The Transition of Welfare in Africa in the 2000s: Evidence from Synthetic Panel Data

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Abstract

Absent actual panel household survey data, we construct for the first time synthetic panel data for more than twenty countries accounting for two-thirds of the population in Sub-Saharan Africa. We employ in this process repeated cross sections that span, on average, a six-year period for each country. Our analysis suggests that all these countries as a whole have had pro-poor growth. In particular, one third of the poor population escaped poverty during the studied period, which is larger than the proportion of the population that fell into poverty in the same period. The region also saw a nine-percent reduction in poverty and a 28-percent increase in the size of the middle class. Chronic poverty, however, remains high and a considerable proportion of the population are vulnerable to falling into poverty.

JEL: C15, D31, I31, O10, O57

Key words: welfare dynamics, poverty, vulnerability, middle class, pro-poor growth, synthetic panel, household surveys, Africa

I. Introduction

Static poverty measures fail to distinguish between an individual who has been in poverty all her life, and another who happens to have had a small misfortune for the year the measurement was carried out. But these distinctions matter. The forces that conspire to condemn some individuals to remain stuck in poverty for years are generally somewhat different from those that randomly drag them down for a brief period. The latter group may need only some temporary relief—perhaps only some short-term employment insurance till they secure the next decent-paying job—while the former would also need longer-term interventions aimed at breaking the persistence of poverty. Indeed, the longer people spend in poverty, the lesser tends to be their chance of exiting it. As living standards in Africa continue to rise, has its poverty remained mainly chronic, or has it become more transient?

Researchers interested in understanding welfare dynamics in Africa now have access to an emerging collection of nationally representative panel surveys, which represents a vast improvement over the situation just a decade ago.[1] However, data coverage remains low—data are available for only seven countries—and the time period spanned by these panel surveys are mostly limited to short periods of three years or less. We attempt to overcome these obstacles by applying recently developed statistical methods to construct synthetic panels from cross sectional surveys (Dang et al., 2014; Dang and Lanjouw, 2013), which are far more widely available. We construct these synthetic panels for 21 countries with at least two comparable cross sectional surveys accounting for two-thirds of the Sub-Sahara African population and spanning on average six years. Thus by covering the largest number of countries and the longest time periods for Sub-Saharan

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[1] See, for example, the Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA) that are sponsored by the World Bank.

Africa compared to the existing literature, our paper provides the most comprehensive, to date, study of welfare dynamics for the region as a whole.[2]

In addition to generating newer and more data, this synthetic panels approach also enables us to offer a more consistent measurement of poverty dynamics since it applies the same methodology and employs the same standard and welfare measure for all countries, which is not the case in most existing studies that use panel surveys. Furthermore, since synthetic panel data are constructed from cross sectional surveys, these data are also exempt from issues that usually plague panel data quality such as attrition.

Our findings suggest that on average—that is when all the 21 countries are taken together— the region experienced pro-poor growth. Even though chronic poverty remains high, one third of those considered poor in the first period moved out of poverty in the second period, which exceeds the proportion of the population that fell into poverty in the same period. The region also saw a nine-percent (or a five percentage points) reduction in poverty and a 28-percent increase in the size of the middle class, albeit from a somewhat low base. However, the vulnerable category also grows by 12 percent. Our pro-poor growth definition suggests that countries with positive growth are, in a decreasing order, Mauritania, Ethiopia, Togo, Swaziland, Malawi, Chad, Botswana, Ghana, Uganda, Congo DRC, Mozambique, Rwanda, Tanzania, and Sierra Leone. On the other hand, countries with growth that is not pro-poor, in an increasing order of negative growth, are Burkina Faso, Zambia, Madagascar, Cote d'Ivoire, Cameroon, Senegal, and Nigeria. There is also some indicative evidence that most resource-rich and middle-income countries have more upward mobility than downward mobility. A college degree is especially strongly associated with higher

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[2] Similar analyses using synthetic panel data have been done for other regions such as Latin America (e.g., Ferreira et al., 2013; Vakis et al., 2016) or Middle East and North Africa (Dang and Ianchovichina, 2016).

upward mobility and less downward mobility, which holds true to some extent for households with a female household head and urban residence.

This paper consists of four sections. We provide a brief overview of the analytical framework, including the synthetic panels method and our definitions of vulnerability and shared prosperity, and data in the next section. We discuss estimation results with poverty mobility and welfare dynamics in Section III, before offering concluding remarks and some policy recommendation in Section IV.

II. Analytical Framework

We provide in this section a brief overview of the methods that will be employed to construct the synthetic panels, as well as some simple but useful decomposition formulae for poverty mobility (Section II.1). We then describe our definitions of vulnerability and shared prosperity (Section II.2), which have a strong pro-poor growth focus. We discuss the data in the last sub-section (Section II.3).

II.1. Constructing Synthetic Panels and Decomposing Poverty Mobility

We apply the statistical methods that are recently developed by Dang et al. (2014) and Dang and Lanjouw (2013) to construct synthetic panel data from the repeated cross sections.[3] These methods essentially decompose the change in poverty (or welfare) into two components: one that is due to the time-invariant individual characteristics (e.g., ethnicity, religion, place of birth, or completed education), and the other the unobserved time-varying factors (e.g., unexpected shocks to household consumption). Certain deterministic variables such as age can also be included in the first component, since given its value in one survey round, age can then be determined given the

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[3] Validation exercises were implemented for the synthetic panel methods using both synthetic panel data and actual panel data for several different countries in the cited papers. Other recent applications (and validations) include Ferreira et al. (2013) and Cruces et al. (2015) for Latin American countries, Dang et al. (2017) for Senegal, Dang and Lanjouw (in press) for India, the US, and Vietnam.

time interval between the two survey rounds. Similarly, time-varying household characteristics can also fall under the first component if retrospective questions about the values of such characteristics in the first survey round are asked in the second round. An overview of these methods are provided in Appendix 1.

To reduce spurious changes due to changes in household composition over time, we follow the literature on pseudo-panel analysis and restrict the estimation samples to household heads age 25 to 55 in the first cross section and adjust this age range accordingly in the second cross section. This restriction also helps ensure certain variables such as heads' education attainment remains relatively stable over time (assuming most heads are finished with their schooling).[4] This age range is usually used in traditional pseudo-panel analysis but can vary depending on the cultural and economic factors in each specific setting. Population weights are then employed to provide estimates that represent the whole population.

Then let y_{ij} and z_j respectively represent household consumption (income) and the poverty line in survey round j, j= 1 or 2, we are interested in knowing such quantities as

$$P(y_{i1} < z_1 \ and \ y_{i2} > z_2) \qquad (1a)$$

which represents the percentage of households that are poor in the first survey round (year) but non-poor in the second survey round, or

$$P(y_{i2} > z_2 \mid y_{i1} < z_1) \qquad (1b)$$

which represents the percentage of poor households in the first round that escape poverty in the second round.[5] In other words, for the average household, quantity (1a) provides the joint

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[4] While household heads may still increase their education achievement in theory, this rarely happens in practice.
[5] Note that quantities (1a) and (1b) respectively represent the probability that household *i* is poor in the first survey round (year) but nonpoor in the second survey round and the probability that the poor household *i* (in the first round) escapes poverty in the second round. At the population level, these quantities can also be interpreted as percentages of the population groups of interest as discussed above.

(unconditional) probabilities of household poverty status in both years, and quantity (1b) the conditional probabilities of household poverty status in the second year given their poverty status in the first year. For convenience, we also refer to (1a)-type quantities and (1b)-type quantities respectively as the unconditional measure and the conditional measure of poverty mobility.

Some straightforward decompositions are useful for interpretation of results. Note that the following equality holds for the unconditional probabilities

$$P(y_{i1} < z_1 \ and \ y_{i2} < z_2) + P(y_{i1} < z_1 \ and \ y_{i2} > z_2) = P(y_{i1} < z_1) \qquad (2a)$$

where the first and second terms on the left-hand side respectively represent chronic poverty (i.e., the percentage of households that are poor in both years) and upward mobility (i.e., the percentage of households that are poor in the 1st year but escape poverty in the 2nd year). These two terms together make up the percentage of the population that are poor in the 1st year (i.e., the headcount poverty rate in the 1st year). Thus given the same (headcount) poverty rate, Equation (2a) implies an inverse relationship between chronic poverty and upward mobility.

We can have a similar decomposition for the poverty rate in the 2nd period by simply reversing the inequality signs in the 2nd term in the left-hand side, which results in

$$P(y_{i1} < z_1 \ and \ y_{i2} < z_2) + P(y_{i1} > z_1 \ and \ y_{i2} < z_2) = P(y_{i2} < z_2) \qquad (2b)$$

The 2nd term on the left-hand side now represents downward mobility (i.e., the percentage of households that are non-poor in the 1st year but slide into poverty in the 2nd year), which together with chronic poverty (the 1st term on the left-hand side) sums up to the poverty rate in the 2nd period.

Equations (2a) and (2b) provide the unconditional versions of poverty mobility, which do not take into account the information that is offered by a household's poverty status in any given year. We can further extend these equalities by conditioning on household poverty status in *either* period

to obtain the conditional versions. In particular, dividing all terms in Equations (2a) and (2b) by the right-hand side, we have the conditional versions of these equalities

$$P(y_{i1} < z_1 \text{ and } y_{i2} < z_2 \mid y_{i1} < z_1) + P(y_{i1} < z_1 \text{ and } y_{i2} > z_2 \mid y_{i1} < z_1) = 1 \qquad (3a)$$

$$P(y_{i1} < z_1 \text{ and } y_{i2} < z_2 \mid y_{i2} < z_2) + P(y_{i1} > z_1 \text{ and } y_{i2} < z_2 \mid y_{i2} < z_2) = 1 \qquad (3b)$$

It is useful to note that since there are two different components on the left-hand sides of Equation (3a), there is not necessarily a correlation between either of these two components and the total on the left-hand side. A similar result applies for Equations (2a), (2b), and (3b). Put differently, there may be, for instance, no correlation between (unconditional) chronic poverty and the headcount poverty rate.[6] This further indicates that analyzing panel data can reveal dynamic patterns that are masked by cross sectional data. We return to this interesting result in the empirical analyses.

