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HOW COSTLY IS IT TO ACHIEVE THE MILLENNIUM DEVELOPMENT GOAL OF HALVING POVERTY BETWEEN 1990 AND 2015?*

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ABSTRACT

This paper proposes a methodology to estimate required growth rates, investment rates, and per capita foreign aid in US dollars in order to achieve the Millennium Development Goal (MDG) of halving poverty between 1990 and 2015. It provides a methodology which gives a linkage between costs of MDG, growth, poverty, and inequality. In this study, the methodology is applied only to the head-count poverty measure but is applicable to other poverty measures. This study takes into account the distributional aspect to derive the estimates of the projected growth and investment rates required for the next 10 years from 2005 to reach the MDG poverty reduction target. This has been done through simulating different growth scenarios: anti-poor, distribution neutral, and pro-poor. The proposed methodology is applied to the 15 Sub-Saharan African countries.

Keywords: Growth, Poverty, Inequality, Millennium Development Goal, Foreign Aid, Investment, Sub-Saharan Africa

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1 INTRODUCTION

Poverty has been perceived as an increasingly serious problem in many parts of the developing world. According to the World Bank's (2000) estimates, around 1.1 billion of the world population are living on less than \$1 a day. During the 1990s, in Sub-Saharan Africa (SSA hereafter) both average income of the region and the percentage of the people living below the \$1 poverty line scarcely changed (World Bank database, 2004). Because the population is still growing fairly rapidly in the region, the number of poor people rose substantially in this period.

Rising concerns about poverty are well reflected in one of the Millennium Development Goals of halving poverty between 1990 and 2015. Achieving that goal would require an annual reduction in poverty of around 2.74 percent a year for the 25-year period. The most effective way to reduce poverty in the long-term might be through economic growth, but growth so far has not been sufficient in most countries in SSA. For the SSA region, halving poverty by 2015 would be an ambitious goal to achieve, either because it is not growing fast enough or because what growth it is experiencing is not being translated into poverty reduction at a rapid rate. What is worse, because of relatively slow growth in the 1990s, most countries will have to reduce poverty by over 3 percent per annum in the 2000s to reach the poverty reduction goal in 2015. If the relationship between growth and poverty is as weak as it was in the 1990s, most countries in SSA will fall far short of the ambitious goal they have set for themselves.

It appears clear, then, that to reach the Millennium poverty reduction target, some countries will require specific poverty interventions to make growth more beneficial to the poor. One current of thought is to change the distribution of income, but another argues that it is preferable to search for policies that help the poor and generate growth at the same time. Above all, the crucial element to achieve the MDG in developing countries is much higher investment rates, both private and public. Low-income countries tend to be poorly endowed with basic infrastructure and human capital, which are important factors to attract private investment. In this respect, a strategy to scale up investments in infrastructure and human capital should be made a top priority of national strategies to meet the MDG. A relevant question that arises subsequently is how much investment would be required to support this strategy and ultimately to meet the MDG. This paper attempts to answer this question using unit-recorded household surveys for 15 African countries.

The remainder of the paper is organized as follows: Section II provides a brief outline of the methodology. This section also delineates the description of the data source used for the study. Section III is devoted to empirical analysis, while the final section concludes the paper.

2 DATA AND METHODOLOGY

This study will utilize the unit record household data sets from 15 African countries. With the exception of Guinea, the data sets cover 1996-2001.¹ Although the choice of the 15 selected countries is governed by the availability of household survey information, the sample includes both western and eastern African countries. Thus, the sample countries are broadly representative of the whole of Sub-Saharan Africa. For this study, a poverty line is required for each of the 15 countries. The study uses national poverty lines. These poverty lines have been obtained from various poverty assessments. As these poverty lines do not take into account different needs of household members by age and gender, the lines used in this study have been modified to account for equivalence and household economies of scale (Kakwani and Subbarao, 2005).

This study will only focus on the head-count ratio, which is the most widely used measure of poverty. The head-count measure captures the percentage of people living below a specified threshold of income or consumption. Nevertheless, the proposed methodology can be applied to other poverty measures such as poverty gap and severity of poverty. This paper provides the estimates of per capita investment in US dollars that would be needed in each of the 15 SSA countries in order to achieve the Millennium Development Goal (MDG) of halving the head-count ratio between 1990 and 2015.

2.1 REQUIREMENTS FOR GROWTH RATE

Suppose r is the annual growth rate of per capita mean consumption. If everyone received exactly the same proportional benefits, the inequality of per capita consumption would not change over time. In practice, everyone may not receive the same proportional benefits from economic growth. Some will receive proportionally greater (smaller) benefits than others. Economic growth may be called pro-poor (anti-poor), if it is accompanied by a decrease (increase) in inequality. If growth is pro-poor, then the investment required to achieve a given reduction in poverty will be less than that it will be if growth is not pro-poor. Suppose a 1 % growth rate is accompanied by a change in the Gini index of k %. Growth is defined as pro-poor if k is negative and, anti-poor if k takes a positive value. Growth may be called distribution neutral if k is equal to 0, implying that there is no change in inequality.

Each country included in the 15 African countries has a different survey year. For instance, the period of household survey available for Ethiopia is 2000, whereas the 1998 household survey is used for Zambia. Per capita consumption of each household will change over time because of the growth rate r and change in k that accompanies during the growth process. Suppose x_{it} is the per capita consumption of the i th household in year t and μ_t is the per capita mean consumption of all households. Then, we can establish the following relationship:

$$x_{it} = [x_{it-1} + kr(x_{it-1} - \mu_{t-1})](1 + r) \quad (1)$$

where

$$\mu_t = \mu_{t-1}(1 + r) \quad (2)$$

Applying Kakwani (1980),² it can be easily shown that kr in (1) is equal to the proportional change in the Gini index.

Suppose z_i is the per capita poverty line for the i th household, which is fixed over time. The head-count measure of poverty (the percentage of poor population below the poverty line) in year t will then be given by:

$$H_t = 100 \times \text{Probability}[x_{it} < z_i]$$

To estimate H_t from the household survey, we need to define

$$\zeta_{it} = \begin{cases} 100 & \text{if } x_{it} < z_i \\ 0 & \text{if } x_{it} \geq z_i \end{cases}$$

which gives an estimate of H_t as

$$H_t = \sum_{i=1}^n \zeta_{it} w_i \quad (3)$$

where w_i is the population weight attached to the i th sample household. Note that H_t depends on the growth rate of the economy (r) and the pattern of growth as captured by k . Hence, it is possible to estimate poverty measures every year for any values of r and k . Having computed the estimates of poverty for each period, we can easily calculate the poverty elasticity with respect to growth in any period for any poverty measures and for any values of k by substituting $r = 1\%$ in (1).

Assuming that the head-count ratio declines at uniform rate of m percent per annum between 1990 and 2015, then we have an exponential relationship:

$$P_{2015} = P_{1990} (1+m)^{25} \quad (4)$$

which gives $m = 0.02735$. In other words, to meet the MDG poverty reduction target, the head-count ratio should decline at an annual rate of 2.735 percent. Dividing 2.735 by the estimated poverty elasticity will immediately give us the growth rates of per capita consumption that would be needed to reduce poverty by half between 1990 and 2015.

2.2 REQUIREMENTS FOR INVESTMENT

Taking a step further, our ultimate objective is to estimate investment required to achieve the MDG of halving poverty by 2015. As such, we need to establish the relationship between the projected growth rate of per capita consumption and the investment rate. Since there exists no direct relationship between growth rate of household consumption and investment rate, we assume that per capita household consumption will on average grow at the same rate as growth of per capita GDP. This assumption will allow us to estimate investment requirements using the growth models of capital accumulation.

Note at this point that in this paper, we estimate gross investment which includes both public and private investment.³ Then, the issue of 'crowding-out' stands out, which has to do with the relationship between public and private investment. However, empirical studies point to that there is no evidence of the crowding-out effect of private investment by public investment (Aschauer 1989, Erenburg 1993, Easterly and Rebelo 1993, Erenburg and Wohard 1995, Argimon et al. 1997). While the public sector capital stock may be complementary to the private sector and have a positive effect on growth, its efficiency may be questionable. Moreover, in many developing countries public sector enterprises compete directly with the private sector in the provision of goods and services. In these cases, an increase in public investment could have an adverse effect on private investment both directly, and indirectly through the public sector budget constraint. In addition, a recent study by Weeks and Roy (2004) found no empirical evidence of crowding-out in countries like Cambodia, Nepal, and Mongolia. In that study, they also found that China and Vietnam have had the strongest public investment programmes and also attracted large inflows of foreign direct investment, suggesting that public investment has actually facilitated private investment. Similarly, Chibber et al. (1988) discussed the case of Turkey in the 1980s where, despite very high real interest rates, private investment boomed because of investment by public sector enterprises. Given unclear empirical evidence on the relation between public and private investment, it is assumed in this study that the crowding-out parameter is equal to zero (see Annex).

The productivity of private capital may differ from that of public capital. Our model can indeed take account of the difference in productivity of private and public capitals. Yet, as

we do not have any information on their productivities for each of the African countries in consideration, it is assumed that both private and public capitals take the same value of 1/3. Kahn and Kumar (1993) have investigated the efficiency of public investment relative to private investment and its contribution to long-run growth in developing countries (including 45 SSA countries) between 1970 and 1990. They have found that for Africa, both types of investment had a similar impact on output: during 1970-1990, the elasticity of investment with respect to growth was 0.32 for both private and public investment. This result, thus, seems to support our assumption of the productivities of private and public capitals equal to 1/3.

Growth depends on several kinds of capital including human and physical capital. Here we use a simple growth model, which emphasizes only physical capital. This model assumes that the output-capital ratio is constant. In low-income countries, in general, the ratio takes a value of around 1/3 (Romer 2001). Given this assumption, it is obvious that the growth rate of per capita GDP will be equal to the growth rate of capital per person. The growth rate of capital per person depends positively on the gross investment rate as a share of GDP (denoted as i) and negatively on the rate of population growth. Then, with a little mathematics, we obtain the relationship (see Annex for the proof):

$$i = 3(g + n + d) \quad (5)$$

where g is the growth rate of per capita consumption, n is the growth rate of population and d is the rate of depreciation.⁴

If we substitute g equal to the required growth rate of per capita household consumption to achieve the MDG poverty reduction target in (5) and with estimated rates of population growth and rate of depreciation, we will immediately obtain the required estimates of investment as a share of GDP, i .

