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Reconceptualizing Global Multidimensional Poverty Measurement, with Illustration on Nigerian Data

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Abstract

Multidimensional poverty measures can in theory make well-being comparisons that are less biased than those solely based on monetary poverty. However, global multidimensional poverty measures suffer in practice from limitations that have led to credible criticisms. This paper presents the case for multidimensional poverty measures, two criticisms against their current implementations, as well as recently proposed solutions to improve on these criticisms. The paper develops a method for implementing these solutions in practice. The resulting well-being indicator is used to compare well-being across Nigerian states in 2019. This empirical illustration suggests that these solutions may substantially affect well-being comparisons. The paper also quantifies the potential bias inherent to comparing well-being solely based on monetary poverty. The results find substantially different well-being comparisons between the proposed well-being indicator and monetary poverty even though monetary poverty was (i) high in Nigeria in 2019 and (ii) very heterogeneously distributed across Nigerian states; and (iii) is integrated as one component of the proposed well-being indicator. The paper aims to improve global multidimensional poverty measures by making them more consistent with preference theory and by incorporating the direct impact of mortality, which deprives individuals of the most important functioning.

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Section 1: Motivation

Well-being indicators are important tools in any development agenda. These indicators allow monitoring progress and provide the basis for evidence-based policy making. They are necessary to allocate budgets where well-being is lowest. They help identify which policy is best suited to alleviate the most pressing needs.

In theory, multidimensional poverty measures (MPMs) constitute an appealing type of well-being indicator. The reason is that they can simultaneously account for the multi-dimensional nature of well-being and for the unequal distribution of well-being. In the decades following World War II, average monetary aggregates like GDP per capita were the mainstream indicators used to monitor development. Two main criticisms have been raised against GDP per capita (Hicks and Streeten, 1979; Fleurbaey, 2009). First, GDP per capita does not account for the unequal distribution of consumption in the population. The main response from policy makers to this "distributional" concern has been the development and adoption of monetary poverty indicators (Ravallion, 2015). Second, monetary indicators provide a too narrow coverage of human well-being because they entirely ignore key non-monetary dimensions of well-being. In principle, MPMs can account for both the "distributional" and "dimensional" concerns.

Among the different types of well-being indicators that account for both the "distributional concern" and the "dimensional concern",[4] MPMs stand out because they are widely used in practice. MPMs have for instance been adopted as official indicators by dozens of countries (Unicef, 2021). MPMs have also been adopted to track progress at the global level. The two highest-profile global MPMs are the World Bank's MPM and OPHI-UNDP's global MPI. The popularity of MPMs is in large part attributable to the relative simplicity of the methodology that Alkire and Foster (2011) proposed for their implementation. In a nutshell, the Alkire-Foster methodology identifies an individual as (multidimensionally) poor when the weighted sum of her deprivations surpasses some identification threshold (see Section 2 for more details).

However, the MPMs used in practice face credible criticisms related to their implementations. First, the way in which the Alkire-Foster methodology aggregates across dimensions seems unrelated to preferences (Ravallion, 2011). Non-paternalism requires that the MPM should make similar trade-offs across dimensions as those made by (multidimensionally) poor individuals.[5] Currently, it is unclear how the necessary choices -- weights, deprivation cutoffs, identification threshold – can be made in a way that is consistent with preferences. Second, the main global MPMs either entirely ignore or poorly capture key dimensions of well-being. Although the list of dimensions that are deemed most relevant to well-being is controversial, we argue that an indicator capturing low well-being at the global level should at least account for inadequate consumption, bad health, and premature death.[6] Clearly, data constraints complicate the monitoring of an MPM that simultaneously accounts for the monetary dimension, health, and mortality.

[4] See Fleurbaey (2009) for a review of alternative types of well-being indicators.

[5] Ravallion (2012) argue against aggregations that make implausible trade-offs across dimensions.

[6] The World Bank's MPM ignores mortality and health. We note that this global MPM does account for some health-specific indicators in its five-dimensions version, but they capture health inputs rather than health outcomes and provide a rather narrow coverage of the health dimension. In turn, the global MPI ignores the monetary dimension and provides a narrow coverage of mortality. We note that the global MPI does account to some extent for the indirect impact that mortality has on the relatives of the deceased, but it entirely ignores the direct impact of mortality on the deceased.

However, besides data constraints, another reason why global MPMs barely cover mortality is related to conceptualization. At the time of their design, it was unclear how to meaningfully integrate mortality into MPMs, which may perhaps explain why the direct impact of mortality was ignored.

Recent papers study these two criticisms and propose theoretical solutions aimed at improving on these issues while remaining simple enough to allow for straightforward application. First, Decerf (2023) shows that a preference-based definition of the (multidimensionally) poor distinguishes two types of poor individuals: those who have low well-being because they have an extremely low achievement in at least one dimension ("extremors") and those who have low well-being because they cumulate moderately low achievements in several dimensions ("cumulators"). That paper proposes a refinement of the Alkire-Foster methodology able to simultaneously identify both types of (multidimensionally) poor individuals but does not provide an illustration of how this refinement could be implemented in practice. Second, Baland et al. (2021) and (2022) study how to integrate the direct impact of mortality on the deceased into poverty measurement. The difficulty is that poverty, which affects the quality of life, is measured in a given year whereas the direct impact of mortality, which affects the quantity of life, can only be properly accounted for by taking a lifecycle perspective. These papers show that the direct impact of mortality should be integrated into poverty measures in a specific way and propose several solutions for doing so. These solutions have limited additional data requirements: age-specific mortality rates are sufficient. However, these authors do not provide an empirical application probing the impact that mortality can make on multidimensional poverty comparisons.

This paper demonstrates how to design a multidimensional poverty measure based on these recent theoretical solutions and studies empirically its associated well-being comparisons across the 36 Nigerian states in 2019. The paper thus proposes one way of implementing the refined Alkire-Foster methodology proposed in Decerf (2023) and provides conceptual guidance for the necessary choices. Interestingly, this implementation does *not* require selecting explicit values for weights across dimensions, except for mortality. The illustration on Nigerian data probes the answer to two empirical questions:

- Question 1: what is the magnitude of the impact that the solutions proposed by Decerf (2023) and Baland et al. (2022) have on well-being comparisons?
- Question 2: what is the magnitude of the bias generated when comparing well-being while ignoring non-monetary dimensions? More precisely, how different are well-being comparisons based on monetary poverty from those based on our multidimensional indicator?

