

WHEN THE CENTRE CANNOT HOLD: PATTERNS OF POLARIZATION IN NIGERIA

BY F. CLEMENTI

Università degli Studi di Macerata, Macerata, Italy

A. L. DABALEN AND V. MOLINI*

World Bank, Washington DC, USA

F. SCETTINO

Seconda Università degli Studi di Napoli, Napoli, Italy

This paper advances the hypothesis that Nigeria is going through a process of economic polarization. The notion of polarization is concerned with the disappearance or non-consolidation of the middle class, which occurs when there is a tendency to concentrate in the tails, rather than the middle, of the income/consumption distribution. This paper uses newly available data and the relative distribution methodology (Handcock and Morris, 1998, 1999) to present new results on polarization. The findings confirm the sharp increase of polarization. Compared to 2003, the distribution of consumption has become more concentrated in upper and lower deciles in 2013, while the middle deciles have thinned. A between-group analysis shows the emergence of a macro-regional gap: while the South-South and South-West regions contribute mainly to polarization in the upper tail, households in the North East and North West zones—the conflict-stricken areas—are more likely to fall in the lower national deciles.

JEL Codes: C14, D31, D63, I32, Q34

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1. INTRODUCTION

Despite a stable and sustained real growth of nearly 6 percent per year for almost a decade from 2003, reduction in official poverty rate in Nigeria has not been up to general expectations. While poverty seems to have declined faster in the coastal South and around the Federal Capital, Abuja, a large belt of North-eastern states appear to have experienced a significant increase in poverty. The lack of a faster reduction in poverty despite a significant growth in GDP may be due to an increase in inequality (World Bank, 2013). The latter is, however, just one aspect of the problem. A complementary hypothesis is that Nigeria is also experiencing increasing income

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*Correspondence to: Vasco Molini, Poverty & Equity Global Practice, World Bank, 1818 H Street NW, Washington DC, 20433 USA (vmolini@worldbank.org).

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polarization. Whereas inequality is the overall dispersion of the distribution, polarization is the combination of divergence from global and convergence on local mean incomes. When societies experience income polarization, people cluster around group means and tend to be far from the mean/median of the overall distribution.

An important aspect of the income polarization analysis is that it is concerned with the disappearance or non-consolidation—in the case of Nigeria—of the middle class. This occurs when in a society there is a tendency to concentrate in the tails, rather than the middle, of the income distribution. Within each group there is increasing identification, which means income homogeneity and often declining income inequality, while between the two groups, we have “increasing alienation” instead (Duclos *et al.*, 2004). The combined effect of the forces of alienation and identification between two significantly sized groups would tend to lead to effective opposition, a situation that might give rise to social conflicts and tensions (Esteban and Ray, 1999, 2008, 2011). This problem is made worse when the group at the top of the distribution has disproportionately more voice and power while the other group, comprising those at the bottom, are voiceless in matters that affect their welfare and the society at large. By contrast, a well-off middle class is believed to be important to every society because it is associated with many desirable and stabilizing outcomes such as positive contribution to economic growth, democracy, and social and political stability (Easterly, 2001; Pressman, 2007; Birdsall, 2010).

Nigeria represents an interesting case for an analysis of polarization. As noted earlier, GDP and per capita income have steadily grown in the last decade. After the recent GDP re-basing, Nigeria will become the biggest African economy and yet there are clear signs of a limited consolidation of a national middle class, by which we mean a lack of stable, cohesive and secure middle. Moreover, the country is increasingly affected by sub-regional conflicts driven to a large extent by disaffected (alienated) groups. Studies on polarization in Nigeria are few and may have been hampered by data problems. One of the earliest studies is that of Aigbokhan (2000), who showed that polarization in Nigeria increased between 1985 and 1992, but declined in rural areas. The study also found a higher but declining degree of polarization in rural areas during the 1990s.

Araar (2008) study uses the 2003/2004 round of the National Living Standard Survey (NLSS) to identify the main drivers behind polarization in the 1990s. The study concludes that the population, based on geo-ecological zones, is spatially polarized. Furthermore, employment income and non-farm business income are the two income sources that significantly contribute to total polarization. Awoyemi and Araar (2009) use the same set of data and a decomposition of the Duclos-Esteban-Ray (DER) index of polarization (Duclos *et al.*, 2004) to conclude that, in addition to the geo-ecological zones, differences in education and occupation drive polarization. Their study also shows that the ongoing polarization they find favors a prevalence of the identification component rather than alienation. The study by Awoyemi *et al.* (2010) also uses DER and Foster-Wolfson (2010) indices to look at the polarization dynamics over the longer time span 1996–2004, and show that polarization has declined from 0.30 to 0.25 using Foster-Wolfson index and from 0.44 to 0.38 using DER index. They also show that in the southern macro areas (South-East and South-West) indexes do not vary significantly. Ogunyemi and Oni (2011) and Ogunyemi *et al.* (2011) calculated the same indices on households in

rural areas only from 1980 to 2004, and find a similarly decreasing trend in polarization. More recent studies like Ogunyemi (2013), which compares the 2003/2004 round of the NLSS and the 2009/2010 round of the Harmonized National Living Standard Survey (HNLSS), indicate only a slight tendency towards increasing polarization, and mostly a general absence of movement.

The present paper improves upon these studies in several aspects. First, rather than just computing and comparing polarization indices, we use a non-parametric framework (the “relative distribution” introduced by Handcock and Morris, 1998, 1999) and compare income throughout the entire income range. The relative distribution analysis requires at least two comparable survey rounds in order to investigate changes along the entire distribution. Since the lack of comparable surveys has limited the scope of previous work, the second way in which our study differs from the past studies on polarization in Nigeria is to construct two fully comparable distributions using recent innovations in the use of survey-to-survey imputation techniques, discussed in detail under data section below.

Finally, the flexibility of the relative distribution tool allows an accurate analysis at macro-regional level too. Differently from previous contributions, another goal of this paper is to document not just national, but also sub-national patterns of polarization. Nigeria is highly heterogeneous, so that drivers of polarization can indeed differ across macro regions. It is also worth mentioning that this focus on macro-regions has the potential to inform future research on the link between polarization and regional conflicts. Our findings suggest a sharp increase in polarization between 2003 and 2013. We find that distribution of consumption is concentrated in the lower and upper deciles, while the middle deciles are shrinking. Moreover, a between-group analysis shows that while the South-South and South-West regions contribute mainly to polarization in the upper tail of the national consumption distribution, the North-East and North-West are more likely to fall in the lower deciles.

The rest of the paper is organized as follows. Section 2 reviews the approaches to measuring economic polarization. Section 3 outlines the distinctive features of the relative distribution method. Section 4 presents the data and details the main findings of the study. Section 5 concludes.

2. SOME BACKGROUND ON THE INCOME POLARIZATION LITERATURE

Over the last two decades, the issue of polarization has come to be assigned increasing importance in the analysis of income distribution. Notwithstanding the pains the polarization literature has suffered to distinguish itself from pure inequality measurement—see e.g. Levy and Murnane (1992); Esteban and Ray (1994); Wolfson (1994, 1997), and Foster and Wolfson (2010), it now seems to be fairly widely accepted that polarization is a distinct concept from inequality.

Broadly speaking, the notion of polarization is concerned with the disappearance of the middle class, which occurs when there is a tendency to concentrate in the tails—rather than the middle—of the income distribution. One of the main reasons for looking at income polarization this way, which is usually referred to as “bipolarization”, is that a well-off middle class is important to every society because it contributes significantly to economic growth, as well as to social and political stability (e.g. Easterly, 2001, and Pressman, 2007). In contrast, a society with high

degree of income polarization may give rise to social conflicts and tensions. Therefore, in order for such risks to be minimized, it is necessary to monitor the economic evolution of the society using indices that look at the dispersion of the income distribution from the middle toward either or both of the two tails. Measures of income polarization that correspond to this case have been proposed in the literature by Wolfson (1994, 1997); Wang and Tsui (2000); Chakravarty and Majumder (2001); Rodríguez and Salas (2003); Chakravarty *et al.* (2007); Silber *et al.* (2007); Chakravarty (2009); Chakravarty and D'Ambrosio (2010); Foster and Wolfson (2010); Lasso De La Vega *et al.* (2010), and others.