In the long run, it is not reasonable to assume that population growth will be constant. Over a long period of time, the population growth rate is likely to decline. Instead of making ad-hoc assumptions on the rate of population growth over time, we decided to obtain population projections using a trend regression model:

$$\ln(N)_{it} = \alpha + \beta \times t + \varepsilon_{it} \quad (6)$$

where $\ln(N)_{it}$ is logarithm of total population in i th country at period t and ε is the disturbance term. This model was estimated using the population data for each of the 15 SSA countries for the period 1990-2002 obtained from the 2004 World Development Indicators. Using the estimated coefficients ($\hat{\alpha}$ and $\hat{\beta}$) from (6) and taking exponential, we will be able to project the population numbers from 2003 to 2015. From the predicted number of population, an annual rate of population growth (n) can then be computed up to 2015.

3 EMPIRICAL ANALYSIS

3.1 GROWTH ELASTICITY OF POVERTY REDUCTION

The growth elasticity of poverty reduction can be defined as the percentage reduction in poverty in response to a growth rate of 1 percent provided inequality captured by the Lorenz

curve does not change. The measurement of the growth elasticity of poverty reduction is important because it tells us the extent to which growth reduces poverty when there is no change in the distribution of income or consumption. The elasticity of growth with respect to poverty reduction depends on the initial inequality as well as the level of economic development for each country. This explains why the elasticities vary from one country to another. In this study, these variations are taken into account by using country-specific household surveys and national poverty lines for the 15 countries. More importantly, the elasticity also changes over time within a country because not only the mean income of the society but also its inequality changes over time. As such, the growth elasticity of poverty reduction is expected to differ from one year to another and from one country to another.

For the 15 study countries, the growth elasticities of poverty reduction were estimated for each year up to the year 2015, starting from a year after the survey period. These elasticities differ depending on the values of k , which determines alternative growth scenarios. Hypothetically, we have chosen three alternative values of k ; +0.5, 0.0, and -0.5. With the positive (negative) value of k , it is implied that inequality is concurrently raised (reduced) with growth, and thus, this pattern of growth is classified as anti-poor (pro-poor). Growth is defined as distribution neutral when k takes the value of zero because inequality remains unchanged. In this paper, the change in inequality is measured by the change in the Gini index. Yet, there are infinite ways to achieve a given change in the Gini. It is assumed in this study that the change in the Gini index is achieved by uniformly shifting the Lorenz curve. This shift in the Lorenz curve implies that when growth is pro-poor (anti-poor), the persons below the mean income or consumption will gain proportionally more (less) than those above the mean.

TABLE 1

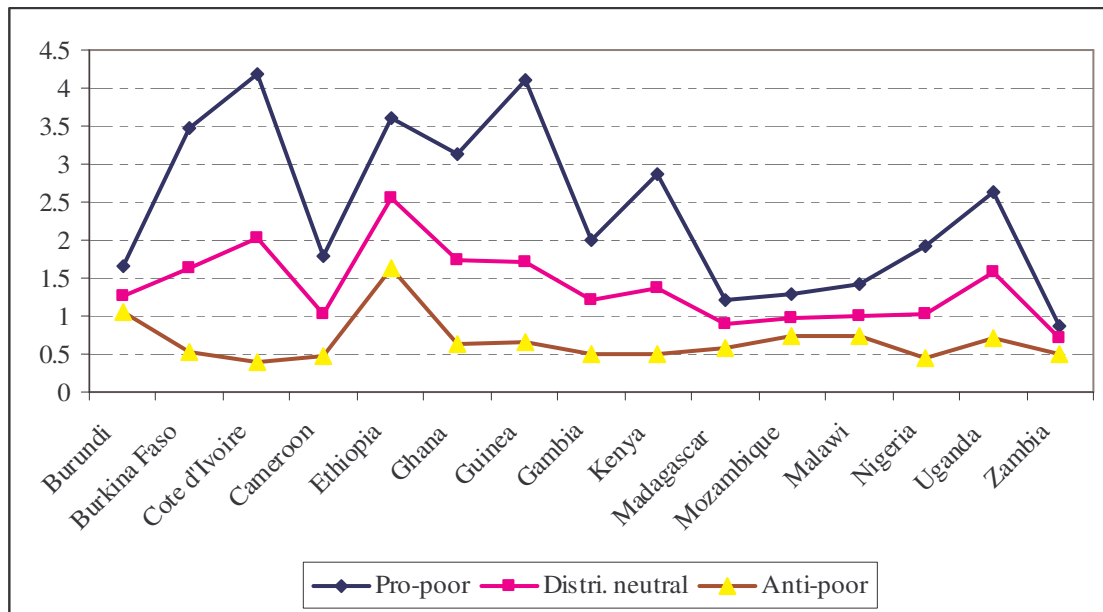
Average elasticity of poverty reduction with respect to growth with alternative growth scenarios: head-count ratio, 2005-2015

Country	Pro-poor	Distribution neutral	Anti-poor
Burundi	1.66	1.26	1.04
Burkina Faso	3.47	1.64	0.52
Cote d'Ivoire	4.18	2.02	0.39
Cameroon	1.80	1.03	0.48
Ethiopia	3.61	2.54	1.63
Ghana	3.13	1.73	0.64
Guinea	4.11	1.72	0.67
Gambia	2.00	1.20	0.51
Kenya	2.86	1.37	0.50
Madagascar	1.22	0.89	0.59
Mozambique	1.28	0.97	0.73
Malawi	1.42	1.01	0.74
Nigeria	1.91	1.02	0.46
Uganda	2.62	1.59	0.72
Zambia	0.87	0.70	0.49
<i>Average</i>	<i>2.41</i>	<i>1.38</i>	<i>0.67</i>

Source: authors' calculations.

FIGURE 1

Average growth-elasticity of poverty: head-count index, 2005-2015



While the growth elasticity of poverty for the head-count ratio is presented for every year in Table A.1 in the Appendix, Table 1 shows only the growth elasticities of poverty reduction averaged over 2005-2015. As would be expected, the magnitude of the elasticity is greatest under the pro-poor growth scenario (Figure 1). This indicates that the impact of growth on poverty reduction is greatest if a 1 percent uniform growth in per capita consumption expenditure accompanies a reduction in the Gini index of 0.5 percent. With the same 1 percent growth in the per capita consumption expenditure, the growth pattern of distribution neutral will lead to a smaller reduction in poverty than the pro-poor scenario, but a greater reduction in poverty than the anti-poor case. The results imply that if growth is pro-poor, a lower growth rate will be required to achieve the same percentage reduction in poverty. Furthermore, the pro-poor growth will require a lower investment per annum to achieve the MDG of halving poverty between 1990 and 2015. All in all, the estimates reveal that the pattern of growth plays an important role in determining the cost of meeting the MDG.⁵

3.2 REQUIRED PER CAPITA GROWTH RATE

To achieve the first MDGs of halving poverty between 1990 – 2015, the poverty reduction required per annum for the 25-year period is precisely 2.735 percent. Using the growth elasticity of poverty reduction calculated in Section A and the required rate of poverty reduction, it is possible to derive the per capita growth rate required to achieve the MDG. Table 2 presents the per capita growth rates required for each of the 15 African countries to achieve the goal, which are averaged over the next 10 years. The detailed table is shown in A.2. in the Appendix.

TABLE 2

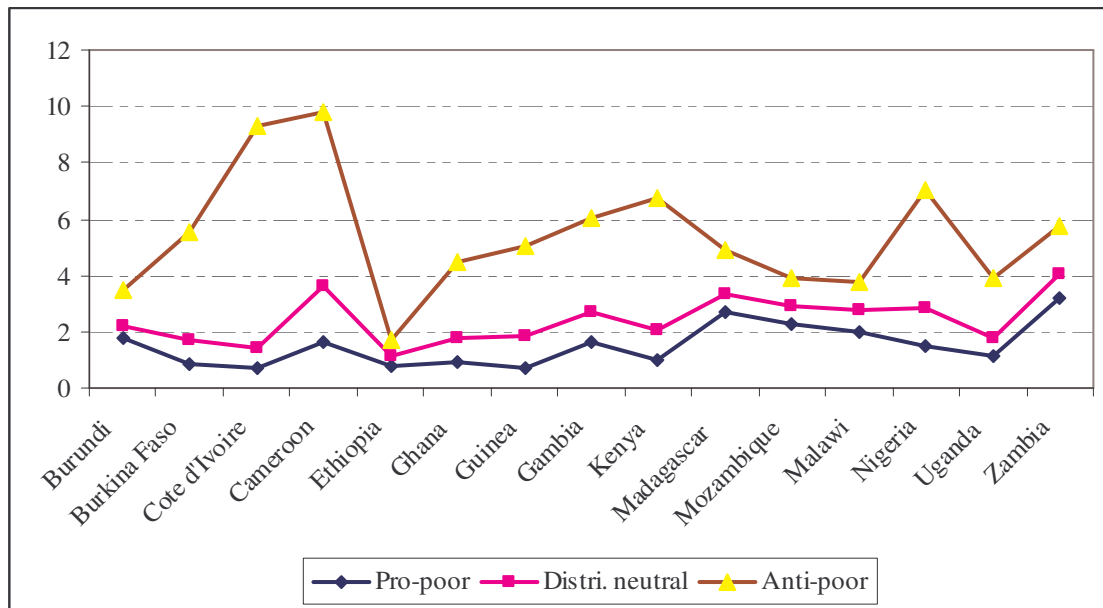
Average per capita growth rates required to meet the first MDG: Head-count ratio, 2005-2015

Country	Pro-poor	Distribution neutral	Anti-poor
Burundi	1.74	2.19	3.45
Burkina Faso	0.82	1.69	5.57
Cote d'Ivoire	0.68	1.43	9.32
Cameroon	1.64	3.61	9.81
Ethiopia	0.78	1.12	1.72
Ghana	0.89	1.74	4.45
Guinea	0.72	1.82	5.06
Gambia	1.64	2.73	6.06
Kenya	1.00	2.07	6.78
Madagascar	2.73	3.34	4.88
Mozambique	2.24	2.90	3.90
Malawi	1.96	2.80	3.78
Nigeria	1.52	2.81	7.01
Uganda	1.13	1.74	3.94
Zambia	3.19	4.03	5.73
<i>Average</i>	<i>1.51</i>	<i>2.40</i>	<i>5.43</i>

Source: authors' calculations.