Yet, another conditional version of Equations (2a) and (2b) can be obtained by further decomposing poverty mobility, conditional on household poverty status in *both* periods

$$P(y_{i1} < z_1 \text{ and } y_{i2} < z_2 \mid y_{i1} < z_1 \text{ or } y_{i2} < z_2) + P(y_{i1} < z_1 \text{ and } y_{i2} > z_2 \mid y_{i1} < z_1 \text{ or } y_{i2} < z_2) +$$
$$+ P(y_{i1} > z_1 \text{ and } y_{i2} < z_2 \mid y_{i1} < z_1 \text{ or } y_{i2} < z_2) = 1$$

$$(4)$$

In Equation (4), the first term on the left-hand side represents the proportion of the population that are chronic poor out of those who were *ever* poor (i.e., the conditional chronic poverty for those who were ever poor). Similarly, the second term on the left-hand side represents upward mobility, and the third term on the left-hand side downward mobility, both terms conditional on those who were ever poor. Compared to Equations (3a) and (3b), Equation (4) is more general and considers as the denominator a larger set of the poor population—the ever-poor—that include not

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[6] But chronic poverty should always be less than or equal to headcount poverty as shown by Equations (2a) and (2b).

just the poor in *either* period 1 or period 2, but in *both* periods. Put differently, the decomposition in Equation (4) offers an analysis of mobility that takes into account both the transiently poor and the chronically poor.

To keep our presentation more concise, unless otherwise noted, hereafter when discussing poverty mobility we refer to the conditional versions (including chronic poverty, upward mobility, and downward mobility).

II.2. Defining Vulnerability and Shared Prosperity
Vulnerability

Using the given poverty lines z_j, Equalities (1a) and (1b) classify the population into two groups, one is poor and the other non-poor. But we can obtain richer analysis by further identifying an additional group out of the latter, the vulnerable that are defined as those that are non-poor but still face a significant risk of falling into poverty. Clearly, poverty reduction can be achieved by not just lifting those who are currently poor out of poverty, but also by providing safety net programs to shield the vulnerable from sinking into this undesirable outcome. Once the vulnerable group is identified, we can (loosely) define as the middle class the remaining population that have higher consumption levels and much lower risk of falling into poverty.

Building on the literature that studies vulnerability to poverty, Dang and Lanjouw (in press) derives the vulnerability line from a specified vulnerability index $\mathcal{P}$. While sharing a similar conceptual approach with existing studies on vulnerability (such as Pritchett et al., 2000; Chaudhuri, 2003, or Christiaensen and Subbarao, 2005), this approach is notably different in several respects. First, it explicitly provides a framework to estimate the vulnerability line that was not discussed in previous studies. This vulnerability line is associated with a vulnerability index that can in turn be derived in various ways including budgetary planning, (ideal or desirable) social

welfare objectives, or relative concepts of well-being. For example, if the available resources for social protection programs can only be deployed to assist a certain proportion (say, 20 percent) of the vulnerable population, this proportion can be a good starting point to derive the vulnerability index. Second, and perhaps more importantly, this approach allows the vulnerability line (and index) to be estimated using cross sectional household surveys, or the synthetic panels that are constructed from these cross sections.[7]

Given a vulnerability line v_j, we can extend Equality (1a) to analyze the dynamics for these three categories: poor, vulnerable, and middle class. For example, the percentage of poor households in the first period that escape poverty but still remain vulnerable in the second period (joint probability) can be calculated using the following quantity $P(y_{i1} < z_1 \ and \ z_2 < y_{i2} < v_2)$.

Table 1 shows a range of values of the vulnerability line that correspond to different vulnerability indexes for all countries. The vulnerability index falls within the range [10, 33], which is comparable to those for India or countries in the Middle East and North Africa region, but higher than that for the US and Vietnam (Dang and Ianchovichina, 2016; Dang and Lanjouw, in press, forthcoming).[8] The vulnerability line ranges from $2.1 to 9.3 dollars per day, in 2011 PPP prices. We will employ a vulnerability index of 15 percent and the associated vulnerability line of $4.3 for our welfare analysis in the next section.

Shared Prosperity

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[7] In addition, other differences are that the target population consists of the currently non-poor households rather than all households; and this approach employs simpler non-parametric estimation methods to estimate vulnerability as a function of consumption alone. See Dang and Lanjouw (in press) for a more detailed comparison of this approach with existing studies. See also Hoddinott and Quisumbing (2010) for a recent review of other approaches to measuring vulnerability.

[8] All numbers are in 2011 PPP dollars per capita per day.

To provide a summary measure of the different growth rates for the three welfare groups, we employ a simple typology of growth scenarios (Dang and Lanjouw, 2016). This typology has a strong pro-poor growth focus, and offers a ranking of the different growth scenarios. For the case of the three welfare categories, there are in total six possible growth scenarios depending on whether (the population share for) each of the three categories is expanding or shrinking.[9] The first three scenarios relate to the reduction of the lowest income category, while the remaining three scenarios concern the expansion of this category. Thus, by our pro-poor definition, these first three scenarios indicate positive pro-poor growth, and the remaining scenarios suggest negative pro-poor growth. The growth of the middle income category helps further determine the rate of pro-poor growth, for example, whether pro-poor growth is more positive or simply positive.

Table 2.1 shows this typology. The most positive pro-poor growth scenario is one where both the low-income and middle-income categories decrease while the top income category expands (Scenario 1). This is also the best general economic growth scenario, as everyone—regardless of their welfare category—is on average better off. The opposite happens with the worst pro-poor growth scenario (Scenario 6) where both the low-income and middle-income categories expand while the top income category shrinks. Put differently, everyone on average is worse off under this scenario. All the remaining scenarios fall in between these two extremes and can be classified based on the changes in the sizes of the three welfare categories.

Some remarks are in order for this simple typology. First, consistent with a pro-poor criterion, pro-poor growth is considered strongest when the two lower income groups are reduced. Second, the ranking provided in Table 2.1 provides a strong focus on the low-income groups, rather than

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[9] Since these three groups add up to 100 percent, two other scenarios of either expanding or shrinking for all these groups as shares of the population are out of the question. In other words, the increases and decreases in the population shares of the three groups should cancel out each other in the total.

the mean of the distribution. From this perspective, a growth scenario where the whole economy may grow on average but poor households become poorer is less desirable than another where the economy can slightly contract but poor households are better off.

Finally, the typology provided in Table 2.1 is general enough to be employed with different (absolute or relative) definitions of welfare categories, as well as different welfare outcomes including objective measures and subjective measures. As proposed in Dang and Lanjouw (2016), the cutoff points delineating the different income groups can also be obtained using a variety of approaches, such as employing a range of fixed percentiles of the income distribution (say, between the 40th and 80th percentiles as in Alesina and Perotti, 1996) or some absolute cutoff thresholds such as between $2 and $10 PPP dollars (Banerjee and Duflo, 2008).

We also show for supplementary analysis estimates that employ the World Bank's definition of shared prosperity, which is growth in mean consumption for the bottom 40 percent of the income distribution (see, e.g., Basu, 2013; Jolliffe et al., 2015).[10] But note that this definition is perhaps more relevant for anonymous growth analysis, where the consumption level for the bottom 40 percent, rather than for the poor population, in each period is tracked. Our typology is more explicitly related to pro-poor growth analysis, where we track welfare of the different population groups over time.

II.3. Data

Construction of the synthetic panel requires a country to have at least two cross sectional surveys. These two surveys should preferably be comparable: that is, they are nationally representative, are conducted around the same time in the calendar year (e.g., to avoid seasonality), and the reporting period and instruments (diary or recalled consumption) are consistent in both

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[10] In a slight abuse of notation, we use the pairs of terms "income" and "consumption" interchangeably in this paper.

surveys. This follows from Equations (1), where it is assumed that to obtain the counterfactual welfare measure (e.g. consumption for the second period), the actual welfare distributions conditional on observable characteristics should be identical. This (somewhat strong) assumption implies that the distributions (for both the welfare measure and the observable characteristics) should be drawn from the same population. It also implies that the variables, especially the welfare measure, must have been collected in the same way—that is, the survey design should be the same. If the two distributions are not comparable, the counterfactual distributions would not be deemed to come from the same data generating process or model; the resultant mobility estimates would be incorrect as a result.

Between 1990 and 2012, at least 148 multi-topic surveys that collected consumption data were completed across countries in Sub-Saharan Africa. More recently, more than half of the countries have conducted a consumption survey between 2011 and 2015 (see Beegle, Christiaensen, Dabalen and Gaddis, 2016). However, only 27 of the 48 countries in Sub-Saharan Africa had at least two comparable household surveys for the period between 1990 and 2012. Among these 27 countries, we are able to use two survey rounds for each of 21 countries to create synthetic panels. These countries and their surveys, which are listed in Table 2, represent around 70 percent of the population of the region and an even higher fraction of its poor population. Nearly all the surveys were conducted in the 2000s, and the two survey rounds in each pair are, on average, separated by about 6 years. Notably, this was also a period of sustained economic growth for the region.