A more general notion of income polarization, which was originally proposed by Esteban and Ray (1994), regards the latter as “clustering” of a population around two or more poles of the distribution, irrespective of where they are located along the income scale. The notion of income polarization in a multi-group context is an attempt at capturing the degree of potential conflict inherent in a given distribution (see Esteban and Ray, 1999, 2008, 2011). The idea is to consider society as an amalgamation of groups, where the individuals in a group share similar attributes with the other members (i.e. have a mutual sense of “identification”) but in terms of the same attributes they are different from the members of the other groups (i.e. have a feeling of “alienation”). Political or social conflict is therefore more likely the more homogeneous and separate the groups are, that is when the within-group income distribution is more clustered around its local mean and the between-group income distance is longer. In addition to Esteban and Ray (1994), indices regarding the concept of income polarization as conflict among groups have been investigated, among others, by Gradín (2000); Milanovic (2000); D'Ambrosio (2001); Zhang and Kanbur (2001); Reynal-Querol (2002); Duclos *et al.* (2004); Lasso De La Vega and Urrutia (2006); Esteban *et al.* (2007); Gagliarano and Mosler (2009), and Poggi and Silber (2010).

Much of the literature so far considered has analyzed summary measures of income polarization. Another strand uses kernel density estimation and mixture models in order to describe changes in polarization patterns over time, not just of personal incomes (as in Jenkins, 1995, 1996; Pittau and Zelli, 2001, 2004, 2006, and Conti *et al.*, 2006) but also of the cross-country distribution of per capita income (see Quah, 1996a, 1996b, 1997; Bianchi, 1997; Jones, 1997; Paap and Van Dijk, 1998; Johnson, 2000; Holzmann *et al.*, 2007; Henderson *et al.*, 2008; Pittau *et al.*, 2010; Anderson *et al.*, 2012, and others). The analysis of the shape of the income distribution provides indeed a picture from which at least three important distributional features can be observed simultaneously (Cowell *et al.*, 1996): income levels and changes in the location of the distribution as a whole; income inequality and changes in the spread of the distribution; clumping and polarization as well as changes in patterns of clustering at different modes. Finally, a rather recent (yet non-parametric) approach that combines the strengths of summary polarization indices with the details of distributional change offered by the kernel density estimates—the so-called “relative distribution”—has been employed by Alderson *et al.* (2005); Massari (2009); Massari *et al.* (2009a, 2009b); Alderson and Doran (2011, 2013), and Borraz *et al.* (2013) to assess the evolution of the middle class and the degree of household income polarization in a number of middle- and high-income countries in the world.

3. THE METHOD BASED ON THE RELATIVE DISTRIBUTION

3.1. *The Relative Distribution: Basic Concepts*

In the current application, the *relative distribution* approach has some important advantages over the other mentioned methods of investigating income polarization. First, it readily lends itself to simple and informative graphical displays of relative data that reveal precisely where and by how much an income distribution changed over time. Second, by providing the potential for decomposition into location and shape components, it allows one to examine several hypotheses regarding the origins of distributional change—such as whether the change consists of an equal absolute subtraction or addition to all incomes that moves the overall distribution either to the left or to the right (while leaving the shape unaltered) or of shape modifications which, by definition, are independent of location shifts.¹ Lastly, it allows us to quantify the degree of polarization due to changes in distributional shape only (i.e. net of location shifts), thus enabling one to isolate aspects of inter-distributional inequality that are often hidden when also changes in location are examined.

Basically, the relative distribution method can be applied whenever the distribution of some quantity across two populations is to be compared, either cross-sectionally or over time.² To proceed, it is necessary to single out one of the two populations, refer to it as the “comparison” population, and refer to the other as the “reference” population. More formally, let Y_0 be the income variable for the reference population and Y the income variable for the comparison population. The relative distribution of Y to Y_0 is defined as the distribution of the random variable:

$$(1) \quad R = F_0(Y),$$

which is obtained from Y by transforming it by the cumulative distribution function of Y_0 , F_0 . As a random variable, R is continuous on the outcome space $[0,1]$, and its realizations, r , are referred to as “relative data”. Intuitively, the relative data can be interpreted as the set of positions that the income observations of the comparison population would have if they were located in the income distribution of the reference population. The probability density function of R , which is called the “relative density”, can be obtained as the ratio of the density of the comparison population to the density of the reference population evaluated at the relative data r :

$$(2) \quad g(r) = \frac{f(F_0^{-1}(r))}{f_0(F_0^{-1}(r))} = \frac{f(y_r)}{f_0(y_r)}, \quad 0 \leq r \leq 1, \quad y_r \geq 0,$$

where $f(\cdot)$ and $f_0(\cdot)$ denote the density functions of Y and Y_0 , respectively, and $y_r = F_0^{-1}(r)$ is the quantile function of Y_0 . The relative density has a simple interpretation, as it describes where households at various quantiles in the

¹Of course, both the location and shape effects—named respectively as “growth” and “inequality” (or “distributional”) effect (Kakwani, 1993; Bourguignon, 2003, 2004)—may also concur together in producing the distributional change.

²Here we limit ourselves to illustrating the basic concepts behind the use of the relative distribution method. Interested readers are referred to Handcock and Morris (1998, 1999; but see also Hao and Naiman, 2010, ch. 5) for a more detailed explication and a discussion of the relationship to alternative econometric methods for measuring distributional differences. A method very similar in spirit to the relative distribution has recently been developed by Silber *et al.* (2014).

comparison distribution are concentrated in terms of the quantiles of the reference distribution. As for any density function, it integrates to 1 over the unit interval, and the area under the curve between two values r_1 and r_2 is the proportion of the comparison population whose income values lie between the r_1^{th} and r_2^{th} quantiles of the reference population.

When the relative density function shows values near to 1, it means that the two populations have a similar density at the r^{th} quantile of the reference population, and thus R has a uniform distribution in the interval $[0,1]$. A relative density greater than 1 means that the comparison population has more density than the reference population at the r^{th} quantile of the latter. Finally, a relative density function less than 1 indicates the opposite. In this way one can distinguish between growth, stability or decline at specific points of the income distribution.

3.2. The Location/Shape Decomposition of the Relative Distribution

As we have said before, one of the major advantages of this method is the possibility to decompose the relative distribution into changes in location, usually associated with changes in the median (or mean) of the income distribution, and changes in shape (including differences in variance, asymmetry and/or other distributional characteristics) that could be linked with several factors like, for instance, polarization. Formally, the decomposition can be written as:

$$(3) \quad g(r) = \frac{f(y_r)}{f_0(y_r)} = \underbrace{\frac{f_{0L}(y_r)}{f_0(y_r)}}_{\text{Overall relative density}} \times \underbrace{\frac{f(y_r)}{f_{0L}(y_r)}}_{\text{Density ratio for the shape effect}}$$

where $f_{0L}(y_r) = f_0(y_r + \rho)$ is a density function adjusted by an additive shift with the same shape as the reference distribution but with the median of the comparison one.³ The value ρ is the difference between the medians of the comparison and reference distributions. If the latter two distributions have the same median, the density ratio for location differences is uniform in $[0,1]$. Conversely, if the two distributions have different median, the “location effect” is increasing (decreasing) in r if the comparison median is higher (lower) than the reference one. The second term, which is the “shape effect”, represents the relative density net of the location effect and is useful to isolate movements (re-distribution) occurring between the reference and comparison populations. For instance, we could observe a shape effect function with some sort of (inverse) U-shaped pattern if the comparison distribution is relatively (less) more spread around the median than the location-adjusted one. Thus, it is possible to determine whether there is polarization of the income distribution (increases in both tails), “downgrading” (increases in the lower tail), “upgrading” (increases in the upper tail) or convergence of incomes towards the median (decreases in both tails).

