

## Original Paper

# Shared Prosperity and the Quintile Income in Sudan:

## Preliminary Findings

Omer Eltayeb Omer<sup>1\*</sup>

<sup>1</sup> Rural Development Department, University of Bakhat Al-Ruda, Eddueim, Sudan

\* Omer Eltayeb Omer, Corresponding author

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### Abstract

*This paper attempted to tackle two issues: the first issue is the income distribution top income quintiles (including some parcels) with bottom 20% and 40% ones. Secondly whether economic growth alone, could reduce extreme poverty and mitigate income inequality in Sudan? Different prosperity shared indicators applied to data obtained from two Labor Force Migration households' Surveys collected by Ministry of Manpower for years 1996 and 2011. The findings of this study indicated that the income share of bottom 40% failed to catch up with shares of top 10%.and overall per capita .Accordingly, all the shared prosperity indicators results were associated with idea of polarization in the Sudan society, and more importantly CAGR (as one of indicators) empathized that the bottom 20% income have to grow by more than 60% annually in order to catch up with overall per capita growth during the period of the study. To improve the picture of the income distribution and to reverse the situation of poverty in Sudan, the pattern of economic growth has to be restructured and to be associated with high economic participation. The paper recommended a deliberate government intervention to improve income distribution.*

### Keywords

*Shared Prosperity, Quintile Income, Overall per capita, Polarization, Sudan*

### 1. Introduction

The main objectives of this paper are to answer the following two questions: firstly whether prosperity sharing proportionately or not? Secondly would economic growth alone is quite sufficient to reduce extreme poverty and to mitigate income inequality? Using data from two Labor Force Migration Households' Surveys (LFMHS) collected by Ministry of Manpower for years 1996 and 2011. Various inequality measures such as Gini, Plama ratios and Coefficient of variation, as well as simple Algebra

methods of shared Prosperity indicators employed to tackle the above twofold questions using data obtained from LFMHS. The growth rates of bottom 40%, top 10% and middle income groups, as well as overall per capita income growth from house hold surveys' data, used by analogy to resemble the Growth Domestic Product (GDP) and its associate GDP per capita. On policy side the paper attempt to elaborate the question concerning the economic and development policies such as economic growth alone is not sufficient to eliminate poverty and inequality, answering such type of question will be helpful for the policy makers to design and forge policies and strategies about how to allocate development resources between regions and economic sectors in order to reduce poverty and to improve income inequality. Though the data isn't timely due to the fact that government often procrastinated in carrying household surveys in regular convergent periods' basis, it is useful in painting an empirical and quantitative documentation picture of bleak economic injustices of long time autocratic government ruled by so called National Congress Party (previously National Islamic Front). This paper cover four sections: section one is an introduction; section two handling Sudan socioeconomic aspects; section three to elaborate data sources and provided under pinning theoretical as well as equation formulas for different shared prosperity indicators and section four covered the discussion and the results of the study. Finally a conclusion to wrap up the proceedings of the paper, and embedded most important results, policy implications and further future suggestions.

## **2. Sudan Socioeconomic Aspects**

Sudan during the period of study achieved higher economic growth rate a 5.8% and sometimes exceeded more than 7% per annum, this spectacular growth led to enlargement of its economic size from US\$ 12 billion to US\$ 65 billion and the per capita income grew by 46% per year due the exploration and exportation of oil (Nadip, E Alvin, & Lange, S2019). However, Sudan forfeited this opportunity to engineer genuine economic transformation and failed to achieve another important macroeconomic objective, that to generate sufficient employment opportunities for population growing with fast growth rate (2.8%), a population that characterized with young age structure, to mean that an army of employment seekers pouring in labor market inactivate to receive new comers. However, the employment remunerative is important than employment opportunities for sustainable poverty reduction (Fields, 2012, 2018). In addition to these demographic aspects, the inappropriateness and non-compliance of the education output to the requirement of the labor market, caused higher youth unemployment, in particular the graduates of social sciences suffered higher unemployment compared to applied science graduates, Sudanese labor market generally is characterized by low educational attainment lack of training and technological development . About 43% of labor force has no education, in the urban sector, the workers with no education represent 13.4%, while in the rural sector they are about 56%, gender wise employed force 34.9% and 65.9% had no education for males and females, respectively (Maglad, 2013; Ali & Elbadawi, 2004).

