticity of the Head Count Ratio with Respect to Gini: ν_H	Kuznets' Elasticity : κ	Growth Elasticity of Poverty: γ	Required Rate of Growth of Per Capita Consumption: $G^*(\mu)$ (%)
1990	-1.050	0.6088	0.1309	-0.9703	5.08
1991	-1.219	0.6195	0.1029	-1.1553	4.18
1992	-0.960	0.6013	0.1497	-0.8700	5.55
1993	-1.239	0.6205	0.1001	-1.1769	4.11
1994	-1.247	0.6209	0.0990	-1.1855	4.08
1995	-1.061	0.6097	0.1287	-0.9825	4.92
1996	-1.117	0.6136	0.1469	-1.0269	4.71
1997	-1.249	0.6210	0.0988	-1.1877	4.07
1998	-1.351	0.6256	0.0857	-1.2974	3.72
1999	-1.318	0.6242	0.0897	-1.2620	3.83

From table (3) it is an easy matter to calculate the average required growth rate of per capita consumption expenditure for various sub-periods of the 1990s decade. For the whole decade the required growth rate is 4.43 percent per annum, for the 1990-1994 sub-period it is 4.6 percent while for the sub-period 1995-1999 it is 4.43. Working with the required per capita growth rate for the 1990s decade and assuming a population growth rate of 2.8 percent per annum, it is clear that achieving the MDG on poverty in Sudan would require real GDP to grow by about 7.23 percent per annum.

The required per capita growth rates could now be compared with the actual average per capita growth rates computed for various sub-periods of the 1990s decade. These have already been reported in relation to table (1). For the whole period the average annual growth rate is computed as 2.21 percent; for the sub-period 1990-1994 the rate is 2.88 percent, and for the sub-period 1995-1998 the rate is 1.59 percent. All of these growth rates fall far short of the required per capita growth rates. On the basis of the above it can be concluded that Sudan, even if it succeeds in establishing and sustaining growth at rates similar to those

achieved during the 1990s decade, will not be able to achieve the IDG on poverty. Indeed, using the growth rates for the 1990s decade it is clear that the required growth is exactly double that of the actual rate achieved.

An alternative way of looking at the feasibility of achieving the MDG on poverty is to ask how long would it take Sudan, growing at an agreed upon average rate, to achieve the reduction of the head-count ratio by half. To answer the question, note that the IDG on poverty requires the following relation to hold:

(19) $(H_T/H_0) = 0.5 = e^{G(H)\,T} = e^{[\gamma\, G(\mu)]T}$

Taking the logarithms of both sides and solving for T gives the time required to half poverty given the growth rate of per capita consumption expenditure; that is:

(20) $T^* = [\ln 0.5 \div \gamma_H\, G(\mu)] = [-0.6932 \div \gamma_H\, G(\mu)\,]$

Using the absolute value of the average growth elasticity of poverty for the 1990s of 1.112 together with the average per capita consumption growth rate of 2.21 per cent per annum, it is an easy matter to show that starting from 2001 it will take Sudan, growing at the average per capita growth rate of the 1990s decade, about 28 years to achieve the IDG on poverty. This is exactly double the time required to reduce poverty by half by the year 2015. Needless to note that for lower growth rates it will take Sudan longer to reduce poverty by half.

On the assumption that country specific horizons would replace the original deadline of 2015 for achieving the MDG on poverty, a further issue regarding the feasibility of achieving the MDG on poverty relates to the investment rates required to generate the desired growth rates. The issue can be addressed in the context of the planning framework provided by the famous Harrod-Domar model (despite recent doubts expressed about the model: see, for example, Easterly (1997))[15]. As is well known according to the Harrod-Domar model the desired growth rate of real GDP, call it Y, is given by:

(21) $G^*(Y) = [s/c]$

[15] Recall that in the Harrod-Domar model GDP is given by $Y = 1/c\ K$ and investment-equals saving is given by $dK/dt = s\ Y = [s/c]K$ which implies that the growth rate of the capital stock G(K) is equal to [s/c]. The growth rate of GDP $G(Y) = G(K) = [s/c]$ as in the text.

Where s is the investment/GDP ratio (i.e. the saving rate) and c is the capital output ratio, the inverse of the average productivity of capital. In a planning context the capital output ratio can be taken as given or estimated from the technical coefficients of production in a given economy. With the desired rate of GDP growth known the required saving rate to achieve the goal can be calculated as:

(22) $s^* = [c][G^*(Y)]$.