Table 2 shows the estimated poverty rate for each country for each of the two periods, and the net changes in poverty between the two periods. Most of the countries witnessed a downward trend in poverty. More than three-fourths (i.e., 16 out of 21) of the countries saw poverty reduction that ranges from around one percentage point (e.g., Nigeria and Togo) to 12 percentage points (e.g.,

Botswana, Mozambique, and Uganda). Almost half of the countries – 10 of 21 – had a poverty reduction rate of 6 percentage points or larger. At the regional level, the (unweighted) regional poverty rate declined by almost five percentage points, or nine percent (= 4.7/50.4)

The estimates in Table 2 are cross sectional estimates, meaning that the poor in each period are anonymous. They only show the net change in poverty over time, but not the composition of the change as measured by quantities (1a) and (1b). Analysis of the latter provides insights into the dynamics process of poverty mobility, but would require panel data that track households (or individuals) over time as discussed earlier. However, panel data are more often than not affected by various issues such as attrition, measurement errors, and sample selection bias which can severely reduce the accuracy of estimates. In addition, even though more household panel surveys have been implemented in recent years with the introduction of LSMS-ISA program supported by the World Bank, most of the panel surveys in Africa are not nationally representative.[11] We turn next to the analysis that is based on the synthetic panels.

III. Welfare Analysis Using the Synthetic Panels

We discuss in this section the results on poverty mobility (Section III.1) before discussing the results on welfare dynamics. While the former focuses on two-by-two transition matrixes (i.e., by cross cutting a household's poor/non-poor status in the 1st period against its poor/non-poor status in the 2nd period), the latter concerns the more general two-by-two transition matrixes (i.e., by cross cutting the household's poor/vulnerable/middle-class status in the 1st period against its poor/non-poor status in the 2nd period).

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[11] Reviewing studies that use the existing panel data for African countries, Beegle et al. (2016) find much variation in the estimates for chronic poverty and transient poverty. Furthermore, chronic poverty estimates for the same country, and in some cases using the same data sets, could also vary widely depending on the method being used. How much of this poverty mobility is due to measurement errors is still a matter of debate. Some researchers argue that up to 50 percent of the transitory poverty may be accounted for by measurement error in income or consumption (Dercon and Krishnan, 2000; Glewwe, 2012; Lee et al., 2016).

III.1. Poverty Mobility

Using Equations (2a) and (2b), we decompose the headcount poverty rate in the second period and show the estimates in Table 3. The headcount poverty rate (column 4) is decomposed into two components: unconditional chronic poverty (i.e., the incidence of those who remain poor in both periods; column 5) and unconditional downward mobility (i.e., those who were non-poor in the first period but became poor in the second period; column 6). Similarly, the poverty rate in the first period (column 3) can also be decomposed into (unconditional) chronic poverty (column 5) and unconditional upward mobility (i.e., those who were poor in the first period but who became non-poor in the current period; column 7). We rank countries in an increasing order of the headcount poverty in the most recent period. For comparison, the net change in poverty (column 8) is obtained by simply subtracting the poverty rate in the first period from that in the second period. As discussed earlier, we have to restrict the estimation samples to household heads age 25-55 in the first survey; consequently, while the poverty estimates in Table 3 are similar to those in Table 2, they are not identical.

Table 3 reveals three interesting aspects of unconditional poverty dynamics in Africa, considering the two survey periods together. First, one third of the population in Africa is chronically poor (column 5). About 17 percent of the population emerged from poverty (that is, were poor in the first period but not the second; column 7), which is slightly higher than the proportion of the population that fall into poverty (13 percent. column 6). Still, this group could be considered vulnerable to falling back into poverty. Second, countries that are similar in terms of poverty rates may be dissimilar in terms of poverty dynamics. For instance, Swaziland and Uganda both show a similar headcount poverty rate that hovers just above 40 percent in the most

recent period (column 2), but chronic poverty rate in the former (18 percent, column 5) is almost half of that in the latter (32 percent, column 5).

Third, a country may have both more headcount poverty and less chronic poverty than another at the same time. As an example, Zambia's headcount poverty rate is 64 percent in the most recent period (column 4), which is more than the corresponding figure of 62 percent for Rwanda; however, Zambia's chronic poverty rate is 6 percentage points less than that of Rwanda (45 percent vs. 51 percent respectively for the two countries, column 5). This provides supportive evidence for our earlier theoretical finding that there can be no correlation between poverty dynamics and the headcount poverty rate. Consequently, for an alternative interpretation of the data that focuses on the poverty dynamics, we graph in Figure 1 the results in Table 3, but we rank countries in an increasing order of unconditional chronic poverty in this figure.

As discussed earlier with Equations (2a) and (2b), the unconditional poverty dynamics does not take into account the information that is offered by a household's poverty status in any given year. The decomposition offered by Equations (3a) and (3b) allows us to detect mobility patterns that control for a household's poverty status. For example, even though Mauritania has the lowest poverty rate in both periods, its conditional chronic poverty out of the headcount poverty in the 2nd period is as large as 62 percent (i.e., divide column 5 by column 4), pushing it down to the middle on this ranking. Another notable example is Madagascar which, despite being the poorest country in the 2nd period, also ranks in the middle in terms of conditional chronic poverty in the same period.

But overall, the 21 countries as a whole show a reasonable performance in terms of poverty mobility. (Conditional) chronic poverty was high at 72 percent (i.e., divide column 5 by column 4). One third of the poor in the first period moved out of poverty in the second period (i.e., divide

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column 7 by column 3 to get 33 percent), which is higher than the downward mobility rate of 28 percent (i.e., divide column 6 by column 4).

The estimation results in Table 3 consider the mobility of those who are poor in either period 1 or period 2. We extend this analysis by further adding to this population those who are poor in both periods such that the population under investigation now include the *ever* poor—that is composed of the transiently poor and the chronically poor, (see Equation (4)). We plot the results in Figure 2, which ranks all countries in a decreasing order of conditional chronic poverty. For this larger population, the conditional chronic poverty and upward mobility rates for all countries are unsurprisingly lower, at 51 percent and 27 percent respectively (compared with the corresponding figures of 72 percent and 33 percent in Table 3). Still, even by this measure, the considerable proportion of chronic poverty suggests that greater efforts can be made to help lift the "poorest of the poor" out of this undesirable welfare status.

III.2. Welfare Dynamics

We now extend the analysis to include the vulnerable population and the middle class and show estimation results in Table 4. The changes in the share of each of the three welfare categories (the poor, the vulnerable, and the middle class) are shown in columns 3 to 5. The corresponding pro-poor growth scenarios to these changes are shown in column 6 in a decreasing order, so that countries with more positive growth rank higher. Countries that fall in the same growth scenario are then ranked in an increasing order for their poverty and vulnerability reduction, so that countries with more poverty reduction are ranked higher. For richer analysis and also for comparison purposes, we also show the growth in the mean consumption for the bottom 40 percent in column 7.

The region as a whole has a pro-poor growth scenario that is more positive, with a 5 percent reduction in poverty and a 28 percent increase in the size of the middle class (Table 4, last row). However, the vulnerable category also grows by 12 percent, suggesting that this expansion may be driven by (some of) those who escaped poverty. The average consumption level for the bottom 40 percent also increases by 11 percent, which provides further supportive evidence for more growth for the poorer population in the region. Five countries that have most positive pro-poor growth are, in a decreasing order of poverty reduction, Mauritania, Ethiopia, Togo, Swaziland, and Malawi. The countries with more positive pro-poor growth include Chad, Botswana, Ghana, Uganda, Congo DRC, Mozambique, Rwanda, and Tanzania, which is followed by Sierra Leone which has a positive pro-poor growth. Countries with a more negative pro-poor growth are Burkina Faso, Zambia, Madagascar, Cote d'Ivoire, Cameroon, which are followed by Senegal and Nigeria which have a most negative pro-poor growth.

As discussed earlier, our definition of pro-poor growth has a stronger focus on the poor than the growth in the consumption of the bottom 40 percent. Table 4 provides several useful illustrations of this nuanced difference. For example, Congo DRC has a quite impressive growth rate of 75 percent for the consumption of the bottom 40 percent, which is the largest growth rate for all countries; however, while its poverty reduction is also quite good at 14 percent, this figure is still lower than several other countries. Furthermore, the vulnerable population of Congo DRC expands significantly by around one and a half times rather than contracts, which can raise concerns about sustainable poverty reduction. As a result, this country has a more pro-poor growth scenario.