The unemployment situation is aggravated further due the application of economic reform policies

based on what called Washington consensus namely the privatization of state owned enterprises as one of main pillars of the blend of World Bank and international monetary Fund programs, bearing in mind the government is main employer particularly in urban sector.

Also harsh authoritarian measures adopted by the ousted government such as fearing non-trustees in different government sectors, and most of the privatized enterprises favored the government affiliates and cronies. Also the defunct regime used economic policies to achieve its own political agenda and to serve the economic interests of the privileged elite and to consolidate their position on market and finance (El-Battahani, 2015).

The pattern of economic growth, which resulted in more than 7% of economic growth, it isn't robust pattern, this high rate of economic growth is not due: to investment in non- oil sector; investment in infrastructure; existence rule of law; existence of virtuous social institutions; prevalence of stable macro-economic environment or viable politics. The growth booming probably due to the natural gifts such as oil and gold, the traditional composition of the economy remain the same—only industrial sector improved due to increased share of oil production—i.e., small enclave modern sector extractive colonial built to serve the interest of colonial and domestic few small group of elite, is remained as dualistic economy with huge traditional agriculture sector dominated by small modern sector, with slight changes if any (Ali & Elbadawi, 2004)

As far as poverty is concerned, head account, according to the household Survey (2009) carried by the National Central Bureau for statistics, it was ranged between 26% as lowest for Khartoum and 69% as highest for Darfur the conflict zone, and 47% for the national level, this means only one of two Sudanese were able get the minimum food and non-food bundle in 2009. The urban poverty was enormously lower than rural areas (Omer, 2018, 2021).

For human development index as it concerned, prepared by United Nation development program, Sudan is classified amongst the poor developing countries in nineties and 2000, while for Millennium Development Goals Interim report (MDGs) in 2004, the performance of Sudan in the eight MDGs goals were significantly low compared with targeted ones. Moreover, Ali showed that need to sustain a growth about 7% per annum to achieve the MDGs on Poverty; otherwise, growing at 2.2 per capita income, Sudan would need 28 years to accomplish the MDGs on poverty (Omer, 2018; and Ali, no date). While for inequality, latest study findings indicted Sudan is highly unequal in terms of Gini, Thiel and Plasma Ratios, and the size of middle class size is shrinking for the whole country, at regional and mode of living levels (Omer, 2018)

### **3. Data and Methods**

#### *3.1 Data*

Data obtained from two Labor forces Migration House- hold Surveys collected by the Ministry of Manpower for the years 1996 and 2011. The data is very comprehensive encompassing information on labor market employment, incomes from wages, agriculture and livestock, non-agriculture activities,

real estate, land rent, remittances and subsidies. To eliminate the effects of money value changes during the period of the study incomes were deflated using 1990 as baseline year, and the corresponding Consumer Price Index (CPI) is used as price deflator in adjusting money values in 1996 and 2011, and to eliminate the percussions of the currency changing from Pound to Dinar and gain from Dinar to Pound as result of National peace agreement 2005 with Sudan People Liberation Army (SPLA).

### 3.2 Prosperity Sharing Indicators

World Bank group in 2013 agreed on two main goals, firstly on the termination of extreme chronic poverty (US\$1.25) for poverty line, adjusted with purchasing power parity, in the world 2030 and secondly to promote shared prosperity in every society. The second goal behind development of simple algebraically and easy calculated quintile income as welfare measure (Rosenbalt & McGavock, 2013; Basu, 2013).