Importantly, we probe the answer to question 2 with a well-being indicator that integrates monetary poverty as one of its dimensions.[7] Moreover, we do so in a conservative context where monetary poverty is high -- 40.5 percent of Nigerians are below the "extreme" International Poverty Line (IPL) of the World Bank in 2019 -- and very heterogeneously distributed across Nigerians states -- their poverty rates range from 10 percent to 90 percent (Lain et al., 2022). This context is conservative in the sense that these two features should reduce the impact that non-monetary dimensions can have on well-being comparisons. The paper's empirical ambitions are limited to these questions and the paper does not claim that its

[7] Other studies contrasting monetary from non-monetary poverty measures in the context of developing countries, like Salecker et al (2020) need not integrate monetary poverty inside their multidimensional indicator. Studies that do integrate it, like Battiston et al (2013) or Evans et al. (2023), base their multidimensional indicator on the classical Alkire-Foster methodology and do not integrate the direct impact of mortality.

proposed well-being indicator is better suited for the Nigerian context than Nigeria's official poverty indicators.

For question 1, the results suggest that each of the two theoretical refinements has the potential to substantially affect well-being evaluations. As explained in Section 2.1, the refinement proposed in Decerf (2023) suggests considering two types of dimension-specific deprivations: extreme deprivation and moderate deprivations. This allows improving the identification of the multidimensionally poor by better accounting for the depth of individuals' dimension-specific deprivation. Our results suggest that ignoring this information on depth – by bundling together extreme and moderate forms of deprivation -- may decrease the fraction of individuals identified as multidimensionally poor by about one quarter. In turn, integrating the direct impact of mortality in the MPM substantially increases the well-being losses captured. When assuming the smallest plausible normative weight to mortality – i.e., assuming that being dead is not worse than being multidimensionally poor – and using 50 years as the age threshold defining premature mortality, we estimate that premature mortality is responsible for more than 30% of the well-being losses our well-being indicator captures in Nigeria in 2019. However, mortality need not dominate well-being comparisons across states because mortality is less heterogeneously distributed across states than monetary poverty. Our results reveal that the value selected for the normative weight given to mortality importantly affects the impact that mortality has on well-being comparisons. This points to the need to better understand the plausible range of values for this normative parameter.

For question 2, the results suggest that accounting for non-monetary dimensions substantially affects well-being comparisons and could have important policy implications. First, we find that non-monetary dimensions -- including mortality -- induce well-being losses that are at least as large as those coming from monetary poverty in Nigeria in 2019. Second, focusing on quality of life -- and thus excluding mortality -- we also find an important bias when ignoring non-monetary dimensions. We classify multidimensionally poor individuals into two categories that are *not* mutually exclusive: "monetary" poor individuals -- who are below Nigeria's national poverty line, which is virtually equal to the IPL in 2019 -- and "other-dimensions" poor individuals -- whose non-monetary deprivations are sufficient to classify them as multidimensionally poor. As expected, other-dimensions poverty is positively correlated with monetary poverty. However, the correlation is far from perfect.[8] As a result, more than one-third of other-dimensions poor individuals are not monetary poor. This shows that ignoring non-monetary dimensions leads to incorrectly identifying these individuals as non-poor, which introduces a bias in well-being comparisons. Importantly, we show that this bias tends to be larger for states that have relatively *small* monetary poverty rates. This suggests that this bias likely increases at the global level given the progress made since 1990 against extreme monetary poverty (World Bank 2022a).

Third, we quantify in two ways the impact that non-monetary dimensions have on well-being comparisons across Nigerian states. We find that 14 percent of pairwise comparisons of states are reversed when switching from a classic monetary poverty measure to our preferred version of our multidimensional indicator. This shows that pairwise comparisons from these two indicators are positively correlated, but this correlation is far from perfect. Our second method assumes that a hypothetical social protection budget is allocated across states proportionally to the well-being recorded in the different states. This second method quantifies the fraction of the budget that must be re-allocated across states when

[8] Interestingly, the non-monetary dimension of security appears to be little correlated with monetary poverty in our data.

switching from one well-being indicator to another. We find that 11 percent of the budget must be re-allocated across states when switching from a classic monetary poverty measure to our preferred version of our multidimensional indicator. We interpret these figures as being substantial. Recall that our well-being indicator integrates monetary poverty as one of its dimensions and that Nigeria has a high monetary poverty rate that is very heterogeneously distributed across Nigerians states.

On top of affecting well-being comparisons, information coming from non-monetary dimensions of well-being is directly policy relevant. This information helps identify the most pressing needs of individuals who have low well-being, thereby pointing to the policies best suited to meet these needs. We discuss how different classification of multidimensionally poor individuals can inform policy.

Finally, the paper falls short of providing a ready-to-use design for an improved global MPM. The design proposed in the empirical illustration leaves several questions open. In the conclusion, we shortly discuss these questions and how one could approach them in future research. We emphasize that this paper overlooks data constraints at the global level, which severely constrain the design of a global MPM.

The remainder is organized as follows. Section 2 presents the case for using MPMs as well as the classic and refined conceptualizations for MPMs. Section 3 presents two designs for our multidimensional indicator ("baseline" and "preferred"). Section 4 presents results on the extent of low well-being in Nigeria and how it can be decomposed into the contribution of alternative dimensions. Section 5 quantifies the impact that non-monetary dimensions have on well-being comparisons. Section 6 concludes.

Section 2: Refined conceptualization of MPM

In this section, we present the conceptual foundations underpinning our well-being indicator. In Section 2.1, we expose a key conceptual limitation of the Alkire-Foster methodology and present one pragmatic refinement that improves on this limitation. We also remind why aggregating across dimensions is required for several key policy purposes. In Section 2.2, we discuss why mortality is a peculiar dimension and how it can be aggregated to MPMs in a meaningful way. In both sections, we present refinements of MPMs whose aim is to better reflect a preference-based definition of well-being.

Section 2.1: Preference-based aggregation of non-monetary dimensions

Among the well-being indicators that account for both the distributional concern and the dimensional concern, multidimensional poverty measures (MPMs) are the most used in practice. This popularity is perhaps the result of their simplicity. At its core, an MPM simply partitions the population into two groups: individuals who are (multidimensionally) poor and those who are not (multidimensionally) poor. The poor are those individuals whose well-being is considered too low. MPMs thus perform inter-personal comparisons of well-being. Such comparisons are required for identifying the worst-offs, which is the first step for the design of evidence-based social protection policies and for evaluating progress against low well-being.