³Median adjustment is preferred here to mean adjustment because of the well-known drawbacks of the mean when distributions are skewed. A *multiplicative* median shift can also be applied. However, the multiplicative shift has the drawback of affecting the shape of the distribution. Indeed, the equiproportionate income changes increase the variance and the rightward shift of the distribution is accompanied by a flattening (or shrinking) of its shape (see e.g. Jenkins and Van Kerm, 2005).

3.3. Relative Polarization Indices

The relative distribution approach also includes a *median relative polarization* index (MRP), which is based on changes in the shape of the income distribution to account for polarization. This index is normalized so that it varies between -1 and 1 , with 0 representing no change in the income distribution relative to the reference year. Positive values represent more polarization—i.e. increases in the tails of the distribution—and negative values represent less polarization—i.e. convergence towards the center of the distribution. The MRP index for the comparison population can be estimated as (Morris *et al.*, 1994, p. 217):

$$(4) \quad \text{MRP} = \frac{4}{n} \left(\sum_{i=1}^n \left| r_i - \frac{1}{2} \right| \right) - 1,$$

where r_i is the proportion of the median-adjusted reference incomes that are less than the i^{th} income from the comparison sample, for $i = 1, \dots, n$, and n is the sample size of the comparison population.

The MRP index can be additively decomposed into the contributions to overall polarization made by the lower and upper halves of the median-adjusted relative distribution, enabling one to distinguish downgrading from upgrading. In terms of data, the *lower relative polarization* index (LRP) and the *upper relative polarization* index (URP) can be calculated as follows:

$$(5) \quad \text{LRP} = \frac{8}{n} \left[\sum_{i=1}^{\lceil n/2 \rceil} \left(\frac{1}{2} - r_i \right) \right] - 1,$$

$$(6) \quad \text{URP} = \frac{8}{n} \left[\sum_{i=\lceil n/2+1 \rceil}^n \left(r_i - \frac{1}{2} \right) \right] - 1,$$

with $\text{MRP} = \frac{1}{2}(\text{LRP} + \text{URP})$. As the MRP, LRP and URP range from -1 to 1 , and equal 0 when there is no change.

3.4. Adjustment for Covariates

Similarly to what is observed for location and shape decomposition, it is possible to adjust the relative distribution for changes in the distribution of covariates measured on the households, which often vary systematically by population. The covariate adjustment technique can be used to separate the impacts of changes in population composition from changes in the covariate-response relationship.⁴ This decomposition according to covariates draws on the definition of a counter-factual distribution for the response variable in the reference population

⁴Recently, there have been several papers that have studied decomposition methods to explain changes in the unconditional distribution of an outcome variable due to either changes in the distribution of the covariates, or changes in the conditional distribution of the outcome given covariates, or both—see for instance the extensive survey by Fortin *et al.* (2011) on the wage decomposition literature. Benefits and drawbacks of some of these methods, and how they are often largely subsumed by the relative distribution framework, are reviewed in Handcock and Morris (1999, ch. 2).

that is *composition-adjusted* to have the same distribution of the covariates as the comparison population.

Assume for simplicity that the covariate Z is categorical.⁵ Let $\{\pi_k^0\}_{k=1}^K$ and $\{\pi_k\}_{k=1}^K$, where K is the number of categories of the covariate, denote the probability mass functions of Z for the reference and comparison populations, i.e. their composition according to the covariate. For conditional comparisons of the response variable Y across the two populations one can consider the density of Y_0 given that $Z_0 = k$:

$$(7) \quad f_{Y_0|Z_0}(y|k), \quad k = 1, \dots, K,$$

and the density of Y given that $Z = k$:

$$(8) \quad f_{Y|Z}(y|k), \quad k = 1, \dots, K.$$

These densities represent the covariate-response relationship. The marginal densities of Y_0 and Y can be written, respectively, as:

$$(9) \quad f_0(y) = \sum_{k=1}^K \pi_k^0 f_{Y_0|Z_0}(y|k) \quad \text{and} \quad f(y) = \sum_{k=1}^K \pi_k f_{Y|Z}(y|k).$$

Then, the counter-factual distribution with the covariate composition of the comparison population and the covariate-response relationship of the reference population is:

$$(10) \quad f_{0C}(y) = \sum_{k=1}^K \pi_k f_{Y_0|Z_0}(y|k),$$

and can be used to decompose the overall relative distribution into a component that represents the effect of changes in the marginal distribution of the covariate (the “composition effect”) and a component that represents the changes in the covariate-response relationship (the “residual effect”). The decomposition can be represented in the following terms:

$$(11) \quad g(r) = \underbrace{\frac{f(y_r)}{f_0(y_r)}}_{\text{Overall relative density}} = \underbrace{\frac{f_{0C}(y_r)}{f_0(y_r)}}_{\text{Density ratio for the composition effect}} \times \underbrace{\frac{f(y_r)}{f_{0C}(y_r)}}_{\text{Density ratio for the residual effect}}.$$

Comparison of $f(y_r)$ to $f_{0C}(y_r)$ —i.e. the residual effect—holds the population composition constant, and therefore isolate changes of income distribution due to the fact that returns to the selected covariate changed over time. By contrast, $f_{0C}(y_r)$ and $f_0(y_r)$ have the same covariate-response relationship, and the comparison between them—i.e. the composition effect— isolate the changes due to the different composition of the population under the assumption that the conditional distribution of income remain unchanged.

⁵The extensions to continuous and multivariate covariates are considered in Handcock and Morris (1999, ch. 7).

4. DATA AND RESULTS

4.1. *The Nigerian Household Consumption Data*

We posit that a comparison of surveys separated relatively further in time is likely to capture more accurately the effect of structural changes in welfare distribution such as inequality, polarization or poverty. This is because in general, absent major shocks, these measures—especially polarization—tend to evolve relatively slowly. In principle, Nigeria surveys present some desirable features that are ideal for conducting long term structural changes. First, they collect consumption, which has proven preferable to income because it is less volatile (see e.g. Deaton and Zaidi, 2002, and Haughton and Khandker, 2009). For example, in agricultural economies income is more volatile and affected by growing and harvest seasons, so that relying on income as an indicator of welfare might under- or over-estimate living standards significantly. Second, consumption is a better measure of permanent welfare, because households can borrow, draw down savings, or get public and private transfers to smooth short-run fluctuations. Third, consumption measures what individuals have purchased, while income measures the potential claims of a person. Finally, the surveys also provide detailed information on several other modules that can be used to assess the evolution of non-income measures of well-being.

The National Bureau of Statistics (NBS) has conducted two Nigeria Living Standard Surveys (henceforth NLSS) in 2003/2004 and 2009/2010 which it uses to monitor progress in poverty reduction.⁶ These surveys are representative at state level, use a month-long diary to collect consumption, and collect data for a year (12 month survey). But NBS also conducts other household surveys, most notably the General Household Survey (GHS) cross section and panel.

The GHS panel is a randomly selected sub-sample of the GHS cross-section which was collected for the first time in 2010/2011. It consists of 5,000 households, and to date two waves have been completed: 2010/2011 (Wave 1) and 2012/2013 (Wave 2). It is representative at national, rural and urban, and zonal (geo-political) levels. In addition to the questions asked in a normal GHS cross section survey, it contains detailed data on agricultural production and other household income earning activities. Consumption data are substantially more detailed and resemble the consumption data of HNLSS but collected using a 7-day recall period. In every panel wave, households are interviewed two times: once in the “post-planting” period, ranging from August to November, and once in the “post-harvesting” period, ranging from February to April.