The concept of pro-poor growth (used interchangeably with inclusive growth) is about change of poverty incidence and inequality changes in the process of economic growth, and whether growth benefits the poor segments in society or not. The world bank defines pro-poor growth only if it reduce poverty, and that if poor receive only a tiny fraction of total benefits of growth still the process will be called pro—poor (Kakwani & Son, 2006; Weisbrot et al., 2001).

From various definitions of pro-poor growth this paper used, the slope of the per capita share of bottom 40%, with respect to overall per capita. Furthermore, shared prosperity indicator will be applied to the above mentioned data.

The specification of whether growth is good for poor people or not, can be expressed in the following terms.

*The slope =*

$$\frac{(\text{per capita of bottom 40\%})_{t+1} - (\text{per capita of bottom 40\%})_t}{(\text{Overall per capita})_{t+1} - (\text{overall per capita})_t} \quad (1)$$

This slope of the relationship between average incomes of poorest quintiles and the overall average incomes should be very close to and not significantly different from one if growth is good for poorest people (Dollar et al., 2013).

The concept of quintile income, which this study exposed to, emanated from Rawlsian notion which emphasize the importance of promoting the welfare of the least fortune members of the society (20% bottom), it can be compared to macroeconomic per capita income in developing countries, Basu preferred to place the cut-off at bottom 40% since the most poorest people located in bottom 40%, Sudan is one of good example the poverty head count 2009 was 47%. Some people criticized the bottom 40 % cut-off for it neglecting inequality, but since overall population forced in poorest 40%, the mentioned cut-off would not ignore the above altogether, for instance if the poorest 40% incomes improved due to the government intervention, the original above cut-off would fall below mechanically into public policy focus (Basu, 2013; Omer, 2018).

Another weakness of the bottom 40% as shared prosperity indicator, if for example two societies have

their bottom 40% quintile connected or cross shares, by shared prosperity the two are identical in terms of income distribution, but in view of the Lorenz curve dominance the society with dominating Lorenz curve has better income distribution, still the shared prosperity is an only goal for the nation to pursue if not another problem appear (Basu, 2013).

Though this paper is not going to engage directly in the discussion of formal derivation and to approach the axiomatic of the prosperity share welfare measure, one have briefly to mention the three most important traits of the shared measure: (i) SP (x) is complete transitive ordering of set x of all possible vector x; (ii) SP(x) meets the criteria of the anonymity, in the sense that two countries with same income vector, but income randomly distributed across the people then the two countries have the same SP(x) value; (iii) also the Shared Prosperity Indicator (SPI) satisfying weak Pareto principle if every individual income rises then society is considered better off. Basu argued that SPI may not meet the weak transfer axiom, especially if transfer from rich in bottom 40% of the distribution to poor one within bottom 40 % (Rosenblatt & J McGavock, 2013). The shared prosperity Indicator is:-

$$\widehat{SP} = [(s(x))/0.4] * Y_{t+1} - ((s(x))/0.4) * Y_t / [((s(x))/0.4) * Y_t] \quad (2)$$

The simplified standard way of writing the percentage change is:

$$\widehat{SP} = \frac{[s_{t+1} * y_{t+1}]}{s_t * y_t - 1} \quad (3)$$

Equation (3) represents simple algebraic formula that signalizes the role of economic growth in the long run, and its positive effects on the share of the bottom quintiles 40% (Rosenblatt & McGavock, 2013).

### 3.2.1 The Shares within the Shares

In other words how incomes distributed within top income group, with figures between two brackets to show the income shares proportionate to their share of population size. This method covering different percentiles, may range for more than the three percentiles, but this study for simplicity will confined to the three ones which include 1%, 0.05% and 0.01%. Moreover, this method is meant to detect whether income is polarized in the higher income plateau or not (Atkinson, 2011).