It can also be useful to compare the growth scenario of Congo DRC with Chad. While the latter has much lower increase in the consumption of the bottom 40 percent, it has much higher poverty

reduction and a smaller growth of the vulnerable population, which combined together ranks it higher in our definition of pro-poor growth. Clearly, it can occur that a countries can have both good poverty and vulnerability reduction and growth in the consumption of the bottom 40 percent; Mauritania stands out as a country that meets all these criteria and ranks highest out of all countries for pro-poor growth. The opposition situation can also happen, where Senegal and Nigeria rank lowest in term of pro-poor growth because of an expansion in their poor and vulnerable population; these countries also have negative growth in the consumption of the bottom 40 percent.[12]

While Table 4 focuses on the increase or decrease of the population size *across* (of) each welfare groups, Table 5 extends this analysis by probing more deeply into the dynamics *among* the groups. For the region as a whole, 14 percent of the population moves up one or two welfare categories (i.e., the sum of the upper off-diagonal cells), which is almost half a times higher than the corresponding figure for those who move down one or two welfare categories (i.e., 10 percent, or the sum of the lower off-diagonal cells). Still, a large degree of immobility exists in the region where as much as 76 percent (=100- 14-10) of the population remains in the same welfare category in both periods.[13]

III.3. Profiling of Countries and Population Groups

Following the classification employed in the recent World Bank's regional report on poverty in Africa (Beegle et al., 2016), we probe more deeply into mobility patterns by dividing countries into four groups: fragile situations, landlocked, resource-poor, and income status. These

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[12] In addition, rows 2 to 5 (Table 4) also show that poverty reduction can occur with *reduced* consumption for the bottom 40 percent. More generally, Table 4 illustrates our earlier discussion that the bottom 40 percent can comprise a wide variety of poverty situations and thus their growth scenarios. Also note that Table 4 provides a discussion of the dynamics of the different welfare categories over time; see Figure 2.1 in the Appendix for the decomposition of these categories in the most recent period. See also Dang et al. (2017) for a more detailed analysis for Senegal.
[13] We provide the specific estimates for upward and downward mobility for each country in Table 2.3 in the Appendix. This table also offers estimates for the transitions between the vulnerable group and the middle class.

classifications have also been employed by earlier studies to investigate poverty in the region. For example, Bloom and Sachs (1998) argue that landlocked countries perform worse than coastal countries because of lower competitiveness and fewer trading activities due to higher transport costs impede trade, and Frankel (2010) offers a comprehensive survey of the relationship between resources and economic growth for countries around the world. We provide the definitions of these classifications and the detailed list of the countries in Table 2.4 in the Appendix.

We show in Figure 3 the transitions among the three categories for countries, conditional on the welfare status in the 1st period, in each classification. In particular, we plot for each country upward mobility (i.e., the percentage of the population that moves up one or two welfare categories in the 2nd period) against downward mobility (i.e., the percentage of the population that moves down one or two welfare categories in the 2nd period). To help with interpretation, we plot a 45-degree line that separates countries into two groups: one group with more upward mobility, and the other group with more downward mobility (or less upward mobility); the former group are thus graphed above this line and the latter group below this line. We use the plus (+) symbol to mark the countries that are in fragile situation (Panel A), landlocked (Panel B), resource-poor (Panel C), and low-income (Panel D).

Several observations are in order for Figure 3. First, there appears to be no clear relationship between falling in a fragile situation or being landlocked and economic mobility (Panels A and B), with the countries scattering rather evenly above and below the 45-degree line. Second, resource-rich and middle-income countries mostly have more upward mobility than downward mobility. Indeed, Figure 3 indicates that out of these two groups, only Zambia—a resource-rich and middle-income country—have more downward mobility (Panels C and D).[14] Finally, notable examples in

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[14] We plot a similar graph for economic mobility versus pro-poor growth and show results in Figure 2.2. Interestingly, several countries remarkably have *both* more (or most) positive pro-poor growth scenarios and more upward mobility

all the groups stand out. For example, three countries with much higher upward mobility than downward mobility, including Botswana, Mauritania, and Ghana, are also countries that are mostly on the favorable side of the classifications (i.e., being non-fragile, coastal, resource-rich and middle-income). On the other hand, Madagascar is the country with the most downward mobility, which is also on the unfavorable side of the classification except for being coastal. The remaining countries are found somewhat in between these two extremes. For example, Burkina Faso has a good performance with more upward mobility than downward mobility, but this country for most part is on the unfavorable side of the classification except for being non-fragile. Another good performer, Cote d'Ivoire has an equal share of both sides with being coastal and resource-rich but fragile and low-income.

We turn next to examining mobility for different population groups. Figure 4 depicts the population characteristics that are associated with upward mobility (Panel A) and downward mobility (Panel B). Factors that have a stronger-than-average correlation with upward mobility include education achievement, having a female household head, and urban residence. These are also the characteristics that are more strongly associated with preventing downward mobility. Out of these factors, attaining a college degree is remarkably strongly associated with more upward (less downward) mobility.[15]

IV. Conclusion

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than downward mobility. These countries include—in a decreasing order of upward mobility—Botswana, Chad, Mauritania, Ghana, Uganda, Sierra Leone, Congo DRC, Ethiopia, and Rwanda. On the other hand, two countries, Zambia and Madagascar, also stand out as having both negative pro-poor growth scenarios and more downward mobility.

[15] These results are mostly similar to those in other contexts including countries in Latin America (Vakis et al., 2016), Middle East and North Africa (Dang and Ianchovichina, 2016), and India (Dang and Lanjouw, forthcoming).

In this paper we provide an analysis of welfare dynamics in the Sub-Saharan African region. In the absence of actual panel data, we construct synthetic panel data from cross sectional surveys using recently developed statistical methods that can offer insights into welfare dynamics for the region. Our findings generally point to strong performance for the region in terms of pro-poor growth and upward mobility. We find that one-third of the poor population escaped poverty, and the size of the middle class increased by 28 percent, albeit from a low base. Chronic poverty, however, still remains high for a number of countries. Furthermore, while many escaped poverty, they remain vulnerable, as evident from the 12-percent increase in the share of the vulnerable population.

We also find some limited evidence suggesting that resource-rich and middle-income countries mostly have more upward mobility than downward mobility, and that a college degree is strongly associated with higher upward mobility and less downward mobility, which holds true to some extent for households with a female household head and urban residence.

These mostly positive outcomes were possible because of favorable global economic conditions from which many African countries benefited in the 2000s. However, the circumstances are changing and domestic economic conditions have deteriorated for many African countries. Although the long-term goal is to increase upward mobility, or exit from poverty, the immediate and medium term goals may be to protect the incomes of the poor and to minimize downward mobility, especially for the vulnerable. Some of the policies that have been shown to achieve these goals include safety net programs and building the assets (especially human capital – education and health) of the poor and the vulnerable, such as investments in early years of the children of the poor, and providing basic package of health services.

Our findings have policy implication, but are subject to the caveat that these relationships between welfare dynamics and the country classifications or population characteristics should be interpreted as associational rather than causal. Furthermore, these results should be interpreted with respect to the specific countries that we study in this paper, and may not be extrapolated to other countries in the region or elsewhere. A fertile direction for research is thus deeper research into specific country contexts, which promises more granularities to policy advice than the regional analysis attempted in our study.

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Table 1: Vulnerability Lines at Given Vulnerability Indexes for All Countries

No	Vulnerability index (%)	Vulnerability line ($PPP)	Increase (%)	Pop. share with consumption above poverty line but less than V-line (%)
1	33	2.10	11	5
2	32	2.18	15	7
3	31	2.26	19	8
4	30	2.32	22	10
5	29	2.40	26	11
6	28	2.48	31	12
7	27	2.58	36	14
8	26	2.64	39	15
9	25	2.74	44	17
10	24	2.84	49	18
11	23	2.92	54	19
12	22	3.02	59	21
13	21	3.16	66	22
14	20	3.28	73	24
15	19	3.44	81	26
16	18	3.62	91	28
17	17	3.78	99	29
18	16	4.06	114	32
19	15	4.30	126	34
20	14	4.74	149	37
21	13	5.20	174	39
22	12	5.88	209	42
23	11	7.00	268	46
24	10	9.30	389	51

Note: Vulnerability lines are in 2011 PPP dollars per capita per day. The relative increases of the vulnerability line from the poverty line is shown under the column "Increase" (column 4). All numbers are estimated with synthetic panel data and weighted with population weights. The incremental value for iteration is 0.02 dollars.

Table 2: Survey Years and Headcount Poverty by Country (percentage)

No	Country	Survey name		Headcount poverty		Net change
			Survey years	1st period	2nd period	
1	Bostwana	Botswana Core Welfare Indicators Survey (BCWIS)	2002-2009	29.8	18.2	-11.6
2	Burkina Faso	Enquête burkinabé sur les conditions de vie des ménages (EBCVM)	2003-2009	57.3	55.3	-2.0
3	Cameroon	Enquete Camerounaise Aupres des Menages (ECAM)	2001-2007	23.1	29.3	6.2
4	Chad	Enquête sur la consommation des ménages et le secteur informel au Tchad (ECOSIT)	2003-2011	62.9	38.4	-24.5
5	Congo, Dem. Rep.	Enquête 1-2-3 sur l'Emploi, le Secteur Informel et les Conditions de Vie des Ménages (E123)	2004-2012	91.2	77.2	-14.0
6	Cote d'Ivoire	Enquête sur le Niveau de Vie des Ménages	2002-2008	23.0	29.0	6.0
7	Ethiopia	Household Income Consumption Expenditure Survey (HICES)	2004-2010	36.3	33.5	-2.8
8	Ghana	Ghana Living Standards Survey (GLSS)	1998-2005	33.8	25.1	-8.7
9	Madagascar	Enquêtes Périodiques auprès des Ménages (EPM)	2005-2010	74.1	81.8	7.7
10	Malawi	Integrated Household Survey (IHS)	2004-2010	73.6	70.9	-2.7
11	Mauritania	Enquête permanente sur les conditions de vie des ménages	2004-2008	14.4	10.9	-3.5
12	Mozambique	Inquérito Sobre Orçamento Familiar (IOF)	2002-2008	80.6	69.1	-11.5
13	Nigeria	General Household Survey-Panel (GHS)	2011-2013	20.4	20.2	-0.2
14	Rwanda	Integrated Household Living Conditions Survey (EICV)	2005-2010	68.7	60.4	-8.3
15	Senegal	Enquête de Suivi de la Pauvreté au Sénégal (ESPS)	2005-2011	37.6	38.0	0.4
16	Sierra Leone	Sierra Leone Integrated Household Survey (SLIHS)	2003-2011	58.6	52.3	-6.3
17	Swaziland	Household Income and Expenditure Survey (HIES)	2000-2009	48.4	42.0	-6.4
18	Tanzania	Household Budget Survey (HBS)	2007-2011	55.1	49.0	-6.1
19	Togo	Questionnaire Unifie Des Indicateurs de base du Bien-etre (QUIBB)	2006-2011	55.6	54.2	-1.4
20	Uganda	Uganda National Household Survey (UNHS)	2005-2009	53.2	41.5	-11.7
21	Zambia	Living Conditions Monitoring Survey (LCMS)	2006-2010	60.5	64.4	3.9
		Regional average		50.4	45.7	-4.7

Note: Authors' calculation based on household survey data. Poverty rates are estimated without any age restriction. The poverty line is set at $1.90/day in 2011 PPP dollars for both periods. Countries are sorted in an alphabetic order. The regional average is a simple average (unweighted).