Preference-based definition of the (multidimensionally) poor

A preference-based definition of the (multidimensionally) poor starts from a preference-based definition of well-being. Consider a utility function U that represents the relevant preference over achievement vectors $x = (x_1, \dots, x_m)$, which captures individual achievements in the key dimensions affecting well-being. An individual with achievement vector x is defined to be (multidimensionally) poor if her utility is smaller than some utility threshold U^*, i.e., $U(x) < U^*$. As graphically illustrated in Figure 1, individuals

are poor when their achievements vector falls below indifference curve U^*. As argued in Decerf (2023), the shape of this indifference curve should obey two restrictions that reflect upper- and lower-bounds for the substitutability across dimensions. First, indifference curve U^* admits a positive asymptote in each of the core dimension of well-being. This restriction reflects the view that if an individual achievement is below an extreme threshold $e_j > 0$ in a core dimension of well-being, she must be poor regardless of her achievements in the other dimensions (Sen 1999, Nussbaum 2009, Alkire et al., 2015). Second, indifference curve U^* has strictly positive marginal rates of substitution. This restriction reflects the views that individuals with utility level U^* are always willing to slightly decrease their achievement in one dimension provided their achievements in other dimensions are sufficiently increased (Ravallion, 2011).

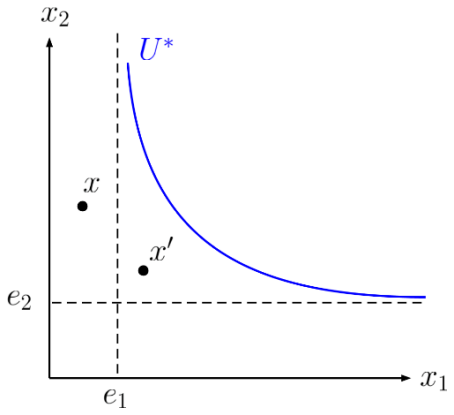

Figure 1: Two types of poor individuals under a preference-based definition of the poor
Note: Indifference curve U^* is in blue, an individual is an extremor if she consumes x and a cumulator if she consumes x'.

An immediate consequence of such preference-based definition of the poor is that there are two types of poor individuals. First, an "**extremor**" is poor because at least one of her achievements is extremely low, i.e., $x_j \leq e_j$ for some core dimension j. Second, a "**cumulator**" is poor because she cumulates moderately low achievements in several dimensions, even though none of her achievements is extremely low. In Figure 1, an individual with achievement vector x is an extremor and an individual with achievement vector x' is a cumulator. Note that it is a priori not possible to rank these two types of poor as a function of well-being. Indeed, some cumulators have lower utility than some extremors (and vice versa).

Aggregating across dimensions improves the identification of the worst-offs

Ravallion (2011) argues that aggregating across dimensions is not necessary for several policy purposes. Of course, this does not mean that aggregating across dimensions is never policy relevant. For instance, prioritarian policy making, whose aim is to provide special attention to the worst-offs, requires identifying who has low well-being and thus requires such aggregation.

Aggregating across dimensions allows improving the identification of the worst-offs. Figure 2.a illustrates this point when considering two dimensions of well-being: consumption and health. Consumption is measured by the monetary value of the commodities consumed while health is measured by some indicator of health status. Here, the worst-offs are the individuals with the lowest well-being, say those below indifference curve U^*. In practice, the monetary approach identifies the worst-offs by selecting a "poverty line", which is a cutoff in the consumption dimension illustrated in Figure 2 by the monetary value z_1. Individuals are thus identified as poor by the monetary approach when $x_1 < z_1$. The "identification

contour" associated to this purely monetary approach is drawn in red in Figure 2.a. This approach makes both exclusion errors and inclusion errors. For instance, an individual with achievement vector x is identified as monetary deprived even though she is not (multidimensionally) poor. In turn, another individual with achievement vector x' is not identified as monetary deprived even though she is (multidimensionally) poor.

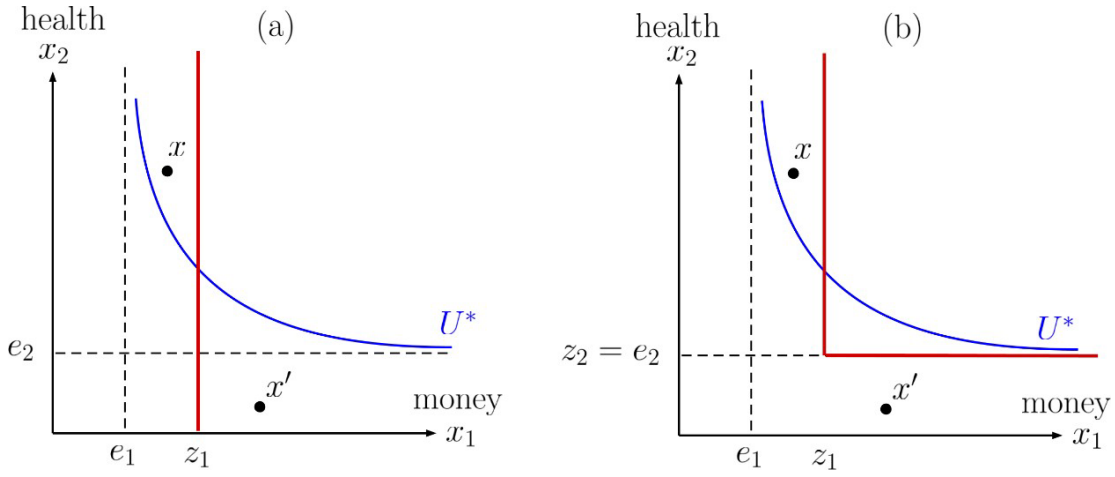

Figure 2: A Monetary poverty measure makes identification errors (a).
A multidimensional identification based on the union approach makes fewer identification errors (b).
Note: Indifference curve U^* is in blue and identification contours are in red.

The fact that the monetary approach makes identification errors is not a sufficient reason to discard it. As shown in Decerf (2023), any identification method is bound to make identification errors as soon as (1) individuals do not freely optimize their achievements in all dimensions and (2) the practitioner only has partial information on indifference curve U^*. Arguably, these two conditions hold in most cases. In particular, condition (1) holds when there are no well-functioning markets for some dimension, which is typically the case for non-monetary dimensions of well-being such as health.