Both Table 2 and Figure 2 reaffirm that while the pro-poor growth will require a lower growth rate than the distribution-neutral growth, anti-poor growth will require a much higher growth rate than distribution-neutral growth in order to achieve the same percentage reduction in poverty. For instance, when the pattern of growth is pro-poor, the average per capita GDP growth required for all 15 countries is only 1.51 percent. Yet, if growth is assumed to be distribution neutral, then the required growth rate becomes 2.40 percent. More importantly, when the growth pattern is anti-poor, the required per capita growth jumps to 5.43 percent. Thus, there is an exponential increase in the required growth when growth accompanies an increase in inequality that uniformly shifts the Lorenz curve (i.e. when growth benefits the non-poor proportionally more than the poor).

FIGURE 2

Average per capita growth rates required to meet the first MDG: Head-count ratio**3.3 REQUIRED INVESTMENT-GDP RATIO**

This section is related to estimating the investment requirement as a share of GDP. To estimate the required investment, we need to project the rate of population growth up to 2015. Using the population figures from 1990 to 2002 obtained from the 2004 WDI, we fitted a time-trend regression of logarithm of actual population against time. Based on the estimated coefficients, we projected the total population from 2003 to 2015 and then computed the annual population growth rates for the countries under consideration. Our estimates show that on average in the 15 countries, there will be an annual growth rate of population of around 2.57 percent between 2003 and 2015.

Having estimated the population growth rates, we can easily calculate the gross investment requirement as a percentage of GDP using equation (5). Recall that the capital-output ratio is assumed to be 3, as is normally the case for developing countries. Moreover, the rate of depreciation for fixed capital is, on average, estimated to be 3.1 for the 15 study countries.⁶ In addition, this study assumes that the parameter of crowding-out of private investment by public investment is zero. A number of studies such as Weeks and Roy (2004) suggest that there is no empirical evidence of the crowding-out. There are some studies that support the crowding-in effect in countries such as China and Vietnam. Then a question arises as to what value should be assumed for the ratio of the crowding-out effect. In fact, assuming a hypothetical value for the parameter will be too *ad hoc*. Yet, under the presumption of the crowding-in of private investment by public investment, our estimates of growth rate required to achieve the first MDGs are likely to be underestimated, and similarly, our estimates of investment requirement are likely to be overestimated.

TABLE 3

Simulated average investment requirement as a share of GDP: Head-count ratio, 2005-2015

Country	Pro-poor	Distribution neutral	Anti-poor
Burundi	20.91	22.42	26.06
Burkina Faso	18.89	21.50	33.14
Cote d'Ivoire	19.86	22.12	45.79
Cameroon	21.87	27.78	46.38
Ethiopia	18.45	19.47	21.26
Ghana	19.34	21.88	30.02
Guinea	18.76	22.03	31.77
Gambia	24.18	27.47	37.44
Kenya	19.66	22.89	37.01
Madagascar	26.37	28.22	32.83
Mozambique	22.82	24.81	27.80
Malawi	21.30	23.85	26.79
Nigeria	21.93	25.82	38.42
Uganda	21.20	23.28	28.64
Zambia	25.75	28.27	33.37
Average	21.42	24.12	33.11

Source: authors' calculations.

FIGURE 3

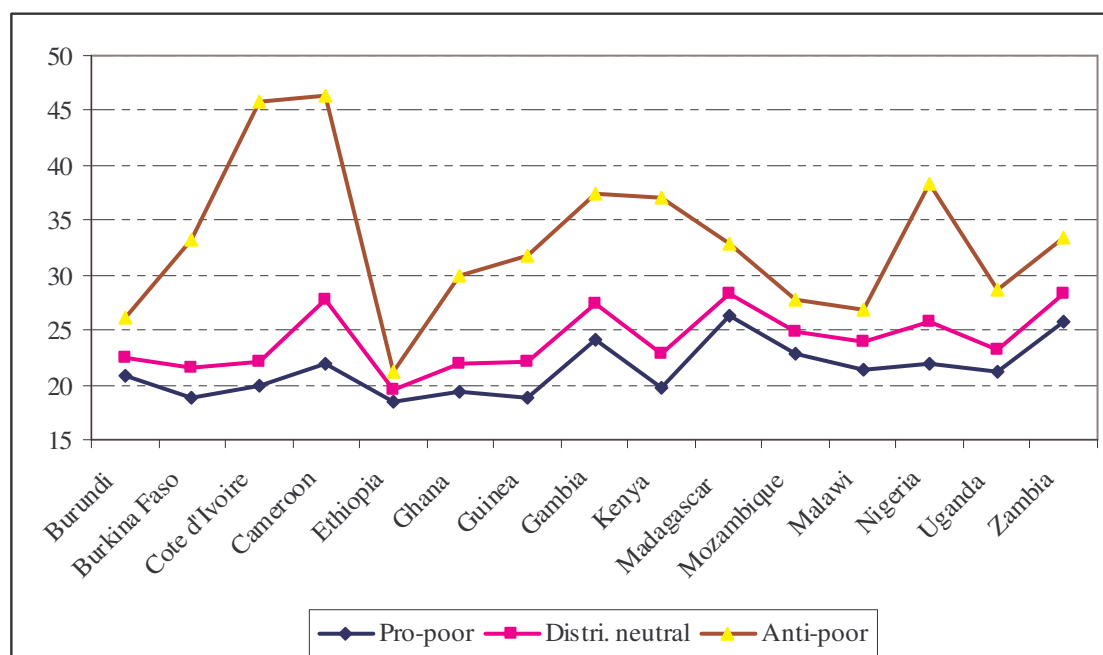
Required gross investment as a share of GDP

Table 3 presents the required average investment as a percentage of GDP. The required investments as percentage of GDP differ across the countries depending on the pattern of growth. With the pro-poor growth scenario, the average required investment is estimated to be 21.42 percent of GDP, which is considerably lower than the rate of 24.12 percent resulted from the distribution-neutral scenario. Detailed estimates of required investment ratio from 2005 to 2015 are presented in Table A.3 in the Appendix. It is evident that the required investment increases sharply if growth accompanies worsening inequality.

Countries can finance their investment requirements from a number of sources. The obvious main source is domestic saving. Domestic saving is the most important and sustainable source of financing economic growth. As argued by Sachs, et al. (2004), saving rates tend to be low in poor developing countries. According to a simple growth theory, a low saving rate is associated with a low capital-labor ratio, which contributes to slow economic growth.

TABLE 4

Investment-Saving Gap and Average Savings as % of GDP

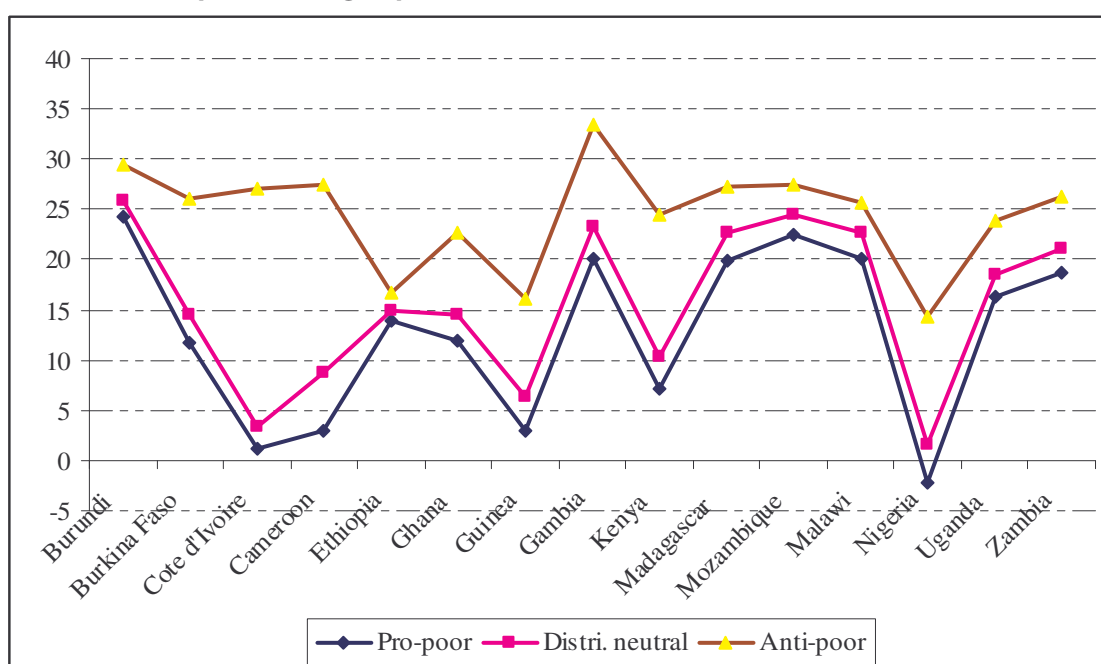
Country	Pro-poor	Distribution Neutral	Anti-poor	Gross national savings % of GDP(average 90-02)
Burundi	24.28	25.79	29.43	-3.37
Burkina Faso	11.80	14.42	26.05	7.09
Cote d'Ivoire	1.12	3.38	27.06	18.74
Cameroon	2.91	8.82	27.42	18.96
Ethiopia	13.90	14.92	16.72	4.55
Ghana	12.01	14.55	22.69	7.33
Guinea	3.00	6.28	16.01	15.76
Gambia	20.07	23.35	33.33	4.11
Kenya	7.06	10.28	24.40	12.61
Madagascar	19.92	22.62	27.24	5.59
Mozambique	22.47	24.46	27.45	0.35
Malawi	20.15	22.70	25.64	1.15
Nigeria	-2.23	1.65	14.26	24.17
Uganda	16.34	18.43	23.79	4.86
Zambia	18.62	21.13	26.24	7.13
<i>Average</i>	<i>12.76</i>	<i>15.52</i>	<i>24.52</i>	<i>8.60</i>

Source: authors' calculations.

As shown in Table 4, saving rates seem to have a positive correlation with per capita income of countries included in the study. For instance, saving rates are as high as about 19 percent of their GDP in relatively affluent countries such as Cote d'Ivoire and Cameroon. Yet, in the poorest countries – including Burundi, Mozambique, and Malawi, saving rates are negative or close to zero. The average saving rate across the 15 countries during 1990-2002 was just 8.6 percent of GDP. In East Asia, which is known as a fast growing region, average saving rates exceed as much as 34 percent of gross national income. Compared to the required investments given in Table 3, it is obvious that none of the 15 African countries will be able to achieve the first MDGs of poverty reduction using their domestic savings.