### 3.2.2 Compound Annual growth Rate (CAGR).

$$(CAGR) = \left[ \frac{BV}{EV} \right]^{\frac{1}{n}},$$

CAGR is another method to be used to, as an alternative to compare between the bottom quintile income (40% 20%) to figure out whether it captured the growth of overall per capita, or top quintile (as top 10% as in this paper), another usage of the CAGR as method to predict by how much the bottom quintile income has to grow to capture the target, the overall per capita or the top10% income as in this study, notably in calculation of warranted quintile income in the end year, then to know by how much (percentage) the quintile income has to grow to capture the target.

Whereas:

BV = Beginning Value.

EV = End Value.

n = number of years.

#### 4. Results

This section is intended to demonstrate the empirical findings of the study on extent of the disproportionate distribution of economic growth benefits between the top quintile (Top 10% ) and bottom quintiles (bottom 20% and 40%) and the degree of inequality in Sudan during the period of study, at national, regions and by mode of living, levels.

Table (1) presents the following findings: at national level in 1996 the share of top 10% is fourteen times, more than the two times of bottom 40% and middle group, respectively; in 2011 the share of top 10% is six times the share of bottom 40%, and equal to 1.5 times points of the middle income group. Furthermore in 2011 the bottom 40% increased by 4.4 point percentage, and middle income group increased by 5.3 point percentage, all these increases came at expense of the share of the top 10% which decreased by 9.73 point percentages in the same year. The picture will be look different if one considered the distribution of shares percentages within bottom 40% and middle income group, for more details see (Omer, 2018).

Urban sector in 1996 resembled the same distribution of national one in the same year, while in 2011 the share of the top 10% decreased significantly, and the middle income group share increased by more than its previous share by more than 20 point percentage. For rural sector the picture is entirely different, the share of the top 10% is almost eight times, and more than ten times of bottom 40% in 1996 and 2011, respectively. The stark observation is the share of middle group is decreased by eight point's percentage in 2011 than its share in 1996, while for the top 10% in 2011 increased by more than eight points percentages than initial level 1996, this increase came at expense of the share of middle income group. Another important observation is that the share of the top 10% at national and by mode of living is more than 53% except for urban in 2011 which is 36.10%.

Another important facets of analysis is reflected by different income inequality measures such as Gini coefficient, and Palma ratio to be supported by coefficient of variation –CV-(standard deviation divided by the mean) and this last measure reflect whether income distribution is stable or not, in case of high CV, i.e., more than three, it means income is highly unequal distributed. Gini coefficient was calculated as 0.73 and 0.61 for 1996 and 2011, respectively. While the income inequality decreased by 12 points, inequality in Sudan still high if compared to regional and international levels, for more details see (Omer, 2018).

As far as mode of living is concerned, the findings revealed that the gini coefficient for the urban is higher than rural ones in 1996, but the picture is totally reversed in 2011, theoretically people move from rural areas with low wage and low income inequality to the high wage and high income unequal urban (Kuznets, 1995). These results bolstered by the values of the CV, that to say income is highly

unequally distributed.

As Palma (2006, 2011) which refers to middle income as 50% income receivers, without indulge in income as proper measure of middle class size. The table showed the fact that income share of middle income group is less than 50% for all findings except for urban sector in 2011 which is more than 50%, one can conclude that the values of Palma ratio is higher by the standard international findings, again this revealed that income distribution is highly unequal, for further information see (Omer, 2018; Omer & Maglad, 2021).

**Table 1. Income Shares of Bottom 40%, Middle Income Group and Inequality Measures for the National and Mode of Living by Percentage**

Income groups	A	B	C	D
	National	National	Urban	Rural
	1996	2011	1996 2011	1996 2011
Bottom 40%	4.564	8.93	5.17 10.78	6.17 6.06
Middle group	31.03	36.43	30.9 53.12	40.27 32.67
Top 10 %	64.37	54.64	64.74 36.10	53.56 61.27
CV	3.83	2.7	3.02 1.62	3.4 26.1
Gini Coefficient	0.71	0.61	0.72 0.46	0.64 0.67
Palma ratio	14.1	6.12	12.51 3.34	8.72 10.11

*Source:* Owen calculation Note; for calculation of Gini coefficient and Palma ratio see (Omer, 2018).