From the previous section the desired GDP growth rate can be estimated by noting that it is equal to the desired per capita growth rate plus the rate of population growth, call it G(N), where N is total population. In the case of Sudan G(N) is usually taken as 2.8 percent per annum. With this assumption it is an easy matter to show that the required GDP growth rate to reduce poverty by half by 2015 ranges from 7.4 percent per annum (if the period 1990-1994 is used as the reference) to 7.1 percent per annum (if the 1995-1999 sub-period is used as a reference). For the whole of the 1990s decade the required GDP growth rate is 7.2 percent per annum.

At an aggregate level, and due to the volatility of growth in developing countries, it is usually problematic to calculate the capital output ratio from time series data. To avoid the problems caused by the fluctuations in the year-on-year growth rates moving average growth rates and investment rates are usually invoked to calculate the capital output ratio. Alternatively, appropriately specified relationships between real GDP and the investment rate can be estimated resulting in an estimate for the aggregate capital output ratio. Table (4) provides the results of calculating five-year moving average for the investment rate and the GDP growth rate in Sudan and the resulting capital output ratio. The results are reported as averages for half-decades over the period 1906-1996.

Table (4):

Five-year Moving Average Capital Output Ratio in Sudan

Year	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	1960-99
Investment Rate (%)	15.53	13.43	13.18	16.96	16.79	19.52	16.48	16.10	16.01
GDP Growth Rate (%)	2.08	2.17	2.07	6.43	1.53	1.63	3.71	5.21	3.10
Capital-output Ratio	7.38	6.19	6.37	2.64	10.97	11.98	4.44	3.09	5.16

Source: own calculations based on GDN data base.

As should be expected in view of the volatility of the growth process the table shows that the five-year moving average capital output ratio fluctuated widely during the period and ranged from about 2.6, reflecting a fairly high level of efficiency use of capital, during the period 1975-1979, to about 12 reflecting a fairly low level of the efficiency use of capital for the period 1985-1989. These extremes of the efficiency use of capital are reflected in the real rate of return to capital of 37.9% per annum for the period 1975-79 and about 8.4% per annum for the period 1985-89. For the remaining periods the real rate of return to capital ranged from a low of 9.1% per annum for the period 1980-84 to a high of 32.4% per annum for the period 1995-99. For the whole period 1960-1999 the average capital output ratio is about 5.2 implying a real rate of return of 19.2% per annum. The average investment rate for the whole period is 16% of GDP.

Substituting the capital output ratio for the whole period of 5.2 together with the required GDP growth rate of 7.2 percent in equation (22) it is easy to calculate the required investment rate as 37.15% of GDP. Thus the required investment rate to achieve the MDG on poverty is 2.3 times the actual average investment rate achieved by the country since independence. Alternatively, using the more favorable capital output ratio of the 1995-99 period of 3.1 together with the required rate of growth of 7.2 percent per annum gives a required investment rate of 22.3% of GDP, which is 1.4 times the average achieved by the country since independence. On both counts it is perhaps clear that given the past performance of the country it will be difficult for Sudan to achieve the MDG on poverty.

IV. Concluding Remarks:

In this paper the feasibility of achieving the Millennium Development Goal (MDG) of reducing poverty by half by the year 2015 is investigated for Sudan on the basis of a relevant analytical framework. It is noted that by poverty, in the context of the MDGs, is meant the spread of poverty as measured by the head count ratio. The major results are (a) to achieve the MDG on poverty Sudan's GDP needs to grow by an annual rate of 7.2 per cent, requiring an investment rate ranging from 35% to 42% of GDP, (b) given Sudan's past growth performance, and assuming that Sudan will be able to sustain a GDP per capita growth rate of 2.2 percent (equivalent to a GDP growth rate of 5 percent) a reasonable horizon for reducing poverty by half would be 28 years starting from 2001, almost double the horizon implied by the MDGs.

These results are almost identical with those established for Sub-Saharan Africa (see, for example, Ali (2001) and ECA (1999)). This is not surprising in view of the fact that Sudan is sometimes classified as a Sub-Saharan African country (e.g. by the World Bank). The wider implication of non-feasibility of the achievement the MDG on poverty for Sudan, and many other Sub-Saharan African countries, has to do with the appropriateness of specifying a uniform horizon for reducing poverty by half applicable to all countries and with the extent of commitment of the donor countries to supplement domestic saving rates in the form of foreign assistance.

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