Table 3: Net and Gross Changes in Poverty over Time for Each Country (percentage)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No	Country	Headcount poverty in 1st period	Headcount poverty in 2nd period			Upward mobile	Net change
			Total	Decomposition			
				Chronic poverty	Downward mobile		
1	Mauritania	14.6	10.5	6.5	4.0	8.1	-4.0
2	Botswana	25.1	17.6	8.9	8.7	16.2	-7.5
3	Nigeria	19.8	21.5	11.7	9.8	8.1	1.7
4	Ghana	33.1	26.1	20.4	5.7	12.7	-7.0
5	Cote d'Ivoire	23.5	28.5	17.3	11.2	6.2	5.0
6	Cameroon	21.5	29.6	13.9	15.7	7.6	8.1
7	Ethiopia	38.8	37.2	28.6	8.6	10.2	-1.6
8	Senegal	37.2	39.0	29.5	9.5	7.7	1.8
9	Chad	64.2	40.7	24.8	15.9	39.4	-23.4
10	Swaziland	44.2	43.0	18.0	25.0	26.2	-1.3
11	Uganda	54.5	43.4	32.4	11.0	22.1	-11.1
12	Tanzania	54.1	48.8	27.6	21.2	26.5	-5.3
13	Togo	54.3	53.4	41.1	12.3	13.2	-0.9
14	Sierra Leone	58.4	53.5	37.8	15.7	20.6	-4.9
15	Burkina Faso	54.6	56.9	47.6	9.3	7.0	2.3
16	Rwanda	68.9	62.0	50.8	11.2	18.1	-6.9
17	Zambia	58.7	63.5	45.1	18.4	13.6	4.9
18	Mozambique	80.8	69.9	51.1	18.8	29.7	-11.0
19	Malawi	73.5	72.5	54.1	18.4	19.4	-1.1
20	Congo, DRC	91.7	78.0	72.8	5.2	18.9	-13.7
21	Madagascar	74.3	82.3	59.9	22.4	14.4	8.0
	Regional average	49.8	46.6	33.3	13.2	16.5	-3.2

Note: Authors' calculation based on household survey data. Household heads' age is between 25 and 5: in the first survey round and adjusted accordingly for the second survey round. The poverty line is set a $1.9/ day in 2011 PPP dollars for both periods. Estimates for chronic poverty are based on the synthetic panels. Countries are ranked in an increasing order of poverty in the 2nd period. Columns 5 and 6 add u to column 4, and columns 5 and 7 add up to column 3. Column 8 is obtained by subtracting column 4 from column 3. The regional average is a simple average (unweighted).

Table 4: Change in Poverty and Shared Prosperity for Each Country (percentage)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
No	Country	Growth in the population share of each welfare category			Pro-poor growth scenario	Growth in mean consumption for bottom 40%
		Poor	Vulnerable	Middle class		
1	Mauritania	-27.7	-18.8	34.7	***	13.2
2	Ethiopia	-3.9	-1.2	26.7	***	-4.0
3	Togo	-1.4	-4.5	14.9	***	-7.8
4	Swaziland	-1.3	-1.3	4.0	***	-7.4
5	Malawi	-1.0	-3.8	28.4	***	-8.1
6	Chad	-36.1	42.6	192.1	**	35.3
7	Botswana	-28.7	6.6	12.5	**	28.9
8	Ghana	-20.7	4.4	21.7	**	14.9
9	Uganda	-19.1	26.3	24.9	**	21.3
10	Congo, DRC	-13.5	149.7	249.4	**	75.0
11	Mozambique	-12.6	70.0	30.9	**	20.9
12	Rwanda	-8.7	19.3	24.4	**	27.0
13	Tanzania	-6.7	10.5	3.6	**	14.6
14	Sierra Leone	-6.5	16.6	-6.7	*	14.9
15	Burkina Faso	6.3	-4.4	-18.0	--	7.6
16	Zambia	7.8	-12.0	-12.1	--	3.7
17	Madagascar	9.5	-32.5	-23.6	--	-5.6
18	Cote d'Ivoire	15.1	-5.3	-5.6	--	-3.4
19	Cameroon	34.5	-12.3	-8.9	--	-5.7
20	Senegal	0.9	3.3	-7.9	---	-3.1
21	Nigeria	5.5	1.4	-6.4	---	-1.7
	Regional average	-5.2	12.1	27.6	**	11.0

Note: Authors' calculation based on household survey data. Household heads' age is between 25 and 55 in the first survey round and adjusted accordingly for the second survey round. The poverty line and vulnerability line are respectively set at $1.9/day and $4.3/day in 2011 PPP dollars for both periods. Pro-poor growth scenarios are based on the classification provided in Table 1.3 in Appendix 1. Countries are ranked first in a decreasing order of pro-poor growth scenario, and then in an increasing order of growth in the population share of poverty and vulnerability. The regional average is a simple average (unweighted).

Table 5: Transition Dynamics among the Three Welfare Groups, All Countries (percentage)

| | | Second year | | | |
		Poor	Vulnerable	Middle class	Total
First year	**Poor**	35.9	8.0	0.1	44.0
		(0.1)	(0.0)	(0.0)	(0.1)
	Vulnerable	5.2	22.3	5.7	33.2
		(0.0)	(0.0)	(0.0)	(0.0)
	Middle class	0.1	4.3	18.4	22.8
		(0.0)	(0.0)	(0.1)	(0.1)
	Total	41.2	34.6	24.2	100
		(0.1)	(0.0)	(0.1)	

Note: Authors' calculation based on household survey data. Bootstrap standard errors in parentheses are estimated with 1,000 bootstraps. Household heads' age is between 25 and 55 in the first survey round and adjusted accordingly for the second survey round. The poverty line and vulnerability line are respectively set at $1.9/day and $4.3/day in 2011 PPP dollars for both periods, with the latter corresponding to a vulnerability index of 0.15. Estimates are obtained with synthetic panel data and weighted with population weights where the second survey round is used as the base year. Estimation sample size of the base year is 149,820 households.