At first glance, these diverse surveys spanning several years would seem to be the data of choice for studying polarization in Nigeria. Unfortunately, these surveys present several challenging problems for studying welfare changes. In particular, the most obvious pair of surveys to compare, the NLSS 2003/2004 and 2009/2010, could not be used because of major data quality problems (World Bank, 2013). This means that in order to enable the data comparison over a longer time span (a decade) we

⁶The 2003/2004 was officially labeled Nigeria Living Standard Survey, while the 2009/2010 was dubbed Harmonized Nigeria Living Standard Survey. Because these are essentially the same types of surveys and conducted as a series with the same purpose in mind, we shall refer to them as NLSSs.

need to create two comparable data sets. To do so, we employ survey-to-survey imputation techniques derived from poverty mapping literature (Elbers *et al.*, 2003). The surveys that fit the purpose are NLSS 2003/2004 and GHS-panels (see Appendix A for a detailed explanation of the methodology applied).

4.2. *Changes in the Nigerian Household Consumption Distribution*

Summary measures for household total consumption expenditure per capita in 2003/2004 and 2012/2013 are presented in Appendix B (see Table B.1).⁷ Besides the growth of the real mean and median consumption expenditures, the most notable feature is that consumption shares of the poorest percentiles of the population decreased between approximately 1.3 and 1.6 percent a year in the period examined, in contrast to what is observed for the richest percentiles, whose shares experienced average yearly increases of around 1.7 percent.

The Gini index grew at an annual average rate of 1.5 percent between 2003/2004 and 2012/2013, while the increment in inequality detected by the Theil index is more pronounced, with an average growth rate of 4.2 percent per annum. As for polarization, a sizeable increase is detected by both the Foster-Wolfson (2010) and Duclos-Esteban-Ray (2004) measures, which amounts to around 1.7 percent per year in the first case and almost 1.5 percent in the second.

Further insight on the key changes occurring in the distribution of total per capita consumption expenditure of Nigerian households is provided by Figure 1, which shows the density overlay for the two survey waves estimated with an adaptive kernel. Two major observations are apparent from this figure: first, the whole distribution shifted rightward following the increment in the median, and second, there was also an alteration of the shape—the consumption distribution is in fact more dispersed in 2012/2013 than in 2003/2004, as it appears to be characterized by a smaller peak and a fatter upper tail that are quite visible in the density overlay. The declines in the mass at the lower and middle ranges of the distribution, and the concomitant spreading out of expenditures in its top half, are also noticeable from Table B.1, where the reported values of the standard deviation, skewness, and kurtosis all show a remarkable growth from one survey wave to the next.

However, the graphical display above does not provide much information on the relative impact that location and shape changes had on the differences in the two distributions at every point of the expenditure scale. It also does not convey whether the upper and lower tails of the consumption distribution were growing at the same rate and for what reasons (i.e. location and/or shape driven). As already pointed out in Section 3, this is exactly what the relative distribution method is particularly good at pulling out of the data.

We have chosen 2003/2004 as the reference distribution throughout the analysis. It is important to note that reversing the reference and comparison population designation will change the view provided by the relative distribution graph and the displays of the estimated effects of location and shape shifts, because these are defined in terms of the reference population scale. The relative polarization indices, however, are *symmetric*, meaning that they are effectively

⁷In order to enhance comparability of consumption data over the years, all expenditures have been deflated across both space and time and are expressed in 2010 Naira.

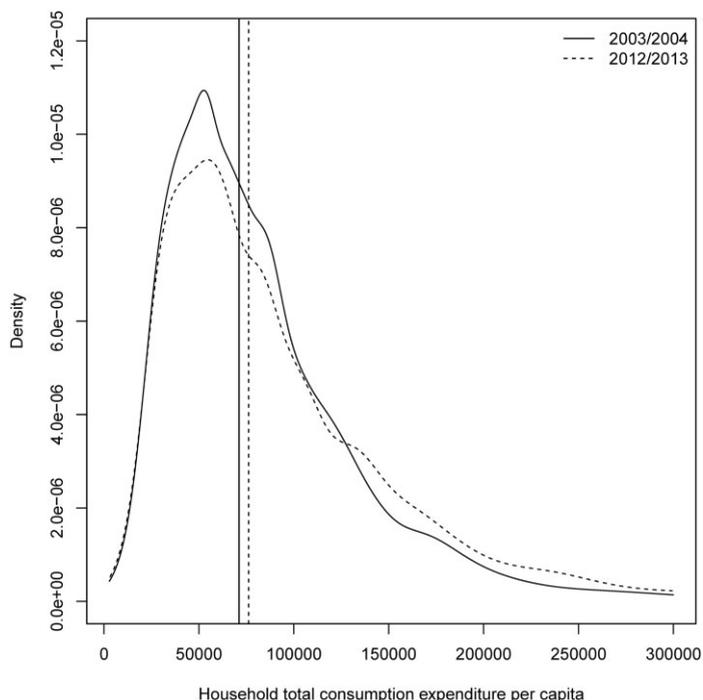


Figure 1. The distribution of total household consumption expenditure in Nigeria, 2003/2004 and 2012/2013. Expenditures in the upper tiers of the densities have been truncated for better presentation of the graph, where the vertical lines denote the medians of the two survey waves

invariant to whether the 2003/2004 or 2012/2013 consumption distribution is chosen as the reference: in fact, swapping the comparison and reference populations yields indices of the same magnitude and opposite sign (e.g. Handcock and Morris, 1999, pp. 71–72, and Hao and Naiman, 2010, pp. 88–89). Thus, reversing the reference and comparison distributions designation will not alter our findings in a substantive way—if not for the fact that polarization would now be analyzed in the reverse direction of time.

The relative density of total per capita consumption expenditure of Nigerian households between 2003/2004 and 2012/2013 is examined in Figure 2(a).⁸ This plot shows the fraction of households in 2012/2013 that fall into each percentile of the 2003/2004 distribution. Households in the low and middle classes moved toward high and, to a less extent, lowest deciles. Indeed, if we choose any percentile approximately between the 2nd and the 80th in the 2003/2004 distribution, the fraction of households in 2012/2013 whose consumption rank corresponds to the chosen percentile is less than the analogous fraction of households in 2003/2004.

To get a more detailed picture, we decompose the relative density into location and shape effects according to Equation (3). Figure 2(b) presents the effect only due to the median shift, that is the pattern that the relative density would have

⁸The relative density function has been obtained by fitting a local polynomial to the estimated relative data.