However, aggregating across dimensions allows reducing the amount of identification errors. This is illustrated in Figure 2.b. Consider the (extreme) health deprivation cutoff $z_2 = e_2$. The union approach based on cutoffs z_1 and z_2, whose identification contour is in red, identifies the (multidimensionally) poor strictly better than the monetary approach. Indeed, it strictly reduces the number of exclusion errors (x' is now correctly identified as poor) and it does not make more inclusion errors. Observe that the same argument can be used to show that MPMs who integrate monetary poverty as one of their dimensions (like the World Bank MPM) have the potential to better identify the multidimensionally poor than MPMs that only integrate non-monetary dimensions (see Supplementary Material S3 from Decerf, 2023).

In general, a good identification method should strive to have the shape of its identification contour as close as possible to the shape of indifference curve U^* to minimize identification errors. A method that does not aggregate across dimensions identifies the poor worse than some method that aggregates across dimensions. This does not mean that a dashboard of dimension-specific indicators, each one summarizing the population's achievements in one dimension, does not provide useful information. It does. However, such dashboard cannot estimate the incidence of low well-being nor satisfactorily identity the individuals with low well-being.

A refinement of the Alkire-Foster identification method

The most popular method for the identification of the (multidimensionally) is proposed by Alkire and Foster (2011) and best exposed in Alkire et al. (2015). In a nutshell, this method starts from binary deprivation statuses in m dimensions. An individual is deprived in dimension j when her achievement x_j is smaller than the deprivation cutoff z_j, i.e., $s_j = 1$ when $x_j < z_j$, otherwise $s_j = 0$. The AF methodology identifies an individual as poor when the weighted sum of her deprivation statuses is too large, i.e.,

$$\sum_{j=1}^{m} w_j s_j \geq k \qquad (1)$$

where w_j is the weight given to dimension j and k is the identification threshold. This clever method avoids an important practical issue faced by both the intersection approach and the union approach. These latter approaches tend to irrelevance when the number m of dimensions increases, unless the deprivation cutoffs are changed to increasingly implausible values.[9]

One key limitation of the AF methodology is to rely on binary deprivation statuses, which follows from the use of a unique cutoff in each dimension. This feature prevents from properly identifying both cumulators and extremors. We illustrate the issue in Figure 3, which considers two dimensions only. Under two dimensions, the AF methodology essentially boils down to either the union approach or the intersection approach, depending on the values given to the weights. The union approach is well-suited to identify extremors but does not perform well at identifying cumulators. As suggested in the left panel, the reason is that the union approach requires rather small cutoffs z_j to limit the inclusion errors that larger cutoffs would entail. In contrast, the intersection approach is well-suited to identify cumulators, but does not perform well at identifying extremors. As suggested in the middle panel, the reason is that the intersection approach requires rather large cutoffs z_j' to limit the exclusion errors that smaller cutoffs would entail.

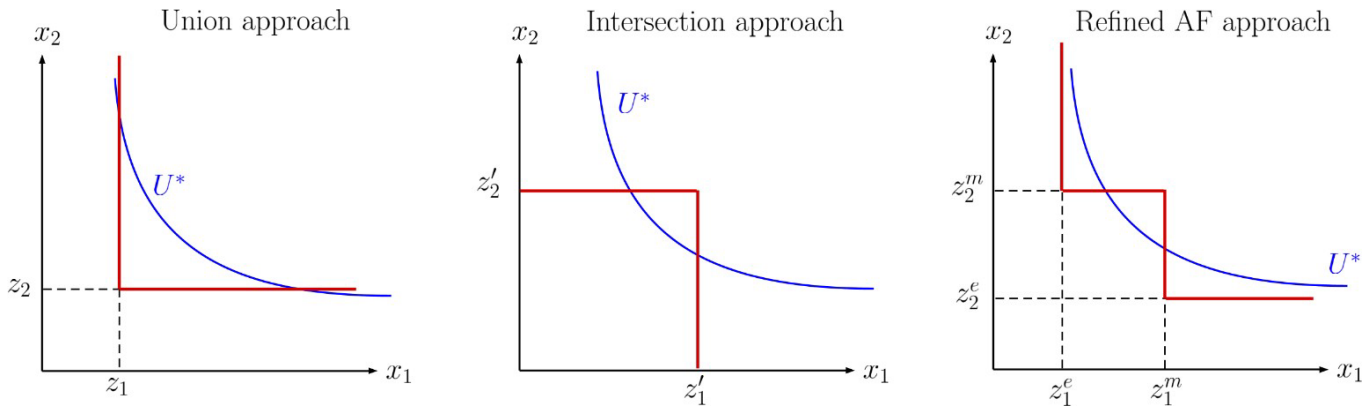

Figure 3: The refined AF approach (c) can identify the poor better than the union approach (a) or the intersection approach (b).

Note: Indifference curve U^* is in blue and identification contours are in red.

[9] When the number m of dimensions increases, if dimension-specific cutoffs are unchanged, then the fraction of individuals identified as poor by the union approach tends to one while the fraction of individuals identified as poor by the intersection approach tends to zero (Rippin, 2010; Dotter and Klasen, 2017).

One simple refinement of the AF methodology that improves on this limitation is to consider three deprivation statuses, which requires using two cutoffs in each dimension j: one extreme cutoff z_j^e and one moderate cutoff z_j^m. Then, an individual can have three mutually exclusive deprivation statuses in each dimension j: extremely deprived when $x_j < z_j^e$, moderately deprived when $z_j^e \leq x_j < z_j^m$ and non-deprived otherwise. Extremors can be properly identified by using the union approach on individuals who have at least one extreme deprivation. Cumulators can be properly identified by using the intersection approaches on individuals who have several moderate deprivations. As illustrated in the right panel of Figure 3, the shape of the identification contour associated to this refinement better approximates indifference curve U^* than the identification contours of the union and intersection approaches. This paper provides the first illustration of how this refinement could be implemented in practice.

Section 2.2: Accounting for the direct impact of mortality

The direct impact of mortality is to curtail the quantity of life (the lifespan) of the deceased. This impact is virtually always ignored by the MPMs used in practice, which only account for quality of life.