Table 4 presents the gap as percentage of GDP between investment required and average saving rate. The average investment-saving gap as percentage of GDP for the 15 countries is 12.76 when growth is pro-poor, but the gap increases steeply to 24.52 when growth is not pro-poor (see also figure 4).

FIGURE 4

Investment Required-Saving Gap as % of GDP**3.4 REQUIREMENTS FOR PER CAPITA FOREIGN AID IN US DOLLARS**

The investment gap can be filled by numerous alternative sources such as Official Development Assistance (ODA), private capital inflows, and borrowing. For African countries, ODA plays an important role in financing investment. To have an idea about how much the per capita gap can be in US dollars, we need to know the per capita GDPs of the countries in US dollars. Per capita GDPs in US dollars in 2002 were available for each of the 15 SSA countries from the 2004 WDI. From Section A, we have also obtained information on the magnitudes of the growth rate of per capita GDP that are required every year. Utilizing these growth rates, we could calculate the per capita GDP in 2002 US dollars for every year. While Table 5 presents the average figures over the next 10 years, detailed figures for 2005-2015 are shown in Table A.5 in the Appendix.

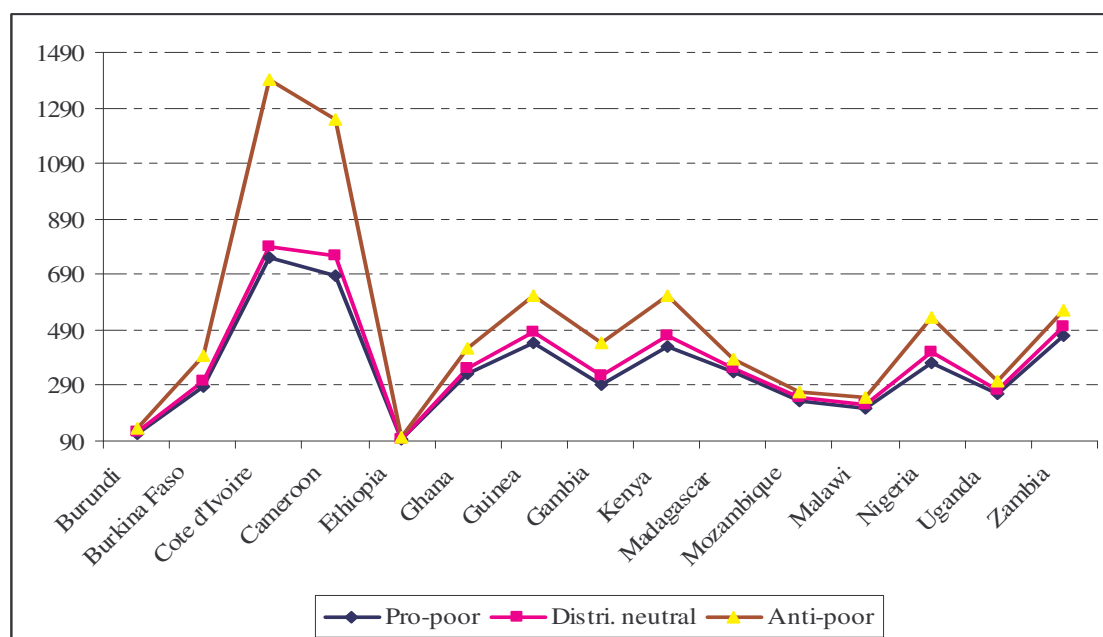
TABLE 5

Simulated average per capita GDP requirement in 2002 US\$: Headcount ratio, 2005-2015

Country	Pro-poor	Distribution neutral	Anti-poor
Burundi	118.00	122.13	135.35
Burkina Faso	284.73	304.28	398.64
Cote d'Ivoire	750.33	792.72	1391.35
Cameroon	685.80	756.61	1248.85
Ethiopia	97.00	99.79	104.16
Ghana	329.48	354.11	426.10
Guinea	443.16	479.95	611.85
Gambia	294.06	324.90	440.30
Kenya	430.17	466.94	615.98
Madagascar	338.77	354.63	387.56
Mozambique	235.95	249.17	267.58
Malawi	209.34	222.87	249.16
Nigeria	373.81	408.24	533.04
Uganda	260.59	274.49	303.97
Zambia	466.85	500.64	557.93
<i>Average</i>	<i>354.54</i>	<i>380.76</i>	<i>511.45</i>

Source: authors' calculations.

FIGURE 5

Average GDP per capita Requirement in 2002 US\$

What emerges from the table is that a greater GDP per capita will be required to achieve the same reduction in the percentage of poverty if growth favors the poor proportionally less than the non-poor. For instance, if growth is anti-poor, on average an additional \$156.91 per person GDP in 2002 US currency (compared to the pro-poor growth) will be required to meet the first MDGs for the next decade.

Given the investment-saving gap as percentage of GDP for every year, we could easily calculate the additional per capita investment requirement to achieve the first MDG in 2002 US dollars. Table 6 presents the average per capita investment-saving gap in 2002 US dollars. The estimates in Table 6 can be, in fact, interpreted as the amount of per person foreign aid required to meet the MDG. As would be expected, per capita aid increases monotonically as growth changes from pro-poor to anti-poor. To reach the MDG target in the next 10-year period, US\$ 35.43 per person on average is required annually under pro-poor growth, whilst more than US\$ 129 on average will be needed as aid in anti-poor growth conditions. It is interesting to note that Nigeria is the only country that will not require foreign assistance for the next decade to fill the gap between its investment and domestic saving (provided it is able to achieve pro-poor growth). This is due to very high domestic saving rate of 24.17 percent of GDP, which is the highest among the 15 countries. The required per capita aid is predicted for every year from 2005 to 2015, and the results are presented in Table A.6. in the Appendix.

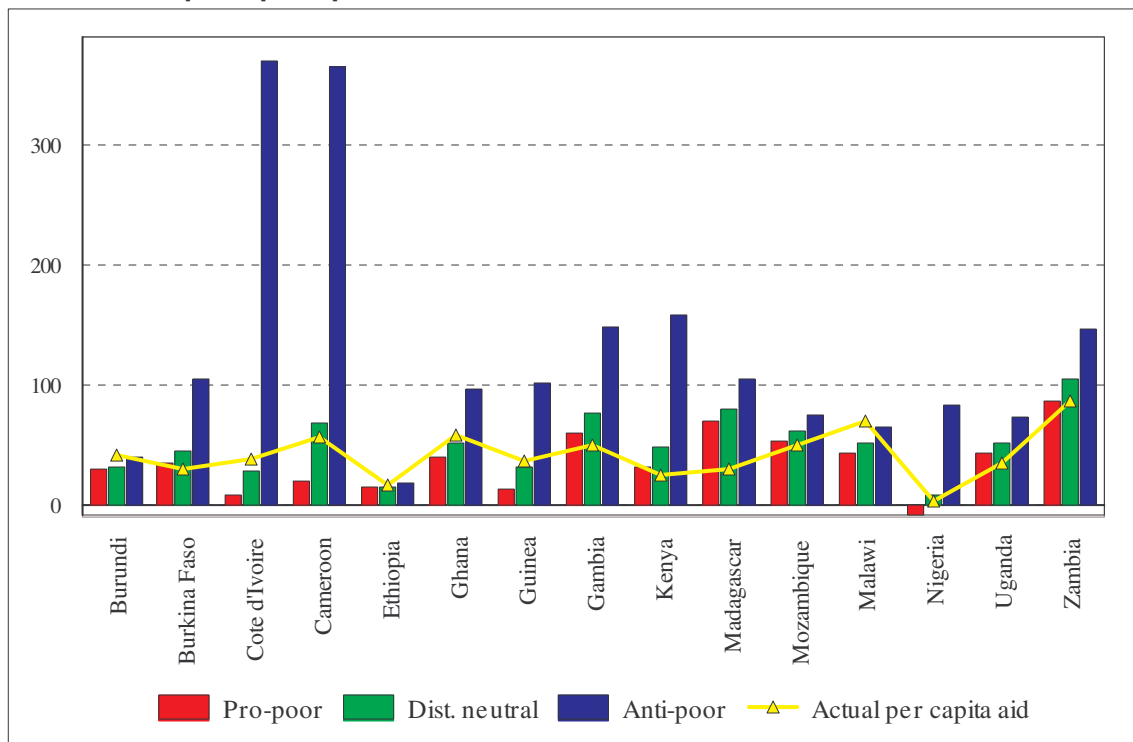
TABLE 6

Simulated average per capita Investment-Saving Gap in 2002 US\$: Headcount ratio, 2005-2015

Country	Pro-poor	Distribution neutral	Anti-poor	Actual level of per capita aid (US\$) received over 1990-2002
Burundi	28.66	31.48	39.71	40.5
Burkina Faso	33.57	43.82	104.79	30.0
Cote d'Ivoire	8.37	26.91	371.09	37.8
Cameroon	19.66	68.20	365.79	55.6
Ethiopia	13.48	14.88	17.38	16.1
Ghana	39.54	51.45	96.64	57.9
Guinea	13.25	30.17	100.56	35.8
Gambia	58.95	75.52	148.48	49.6
Kenya	30.28	47.85	158.73	24.8
Madagascar	69.83	79.72	105.12	29.6
Mozambique	52.96	60.95	73.71	48.9
Malawi	42.10	50.58	63.80	69.3
Nigeria	-8.42	6.90	83.37	2.0
Uganda	42.55	50.51	72.83	34.3
Zambia	86.61	105.47	146.62	86.5
<i>Average</i>	<i>35.43</i>	<i>49.63</i>	<i>129.91</i>	<i>41.24</i>

Source: authors' calculations.

FIGURE 6

Actual vs. required per capita aid in US\$

In addition, we have compared the required per capita aid with the actual aid received between 1990 and 2002. Over the period, some countries have received foreign aid larger than per capita aid required to meet the first MDG, while others have not received aid large enough to achieve the goal. Countries such as Burundi and Malawi fall into the former category: irrespective of growth pattern, actual aid exceeds required aid. On the other hand, countries – including Burkina Faso, Gambia, Kenya, Madagascar, Mozambique, Uganda, and Zambia – can be classified in the latter category. For these countries, they require much larger aid to achieve the goal no matter what pattern of growth they take over the next ten years from 2005. In particular, although Zambia has received an amount of 86.5 US\$ (the largest amount among the 15 countries) for foreign aid for the past decade, it requires more of aid to meet the goal of halving poverty by 2015. Nevertheless, Zambia might be able to achieve the goal if its growth process follows a pro-poor growth over 2005-2015, meaning that the growth benefits the poor proportionally more than the non-poor.