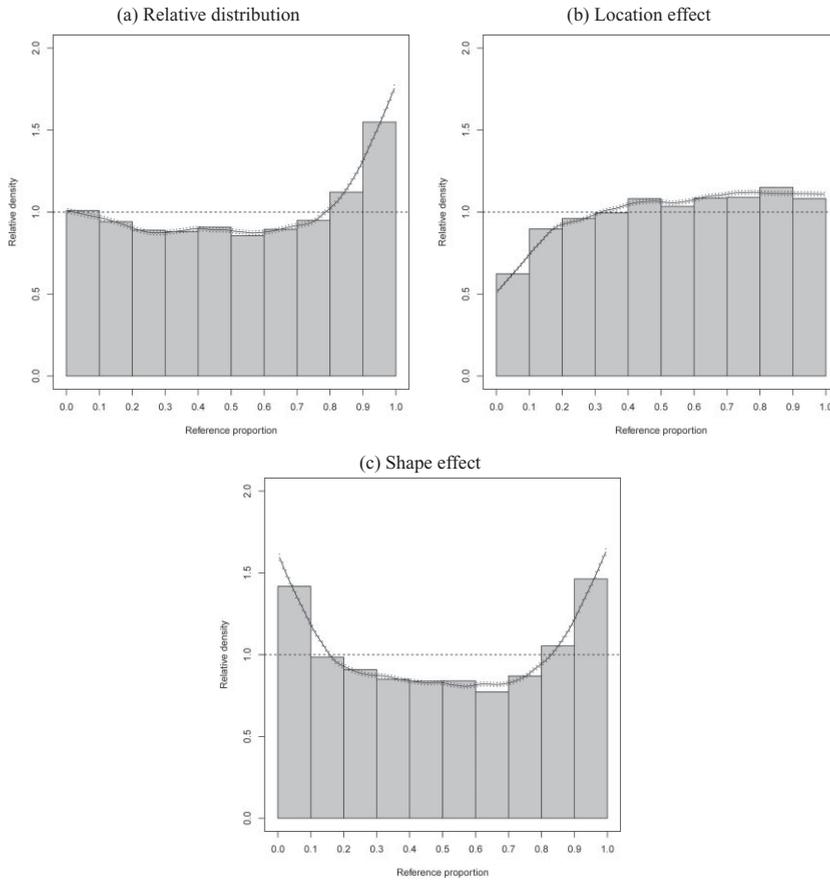


Figure 2. Changes in the Nigerian household consumption distribution between 2003/2004 and 2012/2013. The bars represent the decile breakdown of the relative distribution, showing the fraction of 2012/2013 households that fall into each 2003/2004 decile, while dotted lines indicate the 95 percent pointwise confidence limits based on the asymptotic normal approximation (Handcock and Morris, 1999, p. 144)

displayed if there had been no change in distributional shape but only a location shift of the density. The effect of the median shift was quite large. This alone would have moved out of the four lowest deciles of the reference distribution a substantial fraction of GHS panel 2012/2013 households and placed them in any of the remaining deciles. Note, however, that neither tail of the observed relative distribution is well reproduced by the median shift. For example, the top decile of Figure 2(b) is about 1.1, below the value of 1.5 observed in the actual data, and the bottom deciles of the same figure are also substantially lower than observed. These differences are explained by the shape effect presented in Figure 2(c), which shows the relative density net of the median influence. Without the higher median, the greater dispersion of consumption expenditures in GHS panel 2012/2013 would have led to relatively more low-consuming households in 2012/2013, and this effect was mainly concentrated in the bottom decile. By contrast, at the top of the

distribution the higher spread worked in the same direction of the location shift: operating by itself, it would have increased the share of households in the top decile of the 2012/2013 consumption distribution by nearly 50 percent. In sum, once changes in real median expenditure are netted out, a U-shaped relative density is observed, indicating that income (proxied by consumption) polarization was hollowing out the middle of the Nigerian household consumption distribution—with a cumulative loss that more than halved the number of households in deciles 2 through 8 of the 2012/2013 distribution.

A link between what we have observed in the graphical analysis and the quantification of the degree of polarization is captured by the relative polarization indices. These indices keep track of changes in the shape of the distribution and measure their direction and magnitude. Table 1 reports the median, lower and upper polarization indices computed from the data using Equations (4)–(6), along with their 95 percent confidence intervals and the *p*-values for testing the null hypothesis of no change with respect to the reference distribution. Using weighted estimates of relative polarization measures, the 95 percent confidence interval for the MRP has been calculated as:

CI = weighted estimate $\pm 1.96 \times$ SE, where $SE = 4\sqrt{c_1/m + c_2/n}$ is the standard error of MRP based on the sample variances c_1 and c_2 of, respectively, $\{Q_i - 1/2\}_{i=1}^m$ and $\{Q_i - 1/2\}_{i=1}^n$ —i.e. the absolute deviations around the median of the location-matched quasirelative data $\{Q_i\}_{i=1}^{m,n}$ (m and n denote the comparison and reference sample sizes). As for the *p*-value, since our data sets are large survey samples for which the sample sizes tend to be large, we use the normal approximation to the exact distribution of the MRP estimate as the basis for a test for a given significance level α , that is: $P(|MRP| \leq z_{\alpha/2} \times SE) \approx 1 - \alpha$, where $z_{\alpha/2}$ is the $100 \times (1 - \alpha)$ percentile of the standard normal distribution. Estimation of confidence intervals and *p*-values for the lower relative polarization (LRP) and upper relative polarization (URP) indices is similar (Handcock and Morris, 1999, ch. 10).

The median index is significantly positive, implying a dispersion of the consumption distribution from the middle toward either or both of the two tails. The lower and upper polarization estimates indicate that both tails of the distribution are significantly positively polarized. The upper index, however, is slightly larger, indicating greater polarization in the upper tail of the distribution than in the lower tail.

TABLE 1
RELATIVE POLARIZATION INDICES

| Index ^a | Value | LB ^b | UB ^c | <i>p</i> -value ^d |
|--------------------|-------|-----------------|-----------------|------------------------------|
| MRP | 0.12 | 0.11 | 0.13 | 0.00 |
| LRP | 0.11 | 0.08 | 0.14 | 0.00 |
| URP | 0.13 | 0.10 | 0.16 | 0.00 |

Notes: (a) MRP = median relative polarization index, LRP = lower relative polarization index, URP = upper relative polarization index; (b) lower bound of the 95% confidence interval; (c) upper bound of the 95% confidence interval; (d) refers to the null hypothesis of no change with respect to the reference distribution, i.e. that the index equals 0.

4.3. *Covariate Decompositions*

So far we have focused on comparing the distribution of Nigerian household consumption expenditure between two points in time. However, there are often covariates measured on the households which vary over time, and the impact of these changes on the observed outcomes could be of interest to economic policy and suggest possibilities worthy of consideration by its designers. In the relative distribution setting, exploring the distributional impacts of changes in a covariate requires that the relative distribution is adjusted for these changes using the methods from Section 3.4. This makes it possible to separate the impacts of changes in the distribution of the covariate (the “composition effect”) from changes in the conditional distributions of household consumption expenditure given the covariate levels (the “residual effect”). Our Nigerian consumption microdata provide an opportunity to use this covariate adjustment technique as they contain a large set of covariates describing various socio-demographic characteristics of the respondents, household assets and characteristics of the dwelling. Here, the analysis is restricted to the following covariates: sex of household head; literacy status of household head; zone; main material used for floor; main source of drinking water; main cooking fuel; main toilet facility. This selection was inspired both from previous poverty research—which advocates the inclusion of covariates that change over time, but excluding those of them that are likely to change markedly in the face of evolving economic conditions (e.g. Stifel and Christiaensen, 2007)—and the fact that many of the covariates excluded from the analysis did not affect the statistical significance of the predicting model used to impute the 2003/2004 data.

Summary statistics for the population subgroups defined by the levels of the covariates analyzed and the corresponding average percentage changes between 2003/2004 and 2012/2013 are given in Tables B.2 and B.3 of Appendix B. Both the mean and median consumption expenditures rose during the period analyzed for many population subgroups—exceptions are represented by households headed by illiterate individuals, households with inadequate housing infrastructures (such as unsafe water, low quality flooring material, no toilet facility and firewood as the main cooking device) and households living in the North East and North West zones of the country. At the same time, apart from households in the North Central region, all groups experienced increasing inequality according to both the Gini coefficient and the Theil index. Population and consumption shares changed instead more heterogeneously, following patterns of increases and decreases with different magnitudes over time. In particular, there appears to have been almost no change in the proportion of male-headed households, while female-headed households declined somewhat. By contrast, the fractions of households with a literate head and good quality housing infrastructures (such as safe water, medium-high quality flooring material and non-firewood cooking devices) grew considerably relative to their counterparts—households with no toilet facility, however, are more common in 2012/2013 than in 2003/2004. Finally, the proportions of households that consist of individuals living in the northern zones of the country increased between 2003/2004 and 2012/2013, whereas households in the southern regions declined slightly.