There are several conceptual reasons why the direct impact of mortality should be accounted for. First, MPMs that ignore this direct impact may perversely react to mortality: they may record the death of poor individuals as an improvement (Kanbur and Mukherjee, 2007). Second, mortality outcomes are arguably highly consequential for low well-being. Cross-country well-being comparisons are very substantially affected when the direct impact of mortality is accounted for (Becker et al. 2005; Jones and Klenow, 2016). Third, from a capability perspective, being alive may be considered the most basic functioning. Mortality thus deprives the deceased of the most basic functioning. At the very least, any individual who dies too young should be considered "lifespan deprived". To the extent that being prematurely dead is considered no better than being poor, being prematurely dead should be considered a form of extreme deprivation.

There is also a practical reason to account for mortality. Mortality has two complementary desirable features. First, the lifespan is an outcome whose units can be transparently compared across individuals. Second, mortality reflects several key non-monetary dimensions like health, security or nutrition. These two features are complementary because several non-monetary dimensions that affect mortality are difficult to observe or measure in a parsimonious and comparable way.

The direct impact of mortality requires a specific aggregation

Integrating the direct impact of mortality into an MPM is tricky. The key conceptual difficulty is that MPMs capture low *quality* of life *in a given year* while properly accounting for the impact of mortality on the *quantity* of life requires taking a *lifecycle* perspective.

The solution proposed by Baland et al (2022) is that the well-being indicator aggregates years of life prematurely lost (YLLs) with years of life spent in poverty (PY). From a poverty perspective, in a given year t, alive individuals are either poor or non-poor. However, some individuals who should be alive in year t are already dead because they prematurely died before year t. Thus, three types of individuals should be accounted for in year t: the non-poor individuals whose contribution is normalized to zero, the prematurely dead individuals whose contribution is normalized to one and the poor individuals whose contribution takes a value θ in (0,1), at least when assuming that being poor is not worse than being dead. An obvious drawback with this approach is that its mortality component is affected by the premature mortality taking place *before* year t, which is undesirable when evaluating policies in year t. The proposal

of Baland et al. (2022) is to collect all years of life lost due to the premature deaths occurring in year t and attribute to year t all these years of life lost.[10] Another proposal by Baland et al. (2023) is to aggregate the poverty and mortality observed in year t while assuming that the society is stationary. This assumption is not meant to be realistic but rather to allow for an aggregation of mortality that makes sense from a lifecycle perspective. Indeed, in a stationary population, the population in any given year completely reflects the lifecycle impacts of mortality in that year. In fact, the same assumption underpins the construction of life-expectancy, which is the most popular mortality indicator.

These solutions can still be perversely affected by the death of poor individuals. The reason is that they attribute negative intrinsic value only to *premature* deaths. The next indicator avoids these perverse effects by attributing negative intrinsic values to *all* deaths. By doing so, it arguably better reflects the view that being alive is the most fundamental functioning. This indicator is called poverty-adjusted life-expectancy (PALE). Formally, PALE is defined by the following expression:

$$PALE_\theta = LE * (1 - \theta * H) \qquad (2)$$

where LE is life-expectancy at birth, H is the multidimensional poverty headcount ratio and θ in [0,1] is the same normative weight. PALE takes the perspective of someone who expects to be confronted throughout her life to the (multidimensional) poverty and mortality observed in year t. The larger θ, the smaller the weight attributed to mortality. At one extreme, when θ = 0, i.e., spending one year in multidimensional poverty is considered the same as spending one year out of multidimensional poverty, PALE corresponds to life-expectancy at birth. At the other extreme, when θ = 1, i.e., spending one year in multidimensional poverty is considered the same as losing one year due to death, PALE can be interpreted as the poverty-free life-expectancy, an index proposed by Riumallo-Herl et al. (2018). More generally, PALE normalizes the lifecycle utility expected under a stationary perspective when θ captures the fraction of period-utility lost when multidimensionally poor.[11]

For most purposes, our empirical illustration uses the PALE indicator to aggregate the direct impact of mortality (quantity of life) with other dimensions of deprivations (quality of life). This aggregation combines the advantages of (i) taking the necessary lifecycle perspective, (ii) attributing negative intrinsic value to all deaths, and (iii) always avoiding perverse reactions to the death of a poor individual. This indicator is also very parsimonious in terms of data requirement because the necessary mortality data can be taken from a different source than the data on the quality of life. An important limitation of this well-being indicator is that PALE is not affected by the distribution across individuals of years of life lost and of years of life spent in poverty. This limitation thus makes PALE a second-best indicator, which is relevant when data-constraints prevent from estimating this distribution. Observe that such data-constraints typically prevent estimating this distribution because such estimation requires both information on mobility in and out of poverty throughout the lifecycle as well as information on differentiated mortality rates for poor and non-poor individuals.

[10] For instance, when the age threshold defining premature mortality is 50 years, a 20-year-old who dies loses 30 years of life, which can all be attributed in the year when the 20-year-old dies. Importantly, this proposal yields the same value for stationary populations as the approach based on past mortality. This is important because, in any year, the population pyramid of a stationary population entirely reflects the lifecycle impacts of its mortality.

[11] Formally, we have $\theta=(u(NP)-u(P))/(u(NP)-u(D))$ where $u(NP)$, $u(P)$ and $u(D)$ respectively denote the period-utility of being non-poor, poor or dead.

Section 3: Designing a refined MPM with Nigerian data

In this section, we propose one way of implementing the conceptual refinements discussed in Section 2 in the context of Nigeria in 2019. We discuss how the necessary choices can be made consistently with the theory exposed in Section 2. Our design highlights some distinctive features of the refined AF methodology and why they may help practitioner better identify individuals with low well-being.

Importantly, our design is intended as a mere illustration. We do not claim that this design should be adopted by Nigerian policy makers. Beyond providing a proof of concept, our empirical ambitions are limited to proposing a plausible design that can be used to probe the answer to the two questions raised in the introduction.

Section 3.1: Quality of life and the deprivation mapping

In this section, we propose one way of implementing the refined identification method described in section 2.1. In fact, we propose two designs: a **"baseline" design** and a **"preferred" design**. The "baseline" design provides conservative answers to our two questions because it accounts for fewer dimensions and adopts the smallest plausible weight for mortality. The text presents all results for the "baseline" design, which is easier to discuss. Yet, we view the "preferred" design as more plausible and thus we also present the main results for the "preferred" design.