4 CONCLUSIONS

This paper has proposed a methodology to estimate required growth rates, investment as a share of GDP, and per capita foreign aid in US dollars in order to achieve the first MDGs of poverty reduction. It has provided a methodology which gives a linkage between MDG costs, growth, poverty, and inequality. The methodology has been only applied to the head-count poverty measure but is applicable to other poverty measures such as poverty gap and severity of poverty. This study has taken into account the distributional aspect to derive the estimates

of the projected growth and investment rates required for the next 10 years from 2005 to reach the first MDG. This task was done by providing simulations for different growth scenarios: pro-poor, distribution neutral, and anti-poor.

The proposed methodology was applied to 15 countries that belong to the Sub-Saharan African region. Empirical analysis emerging from the paper is twofold. First, their saving rates are too low to offset their high population growth and the rate of depreciation for fixed capital. Almost all countries will require foreign aid, but some will require more than others. Secondly, per capita foreign aid required to offset the shortfall of investment-saving will be much more if the benefits of growth flow proportionally less to the poor than to the non-poor. Thus, the most important conclusion that emerges from this study is that countries should be encouraged to follow pro-poor policies, which will considerably reduce the requirements for ODA. The study showed that for a country with a high saving rate sufficient to finance gross investment, foreign aid would not be required for the next 10 years on average to achieve the poverty reduction goal. According to our study, Nigeria is the only country that will not require foreign assistance. Yet, our study suggests that this will occur only if growth in Nigeria for the next decade benefits the poor proportionally more than the non-poor.

ANNEX

Assume several parameters, including: K_r is private capital; K_g is public capital; a_r is productivity of capital in private sector; and a_g is productivity of capital in public sector. Using these parameters, we can write the production function as:

$$Y = a_r K_r + a_g K_g \quad (\text{a-1})$$

On differentiating (a-1), we will get:

$$\frac{dY}{dt} = a_r \frac{dK_r}{dt} + a_g \frac{dK_g}{dt}$$

This can be rewritten as:

$$\frac{dY}{dt} = a_r I_r + a_g I_g - d[a_r K_r + a_g K_g] \quad (\text{a-2})$$

where $\frac{dK_r}{dt} = I_r - dK_r$, $\frac{dK_g}{dt} = I_g - dK_g$, and d is the depreciation rate.

From equation (a-2) and utilizing (a-1), the growth rate of output Y can be expressed as:

$$g = (1/Y)(dY/dt) = a_r i_r + a_g i_g - d \quad (\text{a-3})$$

where i_r and i_g are the share of private and public investments in output: $i_r = I_r/Y$ and $i_g = I_g/Y$.

It should be also noted that the rate of population growth matters to the growth rate of the economy. To take into account the rate of population growth, define $\nu = K/N$, where N is population. Then, with a little mathematics, it is possible to express the growth rate of the capital-labor ratio as:

$$(1/\nu)d\nu/dt = (I/Y)(Y/K) - (n+d) = ia - (n+d) \quad (\text{a-4})$$

where $i = I/Y$, $a = Y/K$, $n = (1/N)(dN/dt)$.

Note that the simplest economic model of growth describes output Y as being equal to the capital stock per person, ν , multiplied by a constant value of the average productivity of capital, a . As such, it can be argued that the growth rate of output (g) is equal to the rate of growth of capital per person (see Romer (2001) for its derivation). This allows us to write equation (a-3) as follows:

$$g = a_r i_r + a_g i_g - (d+n) \quad (\text{a-5})$$

Using equation (a-5), the potential growth rate of the economy without public investment ($l_g = 0$) is entirely determined by private investment and is formally defined as:

$$g^o = a_r i_r - (d + n) \quad (\text{a-6})$$

Assuming that the crowding out ratio is ϕ , which is the fraction by which public investment reduces private investment. Given this, the growth rate with public investment ($l_g > 0$) can be defined as:

$$g^* = a_r (i_r - \phi i_g) + a_g i_g - (d + n) \quad (\text{a-7})$$

Suppose that the productivity of private capital is the same as that of public capital: $a_r = a_g = 1/3$. Further suppose that there is no crowding-out of private investment by public investment: $\phi = 0$. With these assumptions, the growth rate of output in the economy (g) can be derived as:

$$g = (1/3)(i_r + i_g) - (d + n) = (1/3)i - (d + n) \quad (\text{a-8})$$

where i is total share of both public and private investment. On solving (a-8) in terms of i to get:

$$i = 3(g + d + n) \quad (\text{a-9})$$

which is the same as equation (5) presented on page 5 of this paper.

To see the impact of crowding-out on the growth rate, subtract (a-7) from (a-6) to get:

$$g^o - g^* = i_g (\phi a_r - a_g) \quad (\text{a-10})$$

One scenario is the case of no crowding-out. If there is no crowding-out, public investment does not reduce private investment. In this case, the parameter of crowding-out (ϕ) is simply zero. Then, there will be no loss of growth in the economy as can be seen from (a-10).

Another scenario is the case of total crowding-out. Although total crowding-out is unlikely to occur in practice, under this extreme scenario public investment offsets private investment by 100 percent. In this case, ϕ takes a value of 1. Then the potential growth rate with public investment can be defined as:

$$g^* = g^o - i_g (a_r - a_g) \quad (\text{a-11})$$

This derivation indicates that there will be always loss of growth if crowding out is total and $a_r > a_g$. However, the crowding-out can lead to a positive impact on growth if public capital is more productive than private capital, i.e. $a_r < a_g$.

APPENDIX

TABLE A.1

Elasticity of poverty with respect to growth with alternative growth scenarios: headcount ratio

Country	Pro-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	-1.60	-1.31	-1.40	-2.71	-1.55	-1.50	-1.72	-1.69	-2.18	-1.56	-1.08
Burkina Faso	-3.05	-3.10	-2.50	-2.36	-3.80	-3.31	-3.69	-3.38	-4.25	-4.79	-3.90
Cote d'Ivoire	-3.54	-3.92	-4.39	-2.98	-3.77	-4.02	-4.20	-5.69	-3.45	-4.82	-5.19
Cameroon	-1.68	-1.22	-1.13	-1.67	-1.69	-1.43	-2.04	-1.88	-1.76	-3.47	-1.82
Ethiopia	-2.65	-3.59	-2.87	-3.74	-3.16	-3.41	-3.25	-3.99	-4.22	-4.81	-4.04
Ghana	-2.60	-2.34	-3.23	-2.78	-3.49	-2.93	-3.09	-3.37	-3.21	-3.75	-3.67
Guinea	-2.40	-2.85	-2.54	-4.33	-4.80	-3.50	-4.33	-4.83	-5.43	-4.16	-6.05
Gambia	-1.04	-1.34	-1.97	-1.62	-2.60	-3.85	-1.32	-1.87	-1.23	-1.33	-3.79
Kenya	-1.60	-2.46	-2.72	-3.12	-2.62	-3.20	-2.81	-2.89	-3.19	-3.70	-3.17
Madagascar	-0.47	-1.31	-0.71	-1.28	-1.56	-0.56	-1.71	-1.12	-1.89	-1.67	-1.19
Mozambique	-1.46	-1.04	-0.89	-1.38	-0.97	-1.35	-1.03	-1.23	-1.71	-1.87	-1.20
Malawi	-1.11	-1.24	-1.16	-1.43	-1.37	-1.48	-1.57	-1.57	-1.47	-1.73	-1.52
Nigeria	-1.49	-1.13	-1.35	-2.31	-2.16	-2.15	-2.16	-2.05	-2.51	-1.86	-1.81
Uganda	-2.34	-2.37	-2.26	-2.71	-2.24	-2.95	-2.23	-3.06	-2.63	-2.85	-3.20
Zambia	-0.72	-0.75	-0.87	-0.78	-0.89	-0.97	-0.99	-0.98	-0.77	-0.92	-0.90

TABLE A.1

Elasticity of poverty with respect to growth with alternative growth scenarios: headcount ratio (continued)

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	-0.88	-0.62	-1.76	-0.30	-1.32	-0.80	-1.26	-1.21	-0.49	-1.02	-1.75
Burkina Faso	-0.49	-0.75	-0.72	-0.54	-0.48	-0.31	-0.43	-0.56	-0.51	-0.40	-0.51
Cote d'Ivoire	-0.30	-0.11	-0.55	-0.69	-0.30	-0.36	-0.34	-0.76	-0.25	-0.49	-0.20
Cameroon	-0.67	-0.21	-0.43	-0.22	-0.43	-0.69	-0.71	-0.06	-0.44	-0.94	-0.48
Ethiopia	-1.35	-1.27	-1.31	-1.88	-1.46	-1.81	-1.87	-1.60	-1.90	-1.70	-1.77
Ghana	-0.76	-0.60	-0.45	-0.48	-0.82	-0.71	-0.85	-0.59	-0.55	-0.63	-0.60
Guinea	-1.07	-0.50	-0.43	-0.53	-0.52	-1.04	-0.98	-0.97	-0.25	-0.68	-0.35
Gambia	-0.80	-0.76	-0.28	-0.48	-0.40	-0.47	-0.45	-0.51	-0.82	-0.27	-0.41
Kenya	-0.53	-1.06	-0.40	-0.56	-0.33	-0.63	-0.47	-0.47	-0.34	-0.16	-0.54
Madagascar	-0.59	-0.40	-0.75	-0.42	-0.83	-0.44	-0.61	-0.50	-0.72	-0.65	-0.57
Mozambique	-0.56	-0.79	-1.05	-0.63	-0.83	-0.81	-0.63	-0.79	-0.74	-0.53	-0.64
Malawi	-0.64	-0.62	-0.67	-0.93	-0.91	-0.76	-0.67	-0.75	-0.65	-0.69	-0.80
Nigeria	-0.38	-0.67	-0.48	-0.61	-0.35	-0.45	-0.40	-0.64	-0.62	-0.20	-0.21
Uganda	-0.76	-0.81	-0.71	-0.99	-0.76	-0.78	-0.81	-0.44	-0.71	-0.68	-0.52
Zambia	-0.51	-0.34	-0.59	-0.56	-0.45	-0.62	-0.60	-0.43	-0.42	-0.43	-0.47