Table 2 presents in columns 2-4 the relative inequality income shares percentages of the poorest 60 % and richest 20% and the ratio richest 20% to poorest 60%. The share of the poorest 60% is almost 11% in 1996, and then increased almost 20% in 2011. On the other hand the share of the share 20 % was 76.43% in 1996 and 65.34% in 2011; the ratios of the percentage of richest 20% to poorest 60% are 7.07 times and 3.3 times for 1996 and 2011, respectively. Though the ratio of richest 20% declined in 2011 to 65.345 yet it is by any means is very high. By contrast the earnings of top richest 20% in one month and half month and four months are equal income earnings of poorest 60% in whole year in 1996 and 2011, respectively. Columns 5-7 of the table include the shares within shares. In other words, the paper question how incomes were distributed within the top income group from 1% to 0.01% parcels? The figures between the two brackets are the income shares proportionate to its share of population size. The share of the top 1%, top 0.05% and top 0.01% and their share to their proportionate population size for 1996 are as following: (6.56%: 65.65 times); (4.9%: 98 times) and (2.46%: 246 times) for the three parcel, respectively. While for 2011, the relative share and proportionate size came as following: (30.55%: 305.5 times); (29.77%: 5945.4 times) and (18.29%: 1829 times) for 1%; 0.05% and 0.01, respectively. Looking to the table one can observed upward

increase trend of the top income parcels over the period of the study. This suggests a high degree of income concentration in the hands of top 10% and particularly the top 0.01% parcel. Moreover, the table findings indicated increase of income concentration within top group in 2011 is higher than 1996 one, put in consideration relative population size of each parcel.

**Table 2. Relative Inequality Income Shares %**

Year	A Poorest 60%	B Richest 20%	C Ratio A/B	D Top 1%	F Top 0.05%	E Top 0.01%
1996	10.854	76.03	7.00	6.56 (65.60)	4.9 (98)	2.46 (246)
2011	19.567	65.345	3.3	30.55 (305.5)	29.77 (595.4)	18.29 (1829)

*Source:* Own calculation, estimates of per capita of household income expressed in constant 1990 terms. Calculation.

Table 3, row (1) presents the results of the relationship between averages income of the bottom 40% and the average overall income, which is used here instead of GDP as indicator of economic growth, for the total sample, regions and rural–urban sectors for the period 2011-1996.

The slopes of the relationship between growth rates are almost between 0.1 and 0.2 which are different significantly from one for the national, regions and mode of living for the entire period of study (for regions' results see annex one), implying that prosperity is not shared by the poorest group, namely the bottom 40%. This result is in agreement with Dollar and Kray (2013) observation that say growth may not alone be good for the poor if not connected with deliberate income distributional policies such as progressive taxes and social spending.

Moreover, the anti-poor growth is indicated by using equation (3) to calculate percentage change in the bottom 40% share (it is not part of the table). The results of percentage change in the bottom 40% for the whole sample was -46.9% for 2011-1996. For the same period, the percentage change of bottom 40% was -35% and -0.71% for urban and rural sectors, respectively. Thus these findings implied that the benefits of growth are not favouring the bottom 40%.

To continue with Table 3, row (2) the prosperity share measure which study how income of bottom 40% grow from one period to the next, this table showed the following findings, the shared prosperity measure is negative and almost 1%. Though the decrease of the per capita is less than 1%, this result confirmed the results of the previous two tables the share of poorest 40% is falling behind the rest, or



not catch up the incomes, of the middle income group and the top 10%, though the results is not agreed with results of Palma regarding the decrease shares of bottom 40%, going the top 10%, yet Plama ratio is by all means is higher, internationally wise (Omer, 2018).