The unit of analysis is the individual. The main difficulty is that the relevant information is often available only at the household level. This is typically the case for monetary outcomes, which are only observed at household level. In contrast, health outcomes are sometimes available at the individual level. This is fortunate because health outcomes are expected to be very unequal across household members, if only because of lifecycle effects.[12] Observing outcomes for different units of analysis for different dimensions is not necessarily a problem, but it requires making strong assumptions to translate the observed household-level outcomes into individual-level outcomes. For instance, equal sharing of monetary resources is often assumed for the monetary dimension.

To capture quality of life, we consider the monetary dimension (consumption in Nigeria) together with several non-monetary dimensions. Ideally, the design should capture the main well-being-related dimensions for which comparable data are available. One difficulty is that the relative importance of alternative dimensions may differ by context. However, some dimensions are important in virtually all contexts. This is arguably the case of both consumption and health. On top of these two dimensions, we also consider security and housing. Finally, for our preferred design, we additionally consider education. We believe that all these dimensions make sense in the Nigerian context. The key aspect for our purpose is to consider both monetary and non-monetary dimensions, which allows reducing misidentification errors when data constraints permit.[13]

Each dimension is covered by a series of dimension-specific indicators. The main step for the implementation of the refined AF methodology presented in Section 2.1 is to define what we call the

[12] Studies looking at intra-household distribution of monetary resources also find substantial inequalities (Lise and Seitz, 2011; Lechene et al. 2021).

[13] As shown in the supplementary material S3 attached to Decerf (2023), an identification method that does not combine monetary and non-monetary dimensions makes more identification errors than some identification method that combines them.

"**deprivations mapping**". For each individual and each dimension, the deprivation mapping defines the circumstances under which the individual is extremely, moderately, or not deprived in the dimension. The deprivation mapping makes the link between the individual outcomes captured by the dimension-specific indicators and the individual's deprivation status. Before discussing the conceptual principles guiding the definition of the deprivation mapping (see Section 3.2), we present in the remainder of section 3.1 what this mapping looks like in our illustration.

Table 1 defines our deprivation mappings for the baseline and preferred designs. Consider first our baseline design. We begin with the monetary dimension. In Nigeria, the monetary aggregate is defined as the market value of consumption. In 2019, the national poverty line was $1.93 per person per day in 2011 PPPs (see page 19 of World Bank, 2022b). The national monetary line was thus almost equal to the World Bank's extreme poverty line, which is $1.9 per person per day (2011 PPPs). The deprivation mapping for the baseline design assumes that an individual is extremely monetary deprived if her consumption is below the national poverty line, otherwise she is not monetary deprived. Given that an extreme deprivation automatically confers (multidimensional) poverty status, this assumption is equivalent to the one used by the WB's MPM, which automatically classify as (multidimensionally) poor individuals who are below the extreme monetary line.

We succinctly describe the non-monetary deprivations used in the baseline design. In the health dimension, individuals are extremely deprived in three cases: they suffer from a heavy disability, they are an underweight woman between 15 and 49 years old (age-window and gender for which we have data) or they are a stunted child. In turn, individuals who are not extremely health deprived are moderately health deprived in two cases: they suffer from a mild disability, or they suffer from severe over-weight (obesity). In the security dimension, an individual is extremely security deprived if her household has been victim of an insecurity event with "physical" consequences or if she lives in a district where at least a quarter of the households have been victim of an insecurity event with "physical" consequences. In turn, an individual who is not extremely security deprived is moderately security deprived if her household has been victim of an insecurity event with "material" consequences or if she lives in a district where at least a quarter of the households have been victim of an insecurity event with "material" consequences. In the housing dimension, we consider whether an individual lives in a household that has access to electricity, limited-standard drinking water, limited-standard sanitation and whose dwelling is made of appropriate materials. An individual is extremely housing deprived if her household is deprived in the four housing indicators and moderately housing deprived if her household is deprived in three housing indicators.

The deprivation mapping for the preferred design is the same as that of the baseline design, except that the former additionally considers a moderate monetary deprivation status and the education dimension. An individual is moderately monetary deprived if her consumption is above the national poverty line but below the WB's societal poverty line in her state.[14] An individual is extremely education deprived if she is a child not enrolled in school. An individual is moderately education deprived if she lives in a household where no adult has completed primary education and no adult can read or write.

[14] The WB societal poverty line is a (weakly) relative monetary line whose value increases with median income but is never smaller than the extreme poverty line (Jolliffe and Prydz, 2021). Considering individuals whose income is between the extreme and societal poverty lines as moderately monetary deprived is consistent with the view that being absolutely income poor is worse than being only relatively income poor (Decerf, 2017; Decerf and Ferrando, 2022).

Table 1: Deprivation mapping: from dimension-specific indicators to deprivation statuses

Dimensions	Deprivation status	Indicators
Monetary	Extreme	The household annual consumption per capita is below national poverty line evaluated to 137430 Naira annual per capita (PA NGA).
	Moderate (only Preferred)	*The household annual consumption per capita is above national poverty line but below state societal poverty line: 1 + 0.5 x where x is the median state consumption in $ per day per capita.*
Health	Extreme	The individual suffers from at least one disability causing him a lot of difficulties in daily life or/and suffers from an extreme bad nutritional status, meaning a stunting condition for children (HAZ[1] < -2) or being undernourished (BMI[2] < 18.5) for adults.
	Moderate	The individual suffers from at least one disability causing him only some difficulties in daily life and/or suffers from a moderate nutritional status, meaning being obese (30 < BMI) for adults.
Housing	Extreme	The individual belongs to a household deprived regarding all following household-level indicators: i) Household lacks access to limited-standard drinking water[3]; ii) Household lacks access to limited-standard sanitation[4]; iii) Household has no access to electricity; iv) Household has inadequate housing[5]
	Moderate	The individual belongs to a household deprived regarding three of the following household-level indicators: i) Household lacks access to limited-standard drinking water; ii) Household lacks access to limited-standard sanitation; iii) Household has no access to electricity; iv) Household has inadequate housing
Security	Extreme	The individual belongs to a household, subjected the last 12 months to an extreme insecurity event[6] or belongs to a local government area (LGA) with at least one quarter of neighborhood households subjected to crime/violence with extreme consequences the last 12 months.
	Moderate	The individual belongs to a household, subjected the last 12 months to a moderate insecurity event[7] or belongs to a local government area (LGA) with at least one quarter of neighborhood households subjected to crime/violence with moderate consequences the last 12 months.
Education (only Preferred)	*Extreme*	*The individual is a school-age child up to the age of grade 8, not enrolled in school*
	Moderate	*The individual belongs to a household in which no adult (age of grade 9 or above) has completed primary education, and no adult can read nor write*