Figure 1: Decomposition of Unconditional Poverty Mobility
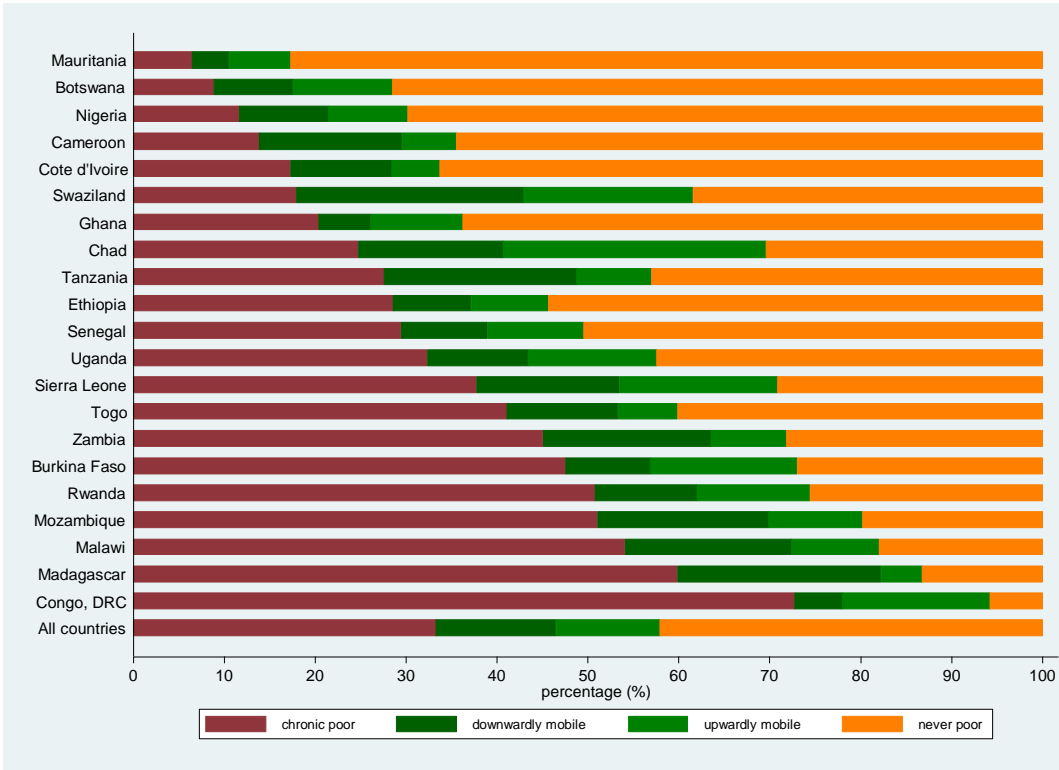
Figure 2: Proportions of Chronic Poverty, Downward Mobility, and Upward Mobility out of Those Who Were Ever Poor
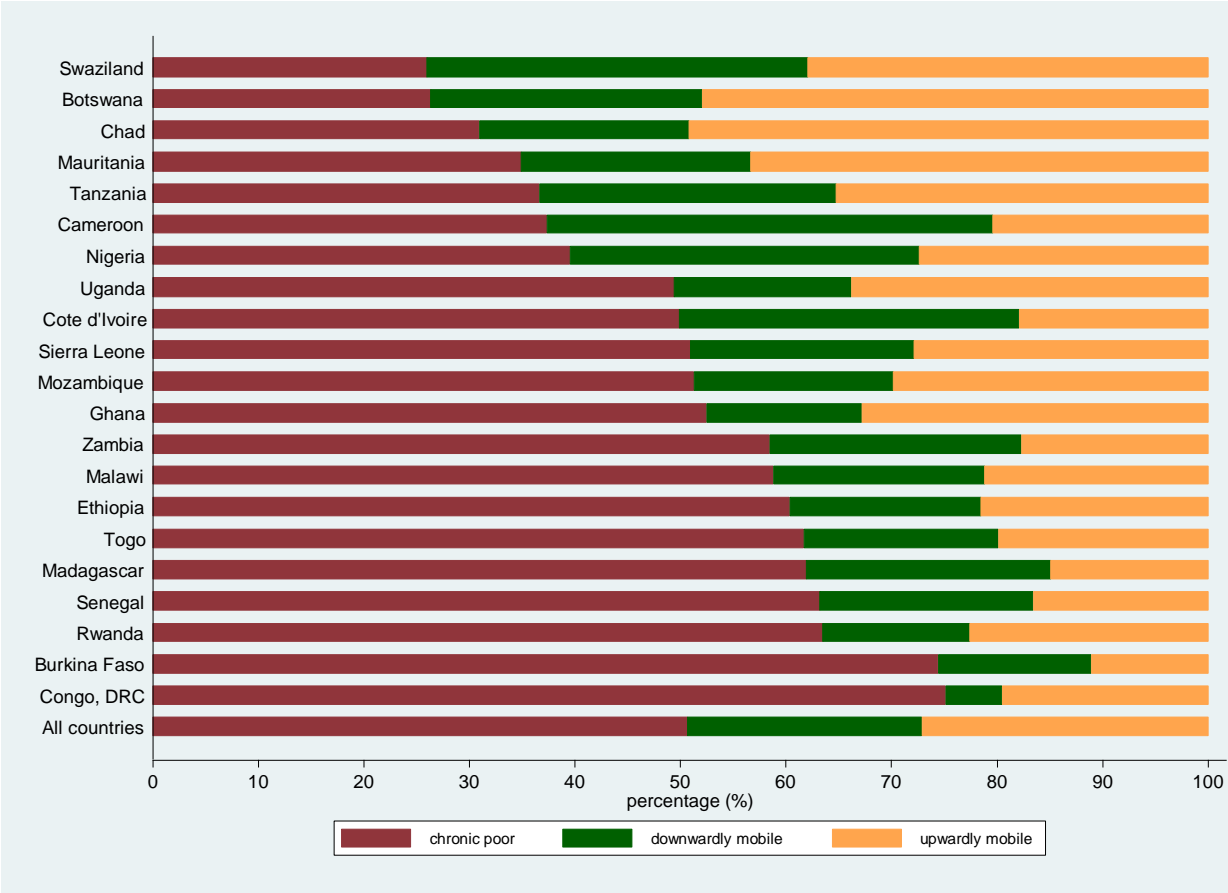
Figure 3: Upward Mobility and Downward Mobility by Country Groupings

Note: '+' represents countries that are fragile, landlocked, resource-poor or low-income in Panels A, B, C, and D respectively.

Figure 4: Upward Mobility and Downward Mobility by Population Groups

Note: dashed lines represent the regional averages for upward mobility & downward mobility respectively.
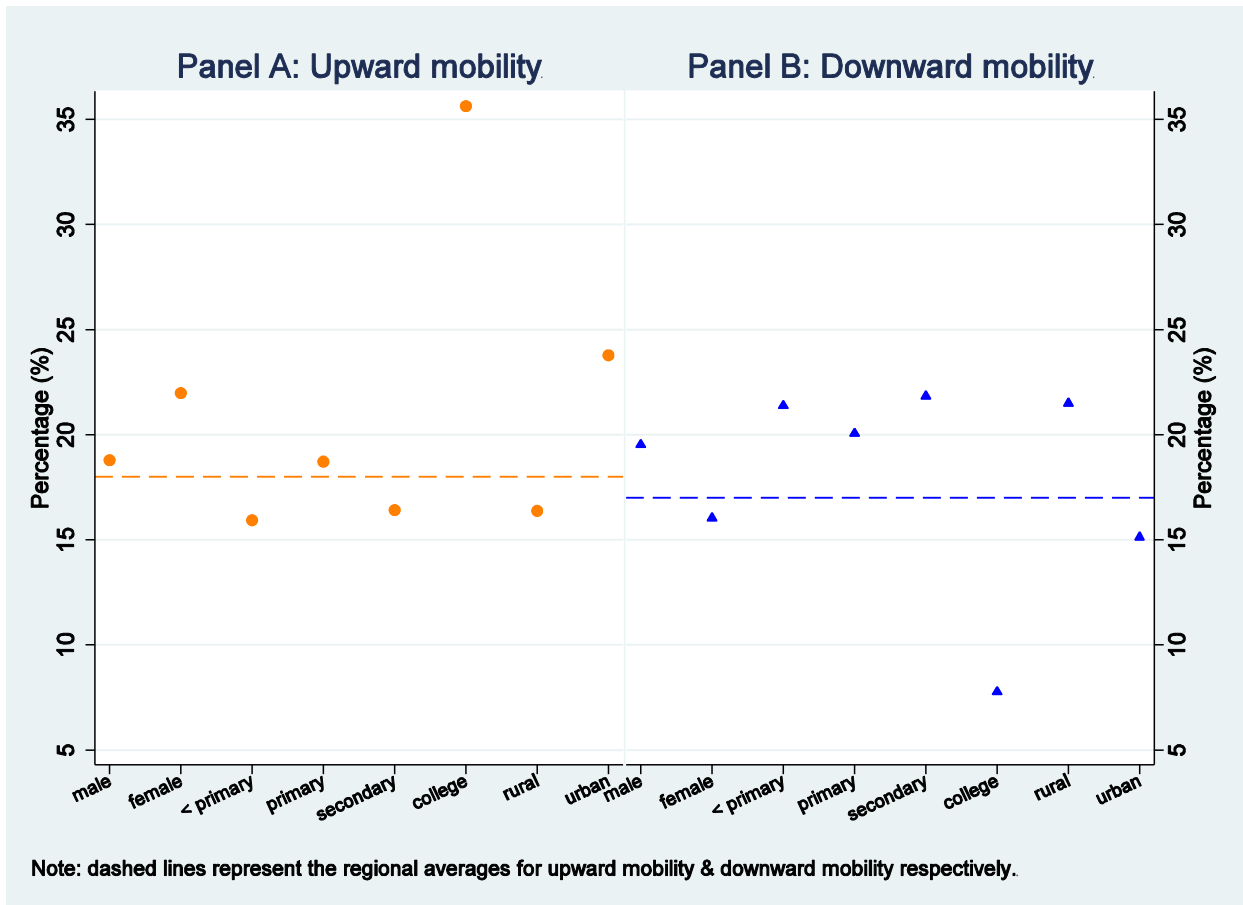
Appendix 1: Overview of Synthetic Panel Methods

We provide an overview of the methods that construct synthetic panels and vulnerability lines developed by Dang et al. (2014) and Dang and Lanjouw (2013) in this appendix. Let x_{ij} be a vector of household characteristics observed in survey round j (j= 1 or 2) that are also observed in the other survey round for household i, i= 1,…, N. These household characteristics can include such time-invariant variables as ethnicity, religion, language, place of birth, parental education, and other time-varying household characteristics if retrospective questions about the round-1 values of such characteristics are asked in the second round survey. To reduce spurious changes due to changes in household composition over time, we usually restrict the estimation samples to household heads age, say 25 to 55 in the first cross section and adjust this age range accordingly in the second cross section.[16]