The above population trends are also visible from Figure 3, which plots the relative distributions of the covariates for 2012/2013 to 2003/2004. Conceptually,

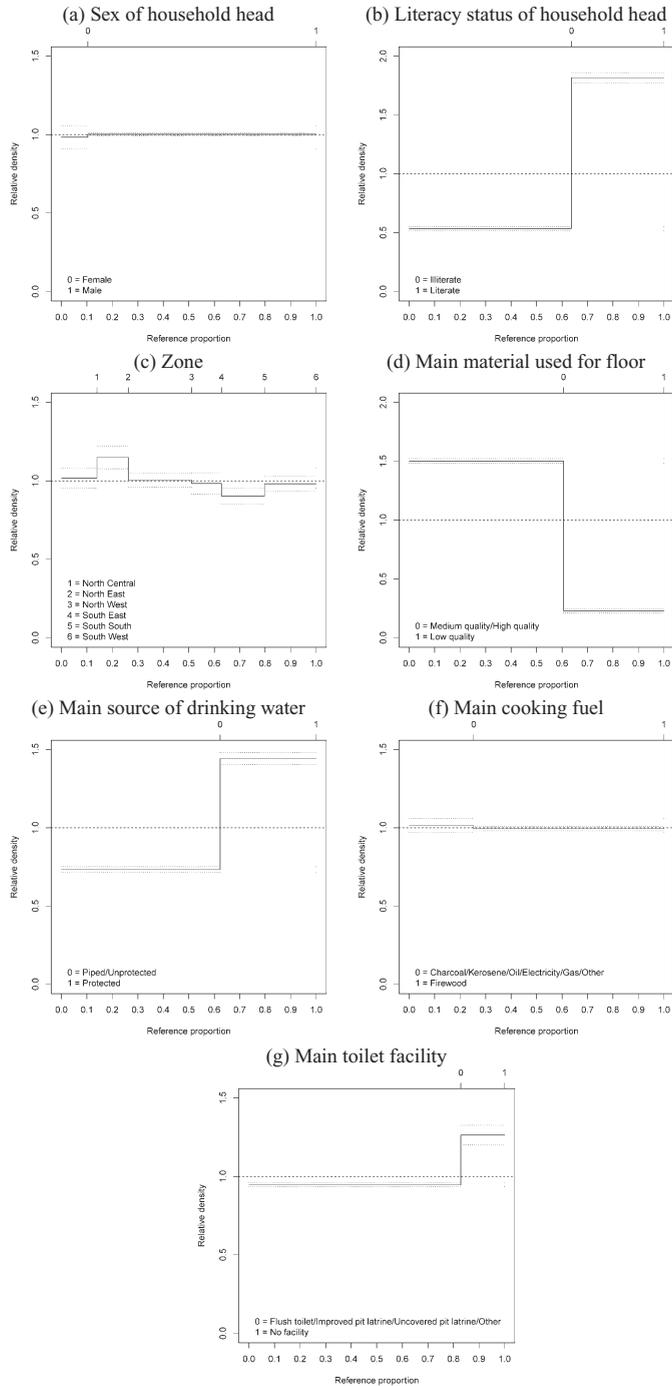


Figure 3. The relative distributions of the covariates for 2012/2013 to 2003/2004. The upper axes are labelled by the levels of categorical variables. The dotted lines are 95 percent pointwise confidence bounds

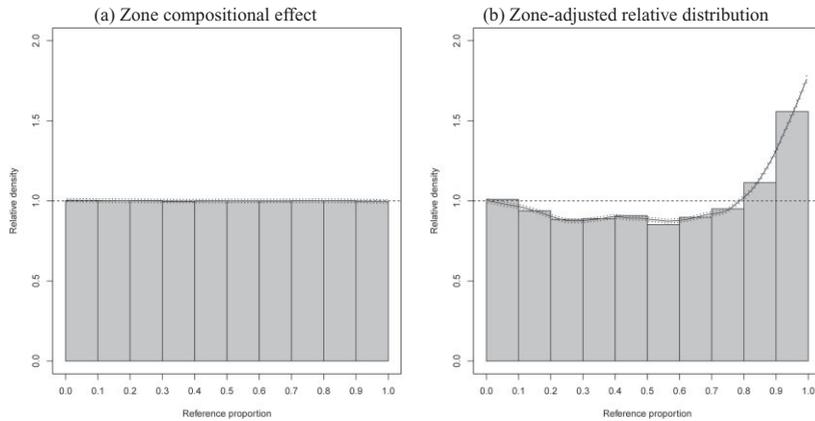


Figure 4. Adjusting the relative density of Nigerian consumption expenditure for changes in the region of residence (zone) covariate distribution between 2003/2004 and 2012/2013

these relative densities are similar to the one constructed for consumption expenditure in the previous section, though the graphs are not nearly as smooth because of natural discreteness of the covariates. By reading across the bottom axis one can see the frequencies of reference households cumulated by levels of the covariates, while reading off the y -axis for a given level of the categorical variables allows one to find the relative frequency of comparison households in each group defined by that level. The labels at the top show the categories of the covariates, and can be used for both the reference and comparison populations.

However, as already mentioned earlier in this section, in order to assess the impact of changes in population characteristics on the Nigerian consumption distribution the relative density must be decomposed by the distributions of the covariates. This is shown in Figure 4 for the region of residence (zone) covariate, which presents both the covariate composition effect as well as the effect of residual changes—i.e. the expected relative density of Nigerian consumption expenditures had the covariate composition of the 2003/2004 and 2012/2013 populations been identical. The results in panel (a) are pretty close to a uniform distribution, suggesting that the observed differences in population composition according to the selected covariate had little effect on the overall changes occurred over the decade. This perception is confirmed by the adjusted distribution graphed in panel (b) which, in the absence of a major compositional effect, is not much different than the original one depicted in Figure 2(a). Results for other covariates—not shown for brevity, but available upon request—are very similar: there were slight decreases in the bottom half and tiny growth at the top of the distribution associated with some of the compositional shifts in these covariates, but the observed changes were only partly driven by modifications in the characteristics of the population.

A similar conclusion can be drawn when looking at Table 2, which presents the set of relative polarization indices for each group defined by the covariates obtained by comparing their consumption distributions over time. Note that, by comparing the subgroup distributions over time, we are effectively controlling for the compositional differences, even though no explicit composition *effect* is identified. If each