Baseline Preferred

Source: Authors

Note: [1] Height for Age Z score

[2] Body Mass Index

[3]Limited-standard drinking water refers to drinking water that comes from an improved source, defined as those that are likely to be protected from outside contamination, and from fecal matter in particular. It includes for example, piped, borehole, protected dug well, rainwater, or delivered water (PSPR 2018, WHO)

[4]Limited-standard sanitation refers to improved sanitation facilities, defined as those that hygienically separate human waste from human contact, including flush/pour flush to piped sewer system, septic tank, or a composting latrine (PSPR 2018, WHO)

[5]Inadequate housing refers to houses characterized by at least one of the following three conditions: the floor is of natural materials, the roof or the walls are of rudimentary materials (UNDP)

[6]Extreme insecurity events include events where any member of the household has been murdered, injured, or disabled, subjected to sexual violence, captured, or abducted, or made a refugee

[7]Moderate insecurity events include events where any member has been physically attacked, forced to work, restricted from going to school or hospitals, robbed, or where household's dwelling has been damaged, or household's land has been occupied or taken by force.

This table presents, for each baseline and preferred scenario, the combination of basic indicators that allow to define, for each poverty dimension – monetary, education, health, housing, security-, a state of non-deprivation, moderate deprivation, and extreme deprivation.

Section 3.2: Principles guiding the necessary choices for our well-being indicator

In this section, we finalize the baseline and preferred designs of our multidimensional well-being indicator. Two pieces are missing: the exact aggregation of an individual's deprivation statuses into her (multidimensional) poverty status and the selection of a value for the normative weight θ, which defines the trade-off between quantity of life and quality of life. We also comment on the conceptual principles guiding the design and the differences with the classical AF methodology.

Aggregation of deprivations related to quality of life

The aggregation of quality of life requires both a deprivation mapping (section 3.1) and a method to aggregate deprivation statuses into (multidimensional) poverty status. For the latter method, we follow the theory presented in section 2.1. That is, two types of individuals are (multidimensional) poor. First, any individual who suffers from at least one extreme deprivation is identified as poor (extremor). Second, any individual who is not an extremor but cumulates enough moderate deprivations is identified as poor (cumulator). In this illustration, we assume that **two** moderate deprivations are sufficient to be considered poor. This choice completes the aggregation of quality of life, which means that all the necessary choices have been made to compute the fraction of (multidimensionally) poor, which we denote by H.

Five important remarks are in order. First, the design of the deprivation mapping should be made while accounting for the way in which deprivations statuses are aggregated. For extreme deprivation status, the selection of dimension-specific indicators conferring extreme deprivation should be plausibly consistent across dimensions. Assume as a starting point that an individual whose consumption is below the extreme poverty line ($1.9 per day in 2011PPPs) is considered extremely monetary deprived and thus (multidimensionally) poor. The components of the mapping related to extreme deprivations in other dimensions must be consistent with this starting point. Take the health dimension for example. Loosely speaking, it should be plausible that, ceteris paribus, suffering from a heavy disability leads to a similarly low well-being level as having consumption below the extreme poverty line. Graphically, the extreme deprivation cutoffs selected in different dimensions should "approximate" the same indifference curve U^* (recall the right panel of Figure 3 in Section 2.1). Then, the components of the mapping related to moderate deprivations must be consistent with both this starting point and the assumption that two moderate deprivations are sufficient to be considered poor. Indeed, it should be plausible that suffering only from one moderate deprivation in one dimension leads to a higher level of well-being than suffering from one extreme deprivation. Loosely speaking, it should be plausible that, ceteris paribus, suffering only from a mild disability leads to a higher well-being level as having consumption below the extreme poverty line. Graphically, the moderate deprivation cutoff selected in one dimension should not approximate the same indifference curve U^* approximated by the extreme deprivation cutoff in another dimension (recall the right panel of Figure 3 in Section 2.1). Then, it should also be plausible that suffering from **two** moderate deprivations leads to a similarly low well-being level as having consumption below the extreme poverty line. For instance, it should be plausible that suffering from a mild disability and belonging to a household that has been victim of crime with only material consequences leads to a similarly low well-being level as having consumption below the extreme poverty line. These are the considerations that should guide the design of the deprivation mapping. Observe that different empirical methods, like surveys using vignettes or subjective well-being questions, could be used to assess whether these principles plausibly hold.

Second, our identification of the (multidimensionally) poor does not require explicit values for weights (across dimension-specific indicators related to quality of life). This does not mean of course that we do not assume trade-offs across such indicators. Of course, our refined AF method also requires making this kind of assumptions, like the classical AF method. However, not having to select explicit values for weights may help reduce identification errors. At least this will be the case if practitioners feel compelled to use equal weights. Practitioners are likely to feel compelled to use equal weights because deviating from the "equal weights" dominant practice requires a good justification. Practitioners may lack the legitimacy or the scientific underpinning necessary to select a particular value for these weights. Thus, when using equal weights is the only easily defensible solution, the practitioner loses options that could help better identify individuals with low well-being. For instance, the practitioner may discard well-being relevant information by bringing together ordered categories. For instance, she would not discriminate between heavy and mild forms of disabilities (or between crimes with "physical" or merely "material" consequences), but rather bundle them as health deprivation. Alternatively, in any given dimension, the practitioner may only consider dimension-specific indicators leading to a similar level of well-being, excluding potentially useful indicators.

Third, comparing results across two nested designs, like our baseline and preferred design, does not require any adjustment. In contrast, to meaningfully perform such comparisons, the classical AF methodology would have to change the values selected for its weights and identification threshold (see Eq. 1). Our preferred design differs from our baseline design because the former considers an additional dimension and an additional moderate consumption deprivation status. The theory exposed in section 2.1 explains in which sense the results can be meaningfully compared across our two designs. Fundamentally, the preferred design can be assumed to make a better job at identifying the (multidimensionally) poor than the baseline design because the latter omits well-being relevant information. This is at least true if the extension of the deprivation mapping defining our preferred design is consistent with the deprivation mapping defining our baseline design. Given that the former is a mere extension of the latter, consistency only requires that the same principles described in our first remark (see above) also guide the design of the extension.[15] If it is the case, then the preferred design can be interpreted as making fewer exclusion errors. For instance, children who are not registered into school may not be identified as (multidimensionally) poor by our baseline design, which is an exclusion error whose origin is that our baseline design omits such extreme education deprivation.