TABLE A.1

**Elasticity of poverty with respect to growth with alternative growth scenarios:
headcount ratio (continued)**

Country	Distribution neutral growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	-1.46	-0.88	-1.05	-1.24	-1.31	-1.40	-1.53	-1.01	-1.60	-1.35	-1.07
Burkina Faso	-1.31	-1.39	-1.74	-2.04	-1.56	-1.83	-1.75	-1.55	-1.66	-1.60	-1.58
Cote d'Ivoire	-2.00	-2.04	-1.68	-2.30	-2.56	-2.66	-2.67	-1.28	-1.84	-1.51	-1.68
Cameroon	-1.24	-0.69	-0.68	-0.68	-0.92	-1.47	-1.34	-0.75	-0.24	-2.17	-1.13
Ethiopia	-1.76	-2.38	-2.46	-2.54	-2.83	-2.68	-2.63	-1.71	-3.14	-2.49	-3.34
Ghana	-1.57	-1.63	-1.50	-1.86	-1.24	-1.74	-0.84	-1.39	-2.25	-2.56	-2.42
Guinea	-0.91	-2.09	-1.65	-1.62	-3.37	-1.53	-2.10	-2.03	-1.10	-1.02	-1.47
Gambia	-0.66	-2.27	-0.81	-0.68	-0.89	-1.26	-0.68	-1.02	-1.08	-2.19	-1.69
Kenya	-1.45	-1.28	-1.25	-1.15	-0.98	-1.07	-1.90	-1.32	-1.56	-1.40	-1.67
Madagascar	-0.68	-0.88	-0.53	-1.09	-0.84	-0.47	-1.08	-1.00	-1.07	-1.24	-0.95
Mozambique	-0.89	-1.32	-0.88	-0.99	-0.82	-0.87	-0.78	-0.85	-0.84	-1.27	-1.21
Malawi	-0.98	-1.04	-0.77	-1.22	-0.77	-1.27	-1.26	-0.87	-0.97	-0.85	-1.05
Nigeria	-0.93	-1.15	-1.19	-0.96	-1.00	-1.05	-0.74	-0.87	-1.35	-0.68	-1.28
Uganda	-1.23	-1.72	-1.46	-1.35	-1.57	-1.61	-1.79	-1.80	-1.43	-1.74	-1.83
Zambia	-0.75	-0.80	-0.52	-0.66	-0.64	-0.55	-0.68	-0.73	-0.90	-0.57	-0.88

TABLE A.2

**Simulated per capita growth rates required to meet the MDG poverty reduction target:
head-count ratio**

Country	Pro-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	1.71	2.09	1.95	1.01	1.76	1.82	1.59	1.62	1.25	1.75	2.53
Burkina Faso	0.90	0.88	1.10	1.16	0.72	0.83	0.74	0.81	0.64	0.57	0.70
Cote d'Ivoire	0.77	0.70	0.62	0.92	0.73	0.68	0.65	0.48	0.79	0.57	0.53
Cameroon	1.62	2.25	2.41	1.63	1.62	1.91	1.34	1.45	1.55	0.79	1.50
Ethiopia	1.03	0.76	0.95	0.73	0.87	0.80	0.84	0.69	0.65	0.57	0.68
Ghana	1.05	1.17	0.85	0.98	0.78	0.93	0.88	0.81	0.85	0.73	0.75
Guinea	1.14	0.96	1.08	0.63	0.57	0.78	0.63	0.57	0.50	0.66	0.45
Gambia	2.62	2.04	1.39	1.69	1.05	0.71	2.08	1.46	2.22	2.06	0.72
Kenya	1.71	1.11	1.00	0.88	1.04	0.86	0.97	0.95	0.86	0.74	0.86
Madagascar	2.74	2.09	3.85	2.14	1.75	4.90	1.60	2.45	1.45	1.64	2.30
Mozambique	1.87	2.62	3.08	1.99	2.81	2.03	2.65	2.23	1.60	1.46	2.28
Malawi	2.47	2.21	2.35	1.92	2.00	1.84	1.74	1.74	1.86	1.58	1.80
Nigeria	1.83	2.42	2.03	1.18	1.27	1.27	1.27	1.33	1.09	1.47	1.51
Uganda	1.23	1.40	1.17	1.15	1.21	1.01	1.22	0.93	1.23	0.89	1.04
Zambia	3.81	3.64	3.13	3.51	3.06	2.81	2.77	2.79	3.54	2.99	3.05

TABLE A.2

**Simulated per capita growth rates required to meet the MDG poverty reduction target:
head-count ratio (continued)**

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	3.09	4.41	1.56	9.18	2.07	3.42	2.16	2.26	5.59	2.67	1.56
Burkina Faso	5.54	3.66	3.79	5.06	5.68	8.74	6.34	4.89	5.40	6.85	5.35
Cote d'Ivoire	9.04	26.04	5.01	3.95	9.06	7.59	8.05	3.61	10.99	5.63	13.56
Cameroon	4.10	13.32	6.33	12.52	6.38	3.95	3.86	4.66	6.17	2.90	5.75
Ethiopia	2.03	2.15	2.09	1.45	1.88	1.52	1.46	1.71	1.44	1.61	1.54
Ghana	3.62	4.55	6.10	5.71	3.32	3.84	3.22	4.66	5.01	4.37	4.54
Guinea	2.57	5.52	6.32	5.14	5.29	2.62	2.79	2.82	10.83	4.03	7.73
Gambia	3.43	3.60	9.79	5.69	6.84	5.82	6.09	5.38	3.33	10.05	6.64
Kenya	5.13	2.57	6.77	4.86	8.39	4.35	5.87	5.81	8.14	17.63	5.04
Madagascar	4.67	6.76	3.64	6.47	3.28	6.18	4.46	5.46	3.81	4.23	4.76
Mozambique	4.87	3.46	2.60	4.33	3.31	3.39	4.33	3.46	3.70	5.17	4.25
Malawi	4.29	4.40	4.07	2.93	3.01	3.61	4.09	3.63	4.21	3.94	3.43
Nigeria	7.21	4.06	5.69	4.48	7.87	6.09	6.87	4.27	4.42	13.38	12.80
Uganda	3.58	3.38	3.85	2.77	3.61	3.50	3.39	6.16	3.83	4.03	5.29
Zambia	5.33	8.02	4.64	4.92	6.09	4.39	4.56	6.42	6.57	6.32	5.76

TABLE A.2

**Simulated per capita growth rates required to meet the MDG poverty reduction target:
head-count ratio (continued)**

Country	Distribution neutral growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	1.88	3.10	2.61	2.21	2.09	1.95	1.79	2.70	1.71	2.02	2.56
Burkina Faso	2.08	1.96	1.58	1.34	1.75	1.49	1.56	1.76	1.65	1.71	1.73
Cote d'Ivoire	1.36	1.34	1.62	1.19	1.07	1.03	1.02	2.14	1.49	1.81	1.63
Cameroon	2.20	3.97	4.03	4.02	2.96	1.86	2.03	3.66	11.33	1.26	2.42
Ethiopia	1.55	1.15	1.11	1.08	0.97	1.02	1.04	1.60	0.87	1.10	0.82
Ghana	1.75	1.68	1.82	1.47	2.20	1.57	3.24	1.97	1.22	1.07	1.13
Guinea	3.02	1.31	1.66	1.69	0.81	1.79	1.30	1.34	2.49	2.69	1.86
Gambia	4.11	1.21	3.37	4.03	3.09	2.17	4.02	2.69	2.53	1.25	1.62
Kenya	1.88	2.14	2.19	2.38	2.79	2.55	1.44	2.07	1.75	1.95	1.64
Madagascar	4.00	3.11	5.18	2.50	3.25	5.84	2.52	2.74	2.56	2.21	2.89
Mozambique	3.07	2.07	3.10	2.76	3.35	3.14	3.51	3.22	3.28	2.15	2.26
Malawi	2.78	2.63	3.55	2.25	3.54	2.15	2.16	3.13	2.81	3.23	2.60
Nigeria	2.95	2.38	2.30	2.86	2.74	2.62	3.71	3.16	2.02	4.05	2.13
Uganda	2.23	1.59	1.88	2.02	1.74	1.70	1.53	1.52	1.92	1.58	1.50
Zambia	3.62	3.41	5.23	4.12	4.29	4.95	4.00	3.75	3.03	4.79	3.12

TABLE A.3

Simulated investment as a percentage of GDP required to meet the MDG poverty reduction target: head-count ratio

Country	Pro-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	20.83	21.97	21.57	18.73	20.99	21.17	20.47	20.55	19.47	20.97	23.3
Burkina Faso	19.16	18.95	19.43	19.46	20.15	18.14	19.8	17.79	19.13	18.71	17.05
Cote d'Ivoire	19.97	21.13	19.04	21.24	18.92	20.03	19.71	18.96	20.99	18.76	19.69
Cameroon	23.02	22.94	23.28	22.42	22.16	22.82	20.92	21.07	21.19	18.73	22.06
Ethiopia	19.16	18.62	18.63	18.61	18.47	18.51	18.84	17.85	18.3	17.56	18.41
Ghana	20.68	19.49	19.67	18.62	19.12	19.39	19.07	19.83	18.62	19.2	19.05
Guinea	20.11	19.57	19.92	18.59	18.4	19.04	18.59	18.39	17.45	19.97	16.32
Gambia	27.12	25.39	23.42	24.34	22.41	21.4	25.49	23.65	25.92	25.43	21.43
Kenya	21.57	20.47	19.11	19.4	20.52	18.96	19.91	18.9	19.2	19.39	18.86
Madagascar	35.4	25.45	28.84	25.06	23.61	32.77	22.62	26.29	21.69	23.32	25.05
Mozambique	21.04	24.65	24.38	22.42	24.72	22.23	23.93	22.52	21.76	19.92	23.45
Malawi	24.7	21.15	21.48	22.59	20.2	19.67	21.64	21.48	19.42	20.73	21.26
Nigeria	21.07	24.72	25.3	20.54	20.61	22.23	20.2	21.95	20.98	21.88	21.8
Uganda	22.07	22.32	20.32	22.15	21.04	20.23	21.6	20.48	22.05	19.91	20.99
Zambia	28.96	25.57	26.55	27.5	23.47	25.07	24.77	24.68	26.78	24.95	24.98

TABLE A.3

Simulated investment as a percentage of GDP required to meet the MDG poverty reduction target: head-count ratio (continued)