Despite the fact Sudan during twenties of current century achieved economic growth probably 7%, the share of the bottom 40% is not concomitant with overall economic growth –implied that, the shared prosperity associated with idea of polarization in the Sudan society—one can concluded from this result that economic growth alone can't reduce chronic poverty and alleviated the discreditable inequality. In row (3)—A, one can observed that the bottom 40% income appeared higher than overall income mean for both national and mode of living, as if symptom of equalitarian or inclusive growth, but as in row (3) – B, if inequality of income distribution is considered as shown by previous measures, by taken the mean of income top 10 % as alternative to overall mean income, the lacking of quintile income of bottom 40% is starkly obvious. Furthermore, if one take Rawlsian bottom 20% - minimum percentage principle—for two purposes, the first one to verify the inequality of income distribution during the period of the study which founded as overall mean per capita is 1.32 while the income of bottom 20% quintile equal to 1.04, i.e., the bottom 20% quintile income failed to catch up with overall growth. Secondly, the bottom 20% quintile is easiest for calculation of desired or warranted annual compound growth rate, which founded to be equal to 1.61 as calculated in annex (3) section (ii), if one subtract 1.61 from one, the result is 61% which means that, if the bottom 20% income had grown by 61% annually it could have been caught the desired (warranted) income in 2011.

**Table 3. Measurements Inclusive Growth, Shared Prosperity and CAGR**

Measures	A	B	C
	National	Urban	Rural
Row (1) Slope of relationship between bottom 40% and overall Average income	0.09	0.07	0.13
Row (2) Percentage of shared prosperity	-0.94	-0.99	-0.92
Row (3)* – (A) compound Annual growth rate (CAGR)			
Mean (overall mean)	1.20	0.96	1.01
Quintile ( income of bottom 40% )	1.30	0.04	1.11
Row 3(B) CAGR			
Mean per capita of top 10%	1.40	1.41	1.25
Quintile income of bottom 40	1.02	1.01	0.81

This table compiled from annexes at the end of the paper.

## 5. Discussion

Different methods of prosperity sharing such as; the slope relationship between bottom 40% per capita income and overall per capita, as indicator of whether growth is good for poor people or not, the shared prosperity indicator formulas (2) and (3) in the text are highlighted the trend of economic growth in the long run and its positive effect on the bottom 40% income share; the shares within the shares, namely the top parcels of the top 10% income group, compared proportionately to each share population size, to detect whether income is polarized / concentrated in the hands of higher income group or not?

Last not the least, compound annual growth rate used to check whether the poorest income group by the same of overall per capita or not, in addition to that CAGR is employed as forecasting method. All these measures are applied to data maintained from two labor force migration households' surveys collected by Ministry of Manpower; with sample size 3288 and 11182 households for years 1996 and 2011, respectively. The two surveys are similarly designed, comprehensive national data of employment, wages and salaries and other sources of incomes, the coverage of the two surveys is limited to northern 16 states which regrouped into six regions, the south before its independence, was excluded due to the long persistence civil war. To eliminate the effects of money value changes during the period of the study, the prices of 1990 were considered as base line year and the corresponding Consumer Price Index (CPI) is used in adjusting money values in 1996 and 2011.

Though Sudan during the period of the study witnessed unprecedented economic growth rate probably about 7%, and led to slight improvement of inequality, as Gini ratio indicated a decrease from 0.71 to 0.6 yet Sudan is classified as high income (Omer, 2018). The slight improvement income of the 20% and 40% bottom have had not eliminate poverty or mitigate income inequality. The measures employed in this paper the slope relationship (1) and shared prosperity indicator (2), (3) formulas, the share within the share, and in conclusion the CARG, all together implied that the benefits of growth is enjoyed by the bottom 40%, and these shared prosperity measures associated with idea of polarization in the Sudan society.