Then let y_{ij} represent household consumption or income in survey round j, j= 1 or 2. The linear projection of household consumption (or income) on household characteristics for each survey round is given by

$$y_{ij} = \beta_j' x_{ij} + \varepsilon_{ij} \qquad (1.1)$$

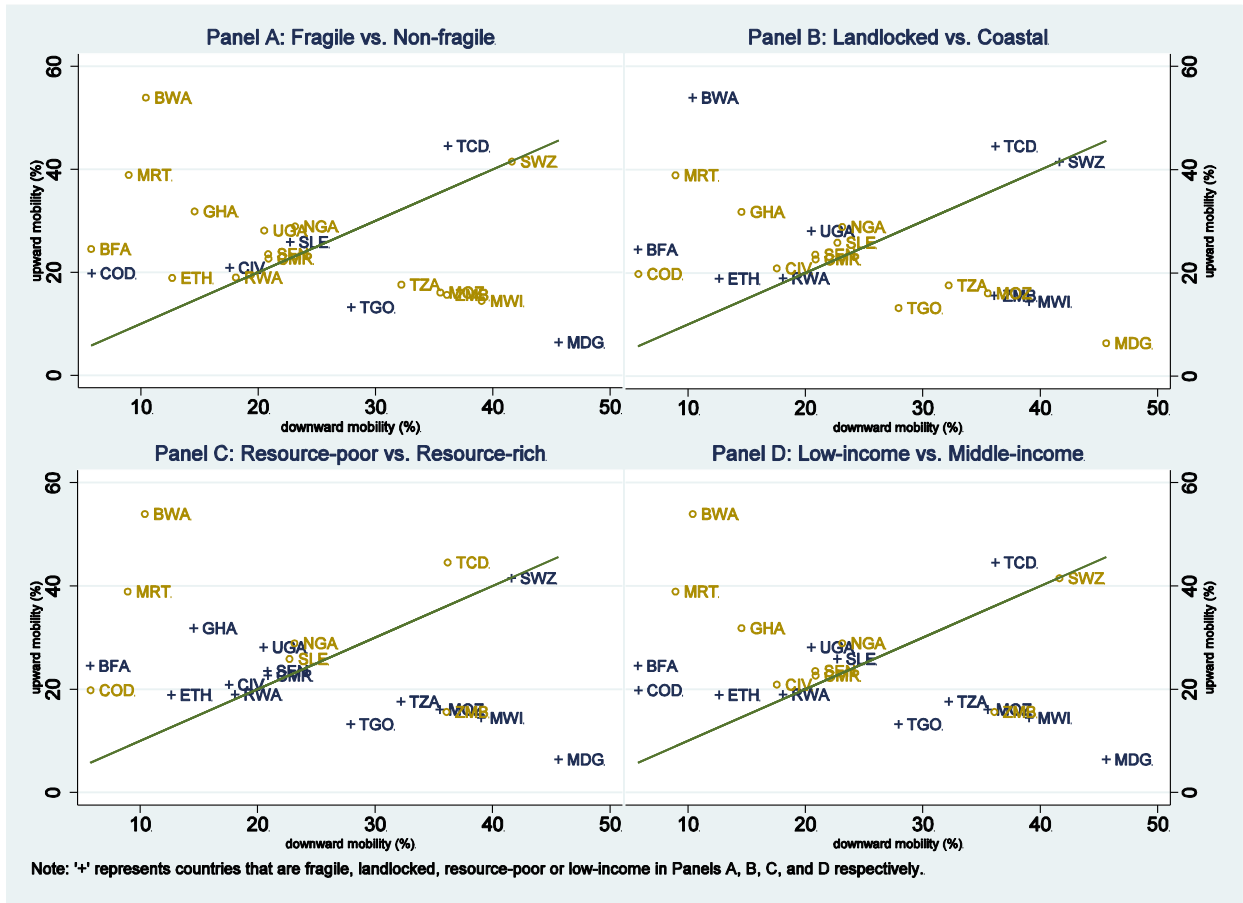Let z_j be the poverty line in period j. We are interested in knowing the unconditional measures of poverty mobility such as

$$P(y_{i1} < z_1 \ and \ y_{i2} > z_2) \qquad (1.2)$$

which represents the percentage of households that are poor in the first survey round (year) but nonpoor in the second survey round, or the conditional measures such as

$$P(y_{i2} > z_2 \mid y_{i1} < z_1) \qquad (1.3)$$

which represents the percentage of poor households in the first round that escape poverty in the second round.

If true panel data are available, we can straightforwardly estimate the quantities in (1.2) and (1.3); but in the absence of such data, we can use synthetic panels to study mobility. To operationalize the framework, we make two standard assumptions. First, we assume that the underlying population being sampled in survey rounds 1 and 2 are identical such that their time-invariant characteristics remain the same over time. More specifically, coupled with equation (1), this implies the conditional distribution of expenditure in a given period is identical whether it is conditional on the given household characteristics in period 1 or period 2 (i.e., $x_{i1} = x_{i2}$ implies $y_{i1}|x_{i1}$ and $y_{i1}|x_{i2}$ have identical distributions). Second, we assume that ε_{i1} and ε_{i2} have a bivariate normal distribution with positive correlation coefficient ρ and standard deviations σ_{ϵ_1} and σ_{ϵ_2} respectively. Quantity (1.2) can be estimated by

$$P(y_{i1} < z_1 \ and \ y_{i2} > z_2) = \Phi_2\left(\frac{z_1 - \beta_1' x_{i2}}{\sigma_{\varepsilon_1}}, -\frac{z_2 - \beta_2' x_{i2}}{\sigma_{\varepsilon_2}}, -\rho\right) \qquad (1.4)$$

where $\Phi_2(.)$ stands for the bivariate normal cumulative distribution function (cdf) (and $\phi_2(.)$ stands for the bivariate normal probability density function (pdf)). Note that in Equation (1.4), the estimated parameters obtained from data in both survey rounds are applied to data from the second

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[16] This age range is usually used in traditional pseudo-panel analysis but can vary depending on the cultural and economic factors in each specific setting.

survey round (x_2) (or the base year) for prediction, but we can use data from the first survey round as the base year as well. It is then straightforward to estimate quantity (1.3) by dividing quantity (1.2) by $\Phi\left(\dfrac{z_1 - \beta_1' x_{i2}}{\sigma_{\varepsilon_1}}\right)$, where $\Phi(.)$ stands for the univariate normal cumulative distribution function (cdf).

In Equation (1.4), the parameters β_j and σ_{ε_j} are estimated from Equation (1), and ρ can be estimated using an approximation of the correlation of the cohort-aggregated household consumption between the two surveys ($\rho_{y_{c1}y_{c2}}$). In particular, given an approximation of $\rho_{y_{c1}y_{c2}}$, where c indexes the cohorts constructed from the household survey data, the partial correlation coefficient ρ can be estimated by

$$\rho = \frac{\rho_{y_{i1}y_{i2}} \sqrt{\mathrm{var}(y_{i1})\,\mathrm{var}(y_{i2})} - \beta_1'\,\mathrm{var}(x_i)\beta_2}{\sigma_{\varepsilon_1}\sigma_{\varepsilon_2}}$$

Note that the standard errors of estimates based on the synthetic panels can in fact be even smaller than that of the true (or design-based) rate if there is a good model fit (or the sample size in the target survey is significantly larger than that in the base survey; see Dang and Lanjouw (2013) for more discussion).

Equation (1.4) can be extended to the more general case of vulnerability. For example, we can estimate the percentage of poor households in the first period that escape poverty but still remain vulnerable in the second period (joint probability) as

$$P(y_{i1} < z_1 \text{ and } z_2 < y_{i2} < v_2) = \Phi_2\left(\frac{z_1 - \beta_1' x_{i2}}{\sigma_{\varepsilon_1}}, \frac{v_2 - \beta_2' x_{i2}}{\sigma_{\varepsilon_2}}, \rho\right) - \Phi_2\left(\frac{z_1 - \beta_1' x_{i2}}{\sigma_{\varepsilon_1}}, \frac{z_2 - \beta_2' x_{i2}}{\sigma_{\varepsilon_2}}, \rho\right)$$

(1.5)

Other formulae and more detailed derivations for other measures of vulnerability dynamics are provided in Dang and Lanjouw (in press).

We provide in Table 1.1 below a sample of the regression parameters and the estimates for chronic poverty with their standard errors.

Table 1.1: Household Consumption Models

	Country											
	Cote d'Ivoire		Mozambique		Malawi		Senegal		Togo		Zambia	
	2002	**2008**	**2002**	**2008**	**2004**	**2010**	**2005**	**2011**	**2006**	**2011**	**2006**	**2010**
Head is female	0.054**	0.029	0.097***	0.099***	0.024	0.096***	0.099***	0.263***	0.196***	0.157***	0.066***	0.123***
	(0.024)	(0.022)	(0.023)	(0.021)	(0.018)	(0.020)	(0.017)	(0.025)	(0.022)	(0.029)	(0.016)	(0.016)
Head's age	-0.011***	-0.008***	0.002	0.005***	-0.005***	0.007***	-0.010***	-0.003**	-0.007***	0.001	-0.010***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Head has less than primary school	0.147***	0.154*	0.288***	0.090***	0.142***	0.253***	0.060***	0.077**	0.137***	0.255***	0.169***	-0.000
	(0.032)	(0.083)	(0.024)	(0.024)	(0.018)	(0.022)	(0.021)	(0.036)	(0.025)	(0.034)	(0.026)	(0.028)
Head completes primary school	0.184***	0.188***	0.693***	0.368***	0.232***	0.362***	0.141***	0.226***	0.216***	0.354***	0.327***	0.150***
	(0.023)	(0.022)	(0.047)	(0.035)	(0.023)	(0.027)	(0.022)	(0.034)	(0.029)	(0.039)	(0.043)	(0.042)
Head completes secondary school	0.399***	0.428***	1.231***	0.879***	0.570***	0.715***	0.423***	0.444***	0.403***	0.520***	0.688***	0.472***
	(0.025)	(0.022)	(0.052)	(0.042)	(0.023)	(0.028)	(0.025)	(0.039)	(0.022)	(0.030)	(0.027)	(0.028)
Head completes college	0.977***	0.896***	2.068***	1.742***	1.414***	1.448***	0.753***	0.909***	0.897***	1.179***	1.585***	1.421***
	(0.035)	(0.044)	(0.078)	(0.064)	(0.050)	(0.046)	(0.031)	(0.053)	(0.042)	(0.055)	(0.031)	(0.030)
Urban	0.375***	0.451***	0.408***	0.366***	0.514***	0.707***	0.561***	0.482***	0.760***	0.617***	0.729***	0.655***
	(0.018)	(0.018)	(0.022)	(0.020)	(0.020)	(0.023)	(0.015)	(0.023)	(0.019)	(0.024)	(0.015)	(0.015)
Constant	7.344***	7.161***	5.749***	5.811***	6.209***	5.478***	6.906***	6.573***	6.386***	5.932***	6.116***	5.991***
	(0.044)	(0.048)	(0.047)	(0.056)	(0.035)	(0.047)	(0.037)	(0.062)	(0.044)	(0.063)	(0.039)	(0.042)
σ	0.77	0.78	0.75	0.77	0.59	0.67	0.62	0.670	0.61	0.69	0.78	0.77
Adjusted R2	0.20	0.18	0.29	0.24	0.28	0.35	0.28	0.26	0.43	0.34	0.47	0.46
ρ	0.87		0.75		0.66		0.78		0.82		0.69	
N	7976	8417	6171	6735	7627	6870	8811	4076	5431	3845	14360	13837
Estimates for chronic poverty using synthetic panels	17.3		51.1		54.1		29.5		41.1		45.1	
	(0.1)		(0.2)		(0.3)		(0.3)		(0.4)		(0.2)	

Note: *p<0 .1, **p<0.05, ***p<0.01. Standard errors are in parentheses. Household heads' ages are restricted to between 25 and 55 for the first survey round and adjusted accordingly for the second survey round.