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	24.98	28.95	20.38	43.25	21.91	25.97	22.19	22.5	32.48	23.71	20.38
Burkina Faso	33.08	27.29	27.53	31.18	35.04	41.88	36.61	30.02	33.38	37.53	30.99
Cote d'Ivoire	44.77	97.14	32.2	30.33	43.94	40.77	41.9	28.36	51.59	33.96	58.77
Cameroon	30.46	56.16	35.04	55.09	36.43	28.94	28.48	144.7	35.04	25.06	34.8
Ethiopia	22.17	22.77	22.02	20.78	21.5	20.65	20.69	20.94	20.68	20.69	21.02
Ghana	28.38	29.64	35.43	32.81	26.73	28.1	26.07	31.37	31.11	30.13	30.42
Guinea	24.4	33.26	35.66	32.11	32.57	24.55	25.06	25.15	48.43	30.08	38.16
Gambia	29.55	30.06	48.64	36.34	39.77	36.72	37.53	35.42	29.24	49.43	39.18
Kenya	31.83	24.86	36.42	31.35	42.57	29.44	34.61	33.49	41.05	70.06	31.4
Madagascar	31.8	39.46	28.23	38.05	28.17	36.64	31.2	35.33	28.77	31.09	32.43
Mozambique	30.03	27.16	22.97	29.46	26.21	26.3	28.96	26.21	28.05	31.04	29.38
Malawi	30.18	27.72	26.65	25.63	23.25	24.97	28.69	27.13	26.48	27.82	26.14
Nigeria	37.2	29.64	36.28	30.45	40.42	36.7	37.01	30.74	30.96	57.62	55.66
Uganda	27.33	26.32	27.57	28.83	28.94	25.51	28.78	28.18	28.54	35.71	29.35
Zambia	33.51	38.72	31.09	31.72	32.57	29.82	30.16	35.58	35.86	34.96	33.13

TABLE A.3

Simulated investment as a percentage of GDP required to meet the MDG poverty reduction target: head-count ratio (continued)

Country	Distribution neutral growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	21.33	25.03	23.53	22.34	21.97	21.56	21.08	23.81	20.83	21.78	23.37
Burkina Faso	22.73	22.2	20.87	20.02	23.24	20.14	22.26	20.65	22.13	22.12	20.14
Cote d'Ivoire	21.75	23.06	22.05	22.05	19.94	21.08	20.82	23.95	23.07	22.5	23.00
Cameroon	24.76	28.12	28.12	29.58	26.19	22.66	23.00	27.7	50.51	20.15	24.83
Ethiopia	20.73	19.77	19.1	19.64	18.77	19.16	19.44	20.59	18.97	19.16	18.84
Ghana	22.76	21.01	22.6	20.08	23.38	21.30	26.14	23.29	19.71	20.21	20.21
Guinea	25.75	20.63	21.67	21.77	19.13	22.07	20.6	20.73	23.41	26.07	20.55
Gambia	31.6	22.88	29.36	31.34	28.53	25.78	31.31	27.33	26.85	23.00	24.12
Kenya	22.09	23.54	22.66	23.92	25.76	24.05	21.32	22.27	21.9	23.03	21.19
Madagascar	29.79	28.52	32.83	26.13	28.09	35.59	25.4	27.16	25.01	25.05	26.81
Mozambique	24.63	23.00	24.45	24.75	26.34	25.55	26.52	25.5	26.79	21.99	23.41
Malawi	25.64	22.42	25.07	23.58	24.84	20.59	22.91	25.65	22.27	25.68	23.66
Nigeria	24.43	24.61	26.1	25.56	25.02	26.27	27.53	27.42	23.77	29.62	23.65
Uganda	25.08	23.49	23.5	23.45	23.04	23.27	23.16	22.8	22.94	21.78	23.63
Zambia	28.39	24.89	32.84	29.33	27.16	31.5	28.47	27.56	25.22	30.36	25.2

TABLE A.4

Simulated Investment-Saving deficit required to meet the MDG poverty reduction target: head-count ratio

Country	Pro-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	24.20	25.34	24.93	22.10	24.37	24.54	23.84	23.93	22.84	24.33	26.67
Burkina Faso	12.08	11.86	12.34	12.38	13.07	11.05	12.71	10.70	12.04	11.62	9.96
Cote d'Ivoire	1.24	2.39	0.31	2.50	0.18	1.30	0.97	0.22	2.25	0.02	0.95
Cameroon	4.06	3.98	4.32	3.46	3.19	3.86	1.96	2.11	2.23	-0.24	3.10
Ethiopia	14.61	14.07	14.08	14.06	13.92	13.96	14.29	13.31	13.75	13.01	13.86
Ghana	13.35	12.16	12.34	11.29	11.79	12.06	11.74	12.50	11.29	11.86	11.72
Guinea	4.36	3.82	4.17	2.84	2.65	3.28	2.83	2.64	1.70	4.21	0.56
Gambia	23.00	21.28	19.31	20.22	18.30	17.28	21.38	19.54	21.81	21.32	17.32
Kenya	8.97	7.86	6.51	6.79	7.91	6.36	7.31	6.29	6.60	6.78	6.26
Madagascar	20.41	19.86	23.25	19.46	18.01	27.18	17.02	20.70	16.09	17.73	19.45
Mozambique	20.70	24.30	24.03	22.07	24.37	21.88	23.58	22.17	21.42	19.57	23.11
Malawi	23.55	20.01	20.33	21.44	19.06	18.52	20.49	20.34	18.28	19.58	20.11
Nigeria	-3.10	0.55	1.13	-3.62	-3.56	-1.93	-3.96	-2.22	-3.19	-2.29	-2.37
Uganda	17.21	17.47	15.46	17.30	16.18	15.37	16.74	15.63	17.19	15.06	16.13
Zambia	21.83	18.44	19.42	20.37	16.34	17.93	17.64	17.55	19.64	17.82	17.85

TABLE A.4

**Simulated Investment-Saving deficit required to meet the MDG poverty reduction target:
head-count ratio (continued)**

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	28.35	32.31	23.75	46.62	25.28	29.33	25.56	25.86	35.85	27.08	23.75
Burkina Faso	26.00	20.20	20.44	24.09	27.95	34.79	29.52	22.94	26.30	30.45	23.90
Cote d'Ivoire	26.03	78.40	13.46	11.60	25.20	22.03	23.17	9.63	32.85	15.22	40.03
Cameroon	11.49	37.19	16.08	36.13	17.46	9.98	9.52	125.73	16.08	6.10	15.83
Ethiopia	17.62	18.22	17.48	16.23	16.95	16.10	16.15	16.39	16.13	16.14	16.47
Ghana	21.05	22.30	28.10	25.48	19.40	20.77	18.74	24.04	23.78	22.80	23.09
Guinea	8.64	17.50	19.91	16.36	16.81	8.79	9.31	9.39	32.68	14.33	22.41
Gambia	25.43	25.95	44.53	32.22	35.66	32.61	33.42	31.30	25.13	45.31	35.07
Kenya	19.22	12.25	23.81	18.74	29.96	16.83	22.00	20.88	28.45	57.46	18.79
Madagascar	26.20	33.86	22.63	32.46	22.58	31.04	25.60	29.74	23.18	25.50	26.84
Mozambique	29.68	26.81	22.62	29.11	25.87	25.95	28.61	25.87	27.71	30.70	29.03
Malawi	29.03	26.57	25.50	24.49	22.10	23.82	27.54	25.98	25.33	26.67	24.99
Nigeria	13.03	5.47	12.11	6.28	16.25	12.53	12.85	6.57	6.79	33.45	31.49
Uganda	22.48	21.46	22.71	23.97	24.09	20.65	23.93	23.33	23.68	30.86	24.49
Zambia	26.37	31.58	23.96	24.59	25.43	22.69	23.03	28.44	28.72	27.83	26.00

TABLE A.4

**Simulated Investment-Saving deficit required to meet the MDG poverty reduction target:
head-count ratio (continued)**

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	28.35	32.31	23.75	46.62	25.28	29.33	25.56	25.86	35.85	27.08	23.75
Burkina Faso	26.00	20.20	20.44	24.09	27.95	34.79	29.52	22.94	26.30	30.45	23.90
Cote d'Ivoire	26.03	78.40	13.46	11.60	25.20	22.03	23.17	9.63	32.85	15.22	40.03
Cameroon	11.49	37.19	16.08	36.13	17.46	9.98	9.52	125.73	16.08	6.10	15.83
Ethiopia	17.62	18.22	17.48	16.23	16.95	16.10	16.15	16.39	16.13	16.14	16.47
Ghana	21.05	22.30	28.10	25.48	19.40	20.77	18.74	24.04	23.78	22.80	23.09
Guinea	8.64	17.50	19.91	16.36	16.81	8.79	9.31	9.39	32.68	14.33	22.41
Gambia	25.43	25.95	44.53	32.22	35.66	32.61	33.42	31.30	25.13	45.31	35.07
Kenya	19.22	12.25	23.81	18.74	29.96	16.83	22.00	20.88	28.45	57.46	18.79
Madagascar	26.20	33.86	22.63	32.46	22.58	31.04	25.60	29.74	23.18	25.50	26.84
Mozambique	29.68	26.81	22.62	29.11	25.87	25.95	28.61	25.87	27.71	30.70	29.03
Malawi	29.03	26.57	25.50	24.49	22.10	23.82	27.54	25.98	25.33	26.67	24.99
Nigeria	13.03	5.47	12.11	6.28	16.25	12.53	12.85	6.57	6.79	33.45	31.49
Uganda	22.48	21.46	22.71	23.97	24.09	20.65	23.93	23.33	23.68	30.86	24.49
Zambia	26.37	31.58	23.96	24.59	25.43	22.69	23.03	28.44	28.72	27.83	26.00

TABLE A.5

Simulated per capita GDP in 2002 US\$ required to meet the MDG poverty reduction target: head-count ratio

Country	Pro-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	108	111	113	114	116	118	120	122	123	125	129
Burkina Faso	272	275	278	281	283	285	287	290	292	293	295
Cote d'Ivoire	725	730	734	741	746	751	756	760	766	770	774
Cameroon	626	640	655	666	677	690	699	709	720	726	737
Ethiopia	93	94	95	96	96	97	98	99	99	100	100
Ghana	315	318	321	324	327	330	333	335	338	341	343
Guinea	427	431	435	438	441	444	447	449	452	455	457
Gambia	272	277	281	286	289	291	297	301	308	314	317
Kenya	410	414	419	422	427	430	434	439	442	446	449
Madagascar	289	295	306	313	318	334	339	347	352	358	366
Mozambique	209	214	221	225	231	236	242	248	252	255	261
Malawi	189	193	198	202	206	210	213	217	221	225	229
Nigeria	345	353	361	365	369	374	379	384	388	394	400
Uganda	246	249	252	255	258	261	264	266	270	272	275
Zambia	397	412	424	439	453	466	478	492	509	524	540