TABLE 2
RELATIVE POLARIZATION INDICES FOR DIFFERENT POPULATION SUBGROUPS

| | MRP | | | LRP | | | URP | | | |
|-----------------------------------|--------------------|-----------------|-----------------|--------------------|-----------------|-----------------|--------------------|-----------------|-----------------|----------------------|
| | Index ^a | LB ^b | UB ^c | Index ^a | LB ^b | UB ^c | Index ^a | LB ^b | UB ^c | p-value ^d |
| Sex of the household head | | | | | | | | | | |
| Male | 0.11 | 0.10 | 0.13 | 0.10 | 0.07 | 0.13 | 0.13 | 0.09 | 0.16 | 0.00 |
| Female | 0.15 | 0.11 | 0.19 | 0.15 | 0.07 | 0.22 | 0.15 | 0.08 | 0.23 | 0.00 |
| Literacy status of household head | | | | | | | | | | |
| Illiterate | -0.01 | -0.03 | 0.01 | -0.03 | -0.07 | 0.02 | 0.01 | -0.03 | 0.05 | 0.33 |
| Literate | 0.10 | 0.08 | 0.12 | 0.08 | 0.04 | 0.13 | 0.12 | 0.08 | 0.16 | 0.00 |
| Zone | | | | | | | | | | |
| North Central | 0.02 | -0.01 | 0.06 | 0.03 | -0.04 | 0.10 | 0.01 | -0.06 | 0.08 | 0.35 |
| North East | -0.07 | -0.11 | -0.04 | -0.07 | -0.14 | 0.00 | -0.08 | -0.15 | -0.01 | 0.02 |
| North West | -0.10 | -0.14 | -0.07 | -0.15 | -0.21 | -0.09 | -0.05 | -0.12 | 0.01 | 0.06 |
| South East | 0.14 | 0.10 | 0.18 | 0.14 | 0.07 | 0.21 | 0.14 | 0.07 | 0.21 | 0.00 |
| South South | 0.21 | 0.17 | 0.25 | 0.23 | 0.15 | 0.31 | 0.19 | 0.11 | 0.26 | 0.00 |
| South West | 0.21 | 0.17 | 0.25 | 0.23 | 0.16 | 0.31 | 0.18 | 0.11 | 0.26 | 0.00 |
| Main material used for floor | | | | | | | | | | |
| Medium quality/High quality | 0.08 | 0.06 | 0.09 | 0.05 | 0.02 | 0.09 | 0.10 | 0.06 | 0.13 | 0.00 |
| Low quality | -0.14 | -0.17 | -0.10 | -0.26 | -0.32 | -0.20 | -0.01 | -0.10 | 0.07 | 0.36 |
| Main source of drinking water | | | | | | | | | | |
| Piped/Unprotected | 0.04 | 0.02 | 0.06 | -0.03 | -0.07 | 0.01 | 0.11 | 0.07 | 0.16 | 0.00 |
| Protected | 0.16 | 0.14 | 0.19 | 0.21 | 0.17 | 0.25 | 0.12 | 0.07 | 0.16 | 0.00 |
| Main cooking fuel | | | | | | | | | | |
| Charcoal/Kerosene/Oil/ | 0.21 | 0.18 | 0.24 | 0.28 | 0.22 | 0.34 | 0.15 | 0.09 | 0.21 | 0.00 |
| Electricity/Gas/Other | | | | | | | | | | |
| Firewood | 0.03 | 0.01 | 0.04 | 0.01 | -0.02 | 0.04 | 0.04 | 0.01 | 0.07 | 0.01 |
| Main toilet facility | | | | | | | | | | |
| Flush toilet/Improved pit | 0.16 | 0.14 | 0.18 | 0.17 | 0.14 | 0.21 | 0.15 | 0.11 | 0.18 | 0.00 |
| latrine/Uncovered pit | | | | | | | | | | |
| latrine/Other | | | | | | | | | | |
| No facility | 0.02 | -0.01 | 0.05 | 0.02 | -0.04 | 0.08 | 0.01 | -0.04 | 0.07 | 0.31 |

Notes: (a) MRP = median relative polarization index, LRP = lower relative polarization index, URP = upper relative polarization index; (b) lower bound of the 95% confidence interval; (c) upper bound of the 95% confidence interval; (d) refers to the null hypothesis of no change with respect to the reference distribution, i.e. that the index equals 0.

of the group-specific polarization indices were close to 0, this would imply that after holding changes in the distributions of the covariates constant there is no residual polarization in consumption expenditures. The polarization we observe in the overall consumption distribution would then be due entirely to changing characteristics of the population over time. Instead, we see a different scenario. Apart from the North Central households and those with an illiterate head and no toilet facility, the estimates indicate a statistically significant increase of polarization in the subgroup distributions, except for households who reside in the North East and North West regions of the country and those with inadequate flooring in dwelling units, for whom some convergence toward the median is detected. The growth of polarization stems from a shift away from the median of both tails, and this seems to happen asymmetrically, as the LRP indices are in many cases more positive than the URPs—thus indicating more polarization in the lower than in the upper tail. Households headed by men, women or illiterates and households with good flooring material in dwellings, unsafe water and cooking with firewood, instead, are more polarized in the upper than in the lower tail of their consumption distribution—or at least they are so the same way. Overall, these patterns confirm that compositional shifts contributed little to the observed consumption polarization or, in other words, holding the changes in population characteristics constant does almost nothing to reduce overall polarization.⁹

The above conclusion suggests that the main drivers of polarization are to be searched elsewhere, namely in the changes occurring over the decade in the consumption distributions of the groups defined by the covariates. While the covariate adjustment technique identifies the impact of changing population characteristics on the distribution of consumption expenditures, comparing the groups defined by the covariates directly makes it possible to analyze the changes within and between these groups' consumption distributions. As already observed, many population subgroups were both location-shifted (Tables B.2 and B.3) and more polarized (Table 2). To see what impact these location and shape shifts in the subgroups' distributions had on their relative positions within the overall consumption distribution, we compare the changes in deciles of the between-group relative distributions for 2003/2004 and 2012/2013 to the changes that would have occurred if only the medians or shapes of the groups had changed. More specifically, for each decile we decompose the absolute change:

$$(12) \quad g(C : R) - g(C_0 : R_0),$$

where $g(C : R)$ and $g(C_0 : R_0)$ denote respectively the relative density for comparison (C) to reference (R) groups of the categorical variables in 2012/2013 and 2003/2004, into the marginal effect of the median shift from the 2003/2004 relative density:

$$(13) \quad g(C_{0L} : R_{0L}) - g(C_0 : R_0),$$

and those of the shape changes in the subgroups' consumption distributions:

⁹This finding can also serve as a check of whether the observed changes in Nigerian consumption distribution are robust to sample size variations. That is, had the modifications in population characteristics due to artefacts of the sample size, rather than to real population trends, our results would not be affected by them.

$$(14) \quad g(C_{0L} : R) - g(C_{0L} : R_{0L}),$$

$$(15) \quad g(C : R) - g(C_{0L} : R),$$

where R_{0L} and C_{0L} denote the distributions of the reference and comparison groups adjusted to have the same median as 2012/2013 but with the same shape as 2003/2004.¹⁰ Summing up to the total difference given by Equation (12), these effects form a complete decomposition and allow us to determine what proportion of households were moved into or out of a decile of the overall distribution by changes in relative median and group-specific shape.

The spatial distribution of household consumption expenditure definitely provided the most attractive results. Figure 5 presents the decomposition for each of the six Nigerian macro-regions as compared to the rest of the country. The solid bars show the total change by decile from Equation (12), and each of the lines represents one of the three components in the decomposition defined by Equations (13)–(15). We can see two ongoing distinctive patterns, both accentuating polarization. In the South South and the South West, relative to the rest of the country, residents tend to move out of the lower deciles of the distribution due to changes in relative median. More precisely, had the location effect been the only one operating, we would have seen in both cases a clear transition of Southerners from lower to upper deciles of the national distribution. However, the shape effect of both regions moved in the opposite direction, partially offsetting the positive impact of growth. Particularly in the lower deciles, the shape change is positive, indicating a clear trend of lower polarization in these areas that goes in the opposite direction *vis-à-vis* the national (residual) trend. This pattern is mirrored by what is going on in the upper deciles: a location effect higher than in the rest of the country (especially in the South West) and an accentuated tendency to upper polarization in both regions. For what concerns the North East and the North West, the conflict-stricken areas, had the location effect been the only operating force we would have seen a disproportionate increase of people in these regions occupying the lower national deciles compared to the rest of the country—they basically lagged behind. The increase of polarization in the rest of the country helped to offset this effect, filling the lower deciles of households from other regions too, whereas for the rest of the distribution we observe in practice a generalized decline of the relative position of these regions in the national distribution. Finally, while the North Central improves relative to the rest of the country in lower deciles, the South East comes to show a more articulated pattern of distributional change.

Results for the other covariates (not shown here but available upon request) looked as expected: compared to 2003/2004, households with an illiterate head or not having good cooking material, toilet, floor and safe water were all increasingly occupying the lower deciles of the distribution, and the gap in terms of consumption with the rest was increasing. Instead, the relative fraction of households headed by females in the upper deciles of the distribution was rising during the period, whereas male-headed households were moving into the deciles below the median. In spite of

¹⁰The decomposition follows the spirit of that presented in Bernhardt *et al.* (1995) and Handcock and Morris (1998, 1999), to whom we refer the reader for more details.