Appendix 2: Additional Tables and Figures

Table 2.1: Typology of Welfare Transition Dynamics over Two Periods

Scenario	Pro-poor Growth	Welfare Category			Notes
		1st group	2nd group	3rd group	
		Lowest income	Middle income	Top income	
1	Strongest/ Most positive	-	-	+	first and second group reduce, and third group expands
2	More positive	-	+	+	first group reduces, and second and third group expands
3	Positive	-	+	-	first and third group reduce, and second group expands
4	Negative	+	-	+	first and third group expand, and second group reduces
5	More negative	+	-	-	first group expands, and second and third group reduce
6	Weakest/ Most negative	+	+	-	first and second group expand, and third group reduces

Note: The signs (-) and (+) respectively stand for decrease and increase. Pro-poor growth is defined as the dynamics that are most beneficial to the different categories in this order: Lowest Income, Middle Income, and Top Income. This typology is modified based on Dang and Lanjouw (2016).

Table 2.2: Change in Shared Prosperity for Each Country (percentage)

(1)	(2)	(3)	(4)	(5)	(6)
No	Country	Growth in the population share of each welfare category			Growth in mean consumption for all groups
		Poor	Vulnerable	Middle class	
1	Congo, DRC	-13.5	149.7	249.4	69.7
2	Chad	-36.1	42.6	192.1	53.5
3	Mozambique	-12.6	70.0	30.9	21.3
4	Uganda	-19.1	26.3	24.9	20.7
5	Rwanda	-8.7	19.3	24.4	20.5
6	Ghana	-20.7	4.4	21.7	20.3
7	Mauritania	-27.7	-18.8	34.7	12.4
8	Malawi	-1.0	-3.8	28.4	5.9
9	Tanzania	-6.7	10.5	3.6	5.6
10	Togo	-1.4	-4.5	14.9	3.8
11	Ethiopia	-3.9	-1.2	26.7	2.5
12	Sierra Leone	-6.5	16.6	-6.7	0.5
13	Nigeria	5.5	1.4	-6.4	-0.5
14	Botswana	-28.7	6.6	12.5	-0.5
15	Senegal	0.9	3.3	-7.9	-2.5
16	Swaziland	-1.3	-1.3	4.0	-3.8
17	Zambia	7.8	-12.0	-12.1	-4.4
18	Burkina Faso	6.3	-4.4	-18.0	-5.6
19	Cote d'Ivoire	15.1	-5.3	-5.6	-6.9
20	Cameroon	34.5	-12.3	-8.9	-10.5
21	Madagascar	9.5	-32.5	-23.6	-16.3
	Regional average	-5.2	12.1	27.6	8.8

Note: Authors' calculation based on household survey data. Household heads' age is between 25 and 55 in the first survey round and adjusted accordingly for the second survey round. The poverty line and vulnerability line are respectively set at $1.9/day and $4.3/day in 2011 PPP dollars for both periods. Pro-poor growth scenarios are based on the classification provided in Table 1.3 in Appendix 1. Countries are ranked first in a decreasing order of mean consumption for all the three groups, and then the Poor, the Vulnerable and the Middle Class.

Table 2.3: Transition Dynamics among the Three Welfare Groups for Each Country (percentage)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No	Country	Proportion of the vulnerable		Proportion of the middle class		Overall downward mobility	Overall upward mobility
		remained in vunerability	moved to middle class	fell to vulnerability	remained in middle class		
1	Botswana	37.1	53.1	9.8	89.3	10.4	53.9
2	Chad	41.5	29.3	36.8	46.7	36.2	44.5
3	Swaziland	34.6	30.8	29.8	51.1	41.6	41.5
4	Mauritania	59.2	34.6	10.9	89.0	8.9	38.9
5	Ghana	55.4	30.8	15.1	84.5	14.6	31.8
6	Nigeria	60.0	22.7	28.9	69.5	23.1	28.9
7	Uganda	56.3	25.0	22.6	76.0	20.5	28.1
8	Sierra Leone	64.5	17.0	36.8	61.7	22.7	25.8
9	Burkina Faso	72.4	22.6	8.1	91.9	5.7	24.5
10	Senegal	60.4	20.7	23.9	75.3	20.8	23.5
11	Cameroon	62.9	18.9	22.8	76.4	20.9	22.6
12	Cote d'Ivoire	63.7	19.3	17.7	81.9	17.6	20.9
13	Congo, DRC	61.0	33.7	10.1	89.9	5.8	19.8
14	Rwanda	66.3	17.0	20.7	78.9	18.1	19.0
15	Ethiopia	73.7	15.7	18.4	81.6	12.7	18.9
16	Tanzania	60.4	12.4	37.4	60.1	32.2	17.6
17	Mozambique	52.4	14.0	35.3	59.9	35.5	16.1
18	Zambia	47.3	15.9	29.5	64.9	36.1	15.6
19	Malawi	47.7	13.0	33.0	61.7	39.1	14.4
20	Togo	60.5	12.6	28.7	70.1	27.9	13.2
21	Madagascar	50.6	5.2	48.0	47.7	45.6	6.4
	Regional average	56.6	22.1	25.0	71.8	23.6	25.0

Note: Authors' calculation based on household survey data. Household heads' age is between 25 and 55 in the first survey round and adjusted accordingly for the second survey round. The poverty line and vulnerability line are respectively set at $1.9/day and $4.3/day in 2011 PPP dollars for both periods. Countries are ranked in a decreasing order of overall upward mobility. Overall downward mobility (column 7) represents the proportion of the population that moved up one or two income categories from the Poor and Vulnerable groups. Overall upward mobility (column 8) represents the proportion of the population that moved down one or two income categories from the Vulnerable and Middle Class groups. The regional average is a simple average (unweighted).

Table 2.4: Country Classifications

No	Country Name	Country code	Fragile Situations	Landlocked	Income grouping	Resource-poor
1	Botswana	BWA	No	Yes	Middle Income	No
2	Burkina Faso	BFA	No	Yes	Low Income	Yes
3	Cameroon	CMR	No	No	Middle Income	Yes
4	Chad	TCD	Yes	Yes	Low Income	No
5	Congo, Dem. Rep.	ZAR	Yes	No	Low Income	No
6	Cote d'Ivoire	CIV	Yes	No	Middle Income	Yes
7	Ethiopia	ETH	No	Yes	Low Income	Yes
8	Ghana	GHA	No	No	Middle Income	Yes
9	Madagascar	MDG	Yes	No	Low Income	Yes
10	Malawi	MWI	No	Yes	Low Income	Yes
11	Mauritania	MRT	No	No	Middle Income	No
12	Mozambique	MOZ	No	No	Low Income	Yes
13	Nigeria	NGA	No	No	Middle Income	No
14	Rwanda	RWA	No	Yes	Low Income	Yes
15	Senegal	SEN	No	No	Middle Income	Yes
16	Sierra Leone	SLE	Yes	No	Low Income	No
17	Swaziland	SWZ	No	Yes	Middle Income	Yes
18	Tanzania	TZA	No	No	Low Income	Yes
19	Togo	TGO	Yes	No	Low Income	Yes
20	Uganda	UGA	No	Yes	Low Income	Yes
21	Zambia	ZMB	No	Yes	Middle Income	No

Note: Resource-rich countries include countries that had average rents from natural resources (excluding forests) that exceeded 10 percent of GDP in 2006–11 and countries with diamonds (Botswana). Fragile countries are countries that appear on the World Bank's 2015 harmonized list of fragile situations, which classifies countries as fragile if they (a) had an average Country Policy and Institutional Assessment (CPIA) rating of 3.2 or less or (b) hosted a UN or regional peace-keeping or peace-building mission in the previous three years. Country income categories are from World Development Indicators. These classifications are based on Beegle et al. (2016).

Figure 2.1: Proportions of the Poor, the Vulnerable, and the Middle Class in Most Recent Year

percentage (%)

poor   vulnerable   middle class

Figure 2.2: Upward Mobility, Downward Mobility and Pro-poor Growth

Note: pro-poor growth scenarios are represented by circles (most positive), diamonds (more positive), squares (positive), triangles (more negative), and crosses (most negative). Positive and negative growth scenarios are depicted in orange and blue respectively.