In addition, the compound annual economic growth revealed that if the income of the bottom 20% income had grown by 61% annually it could have been caught the desired (warranted) income in 2011. Moreover, one can make comment on the meagre improvement of the bottom 40 %, it can be attributed to the exploration and export of oil and gold, and expansive emergence of informal sector predominantly in services sector.

One can wrap up, that economic growth without government redistribution intervention policies is not conducive to eradicate chronic extreme poverty and to improve income inequality in Sudan. As matter of policy implications, after empirical evidence of increase of economic growth in terms of growth of overall per capita income, and the lack of the bottom 40% per capita behind, the trickle down is myth needed to be revised to meet the requirements of reduction of poverty and to mitigate income inequality. Trade openness is important but should be in line with needs of most poorest segments of society, private sector should be encouraged to be employment friendly. For government should

provide investment for infrastructure, enforcement rule of law and viable social institutions, i.e. the government have to provide social services- education and health and enhance stable macro-economic environment The pattern of economic growth instead of being depend on natural gifts- oil and gold, to base on productive one .Other distributive policies such progressive tax may be considered, and rural development policy should has to be forged to address poverty and inequality in rural sector.

In addition to that the household's surveys must be carried in regular convergent periods to avail for the researchers' up to date information to be used by researchers to lend their immediate findings to policy makers.

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## Annex (1)

**Table 1. The Relationship between Average Incomes of Bottom 40% and the Overall Average Incomes, by Regions and Mode of Living**

National –Regions 2011 –1996	A Change of overall Average Incomes	B Growth Average of Bottom 40% Income	C Slope of the Relationship B/ A
National	-73493	-6815.1	0.09
Eastern	-60411	-6645.21	0.11
Northern	-38256	-8449.4	0.22
Khartoum	-265420	-31846	0.12
Central	-54776	-8960.2	0.16
Kordfan	-29427	-3855.5	0.13
Darfur	-28584	-2176.9	0.08
Urban	-166202	-11077.6	0.07
Rural	-30607	-3916.6	0.13
All estimates of Income Shares in the table expressed in constant terms. Source: Own calculations.			

## Annex (2)

**Table 2. Shared Prosperity Indicator**

National And Mode of living	A Per capita income of Bottom 40%	B Overall per –capita Income	Percentage of SP
National 1996 2011	9525 3575	88418 14925	- 0.94
Rural 1996	7116	45548	- 0.92

2011	10766	2298.2	
Urban			
1996	23480	181083	- 0.99
2011	10723	3872	
All estimates of Income Shares in the table expressed in constant terms.			
Source: Own calculations.			

Annex 3:

$$(i) \text{ Compound Annual Growth Rate} = \left[ \frac{BV}{EV} \right]^{\frac{1}{n}}$$

Whereas:

BV = Beginning Value

EV = End Value.

n = number of years

(ii)  $Y_1 = 1996$

$Y_2 = 2011$

N = population of bottom 20%

M = overall mean

$Y = N \cdot M$

$Y_1 = 676 \times 42290899 = 2900647724$

$Y_2 = 2236 \times 7463613 = 16688638668$

To get the fruit of growth one has to follow the coming steps

$\Delta = Y_2 - Y_1 = 13787990944$ ,

If fruit of growth proportionately distributed between the five quintiles then,

$$\frac{\Delta}{5} = \frac{13787990944}{5} = 2757598189,$$

The desired quintile income of 2011 = the fruit of growth + quintile income of 1996

$2757598189 + 2900647724 = 5658245913$

$$\text{Desired Annual Compound Growth Rate} = \left[ \frac{\text{the desired quintile income 2011}}{\text{quintile income 1996}} \right]^{\frac{1}{n}} =$$

$$\left[ \frac{276056507}{2966885} \right]^{\frac{1}{15}} = 1.61$$