TABLE A.5

Simulated per capita GDP in 2002 US\$ required to meet the MDG poverty reduction target: head-count ratio (continued)

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	112	117	118	129	132	137	139	143	151	155	157
Burkina Faso	304	315	327	343	363	394	419	440	464	495	522
Cote d'Ivoire	843	1062	1116	1160	1265	1361	1470	1523	1691	1786	2028
Cameroon	732	830	882	993	1056	1097	1140	1626	1727	1777	1879
Ethiopia	95	97	99	101	103	104	106	108	109	111	113
Ghana	336	352	373	395	408	423	437	457	480	501	524
Guinea	472	498	530	557	587	602	619	636	705	734	790
Gambia	320	332	364	385	411	435	462	487	503	553	590
Kenya	451	463	494	518	562	586	621	657	710	835	878
Madagascar	299	319	331	352	364	386	403	425	442	460	482
Mozambique	223	231	237	247	255	264	275	284	295	310	323
Malawi	206	215	224	230	237	246	256	265	276	287	297
Nigeria	393	408	432	451	487	516	552	575	601	681	768
Uganda	255	262	272	281	292	300	310	321	332	353	366
Zambia	416	449	470	493	523	546	571	607	647	688	728

TABLE A.5.

**Simulated per capita GDP in 2002 US\$ required to meet the MDG poverty reduction target:
head-count ratio (continued)**

Country	Distribution neutral growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	109	112	115	117	120	122	124	128	130	132	136
Burkina Faso	280	286	290	294	299	304	308	314	319	324	330
Cote d'Ivoire	740	750	763	772	780	788	796	813	825	840	854
Cameroon	627	652	678	705	726	740	755	783	871	882	904
Ethiopia	94	96	97	98	99	100	101	102	103	104	105
Ghana	323	328	334	339	347	352	364	371	375	379	383
Guinea	444	450	457	465	469	477	484	490	502	516	525
Gambia	283	286	296	307	317	324	337	346	355	359	365
Kenya	418	427	436	446	459	471	477	487	496	506	514
Madagascar	297	306	322	330	341	360	369	380	389	398	409
Mozambique	215	219	226	232	240	248	257	265	273	279	286
Malawi	193	198	205	210	217	222	227	234	241	248	255
Nigeria	356	364	372	383	393	404	419	432	441	459	468
Uganda	250	255	260	265	269	275	280	284	289	293	299
Zambia	404	418	440	458	478	501	522	541	558	584	602

TABLE A.6

**Simulated per capita foreign aid in 2002 US\$ required to meet the MDG poverty reduction target:
head-count ratio**

Country	Pro-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	26.20	28.00	28.10	25.15	28.22	28.95	28.57	29.13	28.15	30.52	34.30
Burkina Faso	32.90	32.60	34.29	34.78	36.99	31.54	36.55	31.02	35.12	34.09	29.43
Cote d'Ivoire	8.96	17.42	2.24	18.53	1.37	9.74	7.32	1.70	17.25	0.18	7.36
Cameroon	25.42	25.47	28.31	23.04	21.62	26.64	13.68	14.95	16.06	-1.71	22.82
Ethiopia	13.62	13.21	13.35	13.43	13.41	13.56	14.00	13.12	13.65	12.99	13.93
Ghana	41.99	38.71	39.60	36.59	38.51	39.76	39.03	41.91	38.19	40.42	40.22
Guinea	18.58	16.45	18.15	12.42	11.67	14.58	12.65	11.85	7.67	19.16	2.56
Gambia	62.54	59.04	54.30	57.85	52.89	50.31	63.51	58.91	67.20	67.05	54.86
Kenya	36.74	32.58	27.23	28.67	33.74	27.35	31.74	27.59	29.18	30.20	28.12
Madagascar	58.91	58.51	71.14	60.83	57.29	90.67	57.70	71.86	56.69	63.47	71.26
Mozambique	43.20	52.05	53.06	49.69	56.41	51.69	57.17	54.96	53.93	50.01	60.38
Malawi	44.59	38.71	40.27	43.27	39.23	38.84	43.71	44.13	40.40	43.96	45.97
Nigeria	-10.69	1.96	4.07	-13.22	-13.15	-7.24	-15.02	-8.52	-12.38	-9.02	-9.46
Uganda	42.29	43.51	38.96	44.09	41.75	40.06	44.16	41.60	46.34	40.94	44.32
Zambia	86.68	75.88	82.44	89.51	74.00	83.50	84.40	86.31	100.03	93.46	96.47

TABLE A.6

Simulated per capita foreign aid in 2002 US\$ required to meet the MDG poverty reduction target: head-count ratio (continued)

Country	Anti-poor growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	31.66	37.68	28.12	60.28	33.37	40.04	35.64	36.88	53.98	41.86	37.29
Burkina Faso	78.92	63.58	66.77	82.67	101.37	137.21	123.80	100.89	121.91	150.81	124.72
Cote d'Ivoire	219.41	832.88	150.17	134.46	318.70	299.83	340.59	146.63	555.50	271.86	812.00
Cameroon	84.14	308.53	141.84	358.55	184.38	109.55	108.55	2044.69	277.62	108.32	297.47
Ethiopia	16.79	17.74	17.37	16.36	17.41	16.78	17.08	17.63	17.60	17.90	18.55
Ghana	70.81	78.47	104.90	100.55	79.10	87.91	81.87	109.96	114.21	114.29	120.99
Guinea	40.82	87.22	105.50	91.15	98.62	52.93	57.60	59.74	230.41	105.09	177.08
Gambia	81.46	86.10	162.22	124.08	146.70	141.94	154.35	152.36	126.36	250.78	206.96
Kenya	86.75	56.73	117.70	97.12	168.35	98.67	136.58	137.14	202.03	480.02	164.93
Madagascar	78.32	108.05	74.85	114.28	82.10	119.86	103.27	126.48	102.34	117.35	129.40
Mozambique	66.13	61.81	53.50	71.84	65.94	68.41	78.68	73.58	81.74	95.24	93.91
Malawi	59.81	57.15	57.08	56.42	52.46	58.57	70.49	68.91	70.01	76.64	74.26
Nigeria	51.14	22.35	52.29	28.33	79.06	64.70	70.88	37.82	40.79	227.83	241.90
Uganda	57.36	56.27	61.67	67.31	70.23	61.89	74.28	74.96	78.67	108.83	89.68
Zambia	109.60	141.78	112.54	121.17	132.98	123.85	131.45	172.77	185.93	191.50	189.27

TABLE A.6

Simulated per capita foreign aid in 2002 US\$ required to meet the MDG poverty reduction target: head-count ratio (continued)

Country	Distribution neutral growth scenario										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Burundi	26.77	31.74	30.84	30.12	30.32	30.42	30.35	34.69	31.40	33.29	36.30
Burkina Faso	43.80	43.15	39.99	38.00	48.32	39.63	46.77	42.55	47.98	48.77	43.08
Cote d'Ivoire	22.31	32.39	25.24	25.57	9.40	18.42	16.58	42.38	35.73	31.62	36.39
Cameroon	36.37	59.68	62.13	74.87	52.53	27.38	30.46	68.38	274.87	10.47	53.04
Ethiopia	15.28	14.54	14.06	14.74	14.02	14.55	14.98	16.40	14.87	15.23	15.02
Ghana	49.81	44.90	51.04	43.25	55.64	49.17	68.37	59.15	46.45	48.85	49.37
Guinea	44.38	21.93	27.05	27.99	15.82	30.13	23.44	24.36	38.42	53.21	25.17
Gambia	77.67	53.68	74.62	83.73	77.40	70.18	91.62	80.33	80.63	67.84	73.03
Kenya	39.61	46.66	43.85	50.52	60.35	53.87	41.60	47.10	46.07	52.69	44.08
Madagascar	71.79	70.15	87.63	67.74	76.61	108.11	73.17	81.88	75.57	77.42	86.87
Mozambique	52.20	49.70	54.53	56.73	62.45	62.45	67.14	66.59	72.29	60.46	65.87
Malawi	47.34	42.19	49.14	47.11	51.52	43.18	49.38	57.34	50.82	60.93	57.37
Nigeria	0.92	1.61	7.20	5.33	3.36	8.49	14.08	14.06	-1.76	25.02	-2.44
Uganda	50.60	47.46	48.56	49.19	49.00	50.62	51.20	51.04	52.23	49.63	56.10
Zambia	85.98	74.24	113.13	101.70	95.71	122.20	111.31	110.54	100.86	135.69	108.83

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NOTES

1. The household survey information for Guinea is available for 1994.
2. We utilize Theorem 8.4 in Kakwani (1980). Theorem 8.4 states that "The concentration index of the function $g(x)$ is related to the Gini index of $g(x)$ by $C_g = \frac{R[g(x), r(x)]}{R[g(x), r(g(x))]} G_g$, where $r(x)$ stands for the rank of x , $r(g(x))$ the rank of $g(x)$, and R the coefficient of correlation."
3. During 1970-1990, the share of public investment had accounted for nearly half of total investment in developing countries (Khan and Kumar, 1993). In industrial countries, by contrast, public sector investment had accounted for less than one fifth of the total (of around 18 percent of GDP) in the 1980s. To the extent that the needs of developing countries for infrastructural and related capital are greater than those of the industrial countries, and given the indivisibilities and risks involved in the provision of such capital, the share of public investment might be expected to be higher.
4. The rate of depreciation can be estimated from $d = i/3 - \dot{K}/K$ where \dot{K}/K is the annual growth rate of gross fixed capital formation. $n = \dot{N}/N$ is the population growth rate and N is population.
5. This conclusion is valid only if we assume that no additional investment is required in order to achieve a pro-poor growth.
6. The rate of depreciation was estimated for each country using the formula given in Footnote iii. The data were obtained from the 2004 WDI covering the period from 1990 to 2002. For some countries such as Burkina Faso, Ghana, Mozambique and Zambia, the estimated depreciation rates were negative due to negative annual growth rates of fixed capital. As such, these countries were excluded to arrive at an average rate of depreciation equal to 3.1 percent.



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