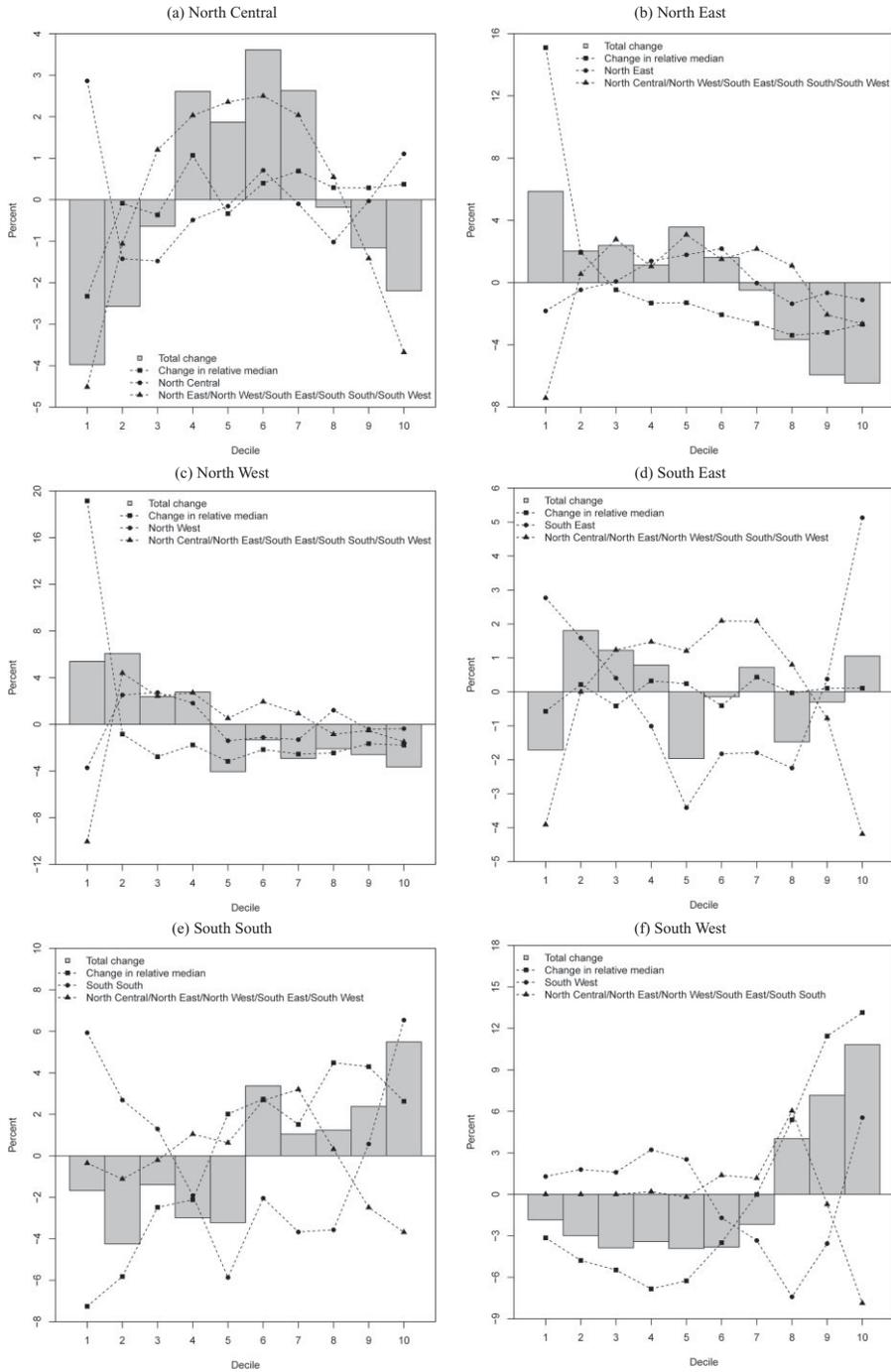


Figure 5. Sources of distributional change in the 2012/2013 to 2003/2004 relative distribution of consumption expenditures by zone

the fact that Nigerian society is mainly patriarchal, where men have better access to productive resources than women, the poor seem more among men than women.

5. CONCLUDING REMARKS

In the last two decades there have been two different narratives on Sub-Saharan Africa. The first paints a picture of an emerging continent where middle classes are expanding and prosperity is reaching large swaths of the population (African Development Bank, 2011; Fine *et al.*, 2012). The other narrative acknowledges the relatively robust growth in the past two decades, but points to slow reduction in poverty. According to this second narrative, the lack of faster reduction in poverty may be due, in part, to increasing disparities.

Nigeria, the most populous country in the African continent, has been enjoying a stable and sustained growth for over a decade since 2003. Yet despite this, the outcomes in terms of poverty reduction have not been satisfactory: while poverty seems to have declined in the coastal South and around the Federal Capital, Abuja, a large belt of North-Eastern states have experienced a clear stagnation in poverty reduction.

Our conjecture is that Nigeria in the last decade has been going through significant changes in the distribution of economic resources that generated mainly, but not exclusively, an increase in polarization. In income-polarized societies people cluster around group means and tend to be far from the mean/median of the overall distribution, which results in the inability of the middle class to consolidate its position. This has several economic consequences for a country, but may also be the underlying cause of growing political instability seen in recent years in many middle income countries.

Studies of polarization in Nigeria are surprisingly few and have tackled the topic with a narrow lense. This paper contributes to our understanding of polarization in Nigeria by using an approach that improves upon previous studies in several ways. First, it considers a longer time horizon—close to a decade—which allows for major changes in welfare distributions to emerge. Second, it tackles a major deficiency—lack of comparability of the available data in Nigeria—by making use of survey-to-survey estimation techniques (Elbers *et al.*, 2003) to achieve comparability of the distributions of interest. Finally, and most importantly, it employs the “relative distribution” approach (Handcock and Morris, 1998, 1999) to analyze changes in the Nigerian household consumption distribution in the considered period. The novelty of this method consists in providing a non-parametric framework for taking into account all of the distributional differences that could arise in the comparison of distributions over time and space. In this way, we are able to summarize multiple features of the expenditure distribution that would not be detected easily from a comparison of standard measures of inequality and polarization.

The analysis reveals significant changes in the consumption distribution. We find a clear rise in polarization, meaning that the distributional movements observed between 2003/2004 and 2012/2013 hollowed out the middle of the Nigerian household consumption distribution and increased concentration of the mass toward higher and lower deciles.

This pattern of distributional change, however, is not entirely homogeneous within the country, but varies from zone to zone. Through covariates analysis,

controlling for spatial characteristics of household head, we show that in the South (South-West and South-South) lower deciles tend to be emptied relative to the rest of the country, confirming the tendency for households from these zones to contribute to upper polarization. In the North-West and in the conflict-stricken North-East, we see the opposite. The overall impact was a generalized hollowing out of the center and a further accentuation of the North-South divide already characterizing the country.

Understanding the political and economic consequences of these sharp distributional changes is beyond the scope of this paper. However, polarization is increasingly becoming a concern in many developing countries. Recent episodes in Brazil, Egypt and Turkey suggest the existence of a link between polarization and conflict, yet so far no relevant empirical evidence has been produced to underpin the existing theoretical models (Esteban and Schneider, 2008). Nigeria is clearly an ideal candidate for such analysis, and our future research will be directed in understanding how existing conflicts in Nigerian society can be interpreted and linked to the patterns of polarization.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher’s web-site:

Appendix A: Imputation Method

Table A.1: Regression results of POVMAP imputation model

Table A.2: Mean and standard deviation of relative polarization indices over $R = 50$ simulation runs for three alternative imputation techniques

Figure A.1: Post-imputation diagnostic plots

Appendix B: Tables

Table B.1: Summary measures of Nigerian household total consumption expenditure per capita

Table B.2: Summary measures for Nigerian household consumption expenditure by population subgroups, 2003/2004 and 2012/2013

Table B.3: Summary measures for Nigerian household consumption expenditure by population subgroups, average annual compound percentage changes from 2003/2004 to 2012/2013