Fourth, from a conceptual perspective, having information at the individual level allows accounting for extreme forms of deprivations that are not equally shared within the household. Think for instance of heavy disabilities. Arguably, individuals afflicted by such disabilities have a level of well-being that is too low and should thus be considered as (multidimensionally) poor. However, other individuals living in their household need not be considered poor if they are not themselves sufficiently deprived in other dimensions. When using the household as unit of analysis, accounting for such heavy disability leads to many identification errors.[16] Hence, a framework combining three deprivation statuses with the individual as unit of analysis holds the potential to reduce identification errors.

[15] For instance, the definition of moderate monetary deprivation should lead to approximately the same well-being level as having a mild disability.

[16] When using the household as unit of analysis, considering all household members as poor whenever one member has a heavy disability would imply many inclusion errors. An alternative would be to consider a household

Fifth, data-constraints prevent from adequately covering several dimensions or properly accounting for joint distribution. The issue arises in our design for the nutrition indicators considered as part of the health dimension. We do not have data on bad nutrition outcomes except between 15 and 49 years old and below 5 years old. For the large fraction of the population outside of these two age windows, we conservatively assume that their nutrition status is normal. Moreover, because nutrition outcomes come from a separate survey, we had to input the nutrition outcomes from DHS to NLSS (see Appendix 3 for details on the imputation model). This imputation is not expected to have a large impact on results given the small fraction of the population for which we have bad nutrition status (see Table A1 in Appendix 1). However, one should bear in mind that our results suffer from this limitation.

Aggregating quality with quantity of life

For the reasons exposed in Section 2.2, we account for the direct impact of mortality on quantity of life using PALE. There only remains to select a value for its normative weight θ, which defines the trade-off between quantity of life and quality of life.

There are several ways one could select a value for θ. First, the selection could be done by a policy maker who has the necessary legitimacy. Second, the selection could be grounded in the views of the individuals themselves. Such views should be collected through dedicated surveys. Third, parametric values for θ could be deduced from assuming a particular Bernouilli (period) utility function, as illustrated in Appendix 2.

For our purposes, we assume two different values for the baseline and preferred designs. We conservatively assume $\theta = 1$ for the baseline design. From a policy making perspective, this choice provides the smallest plausible weight to mortality. The reason is that $\theta = 1$ implies that being dead provides the same well-being level as being (multidimensionally) poor. Arguably, no policy maker would explicitly ground its decisions on the assumption that poor individuals would be better-off dead. Providing the smallest plausible weight to mortality is conservative when probing question 1, namely how much is lost when ignoring non-monetary dimensions of well-being.

We then assume $\theta = 0.5$ for our preferred design. We argue that $\theta = 1$ is an implausible weight for mortality, so smaller values must be considered. The "middle of the road" value $\theta = 0.5$ implies that one year of life lost is equivalent to two $(= 1/\theta)$ years of life spent in poverty. In the absence of convincing evidence, we believe that this value is more plausible than that assumed for the baseline design.

Section 4: Incidence of low well-being in Nigeria in 2019

In this section, we present the data sources, the context and the basic results describing the *incidence* of low well-being in Nigeria in 2019. This incidence is measured by our indicators H and PALE. We focus on the respective contributions of alternative dimensions and the impact of some assumptions underlying

as moderately deprived when one of its members has an extreme form of deprivation. This alternative is clearly less attractive because it could also lead to different types of identification errors. For instance, the heavily disabled individual would incorrectly be considered non-poor if her disability is the only form of deprivation afflicting her household. Or, all other members of her household would incorrectly be considered poor if the household has only one other moderate form of deprivation.

our design. In Section 5, we present the results quantifying the extent to which *well-being comparisons* are altered when accounting for non-monetary dimensions.

Section 4.1: Data sources and the Nigerian context

We compare well-being across the 36 states of Nigeria in 2019. As we explain below, this is a conservative context to probe the answer to question 1.

Data sources

We rely on two main data sources: the 2018-19 Nigeria Living Standards Survey (NLSS) and the 2018 Nigeria Demographic and Health Survey (DHS). The NLSS 2018-19 is a large-scale household survey, focusing on measuring living conditions of the population, collected by the National Bureau of Statistics of Nigeria (NBS) between September of 2018 and October of 2019. The NLSS questionnaire includes wide-ranging modules, covering demographic indicators, education, health, labor, expenditures on food and non-food goods, non-farm enterprises, household assets and durables, access to safety nets, housing conditions, economic shocks, exposure to crime and farm production indicators (NLSS Report 2020). The additional data source, the 2018 NDHS is a survey implemented by the National Population Commission (NPC), whose data collection took place from 14 August to 29 December 2018. It provides up-to-date estimates of basic demographic and health indicators, especially, nutrition data relying on records of anthropometry measurements of children under 5 and women between 15 and 49. We complement these databases with mortality information taken from Human Development Indices for the UNDP Nigeria Human Development Report 2016.

Monetary poverty is high and heterogeneously distributed across Nigerian states

Nigeria provides a conservative context for our purpose. Answering question 1 requires contrasting well-being comparisons obtained from the monetary dimension alone with well-being comparisons obtained from a multidimensional indicator aggregating the monetary and the non-monetary dimensions. As we show below, Nigeria has a high monetary poverty rate and this rate is very heterogeneous across the 36 Nigerian states. Accounting for non-monetary dimensions is less likely to reverse well-being comparisons in a context where the monetary dimension already provides a stark contrast across states.

Monetary poverty was high in Nigeria in 2019. That year, some 40.5 percent of Nigerians had their monetary aggregate below the national poverty line. Monetary poverty was also distributed unequally across Nigeria in 2019. That year, five states had less than 10 percent monetary poverty while two states had more than 85 percent. The map shown in Figure 4 illustrates this heterogeneity across geographical units called “zones”, which are groups of several states. The map shows the heterogeneity in poverty rates across the six zones of Nigeria. Each of the three zones in the south have less monetary poverty than each of the three zones in the north. Monetary poverty in the South-West zone is about 10 percent while monetary poverty in the North-East zone is about 70 percent.

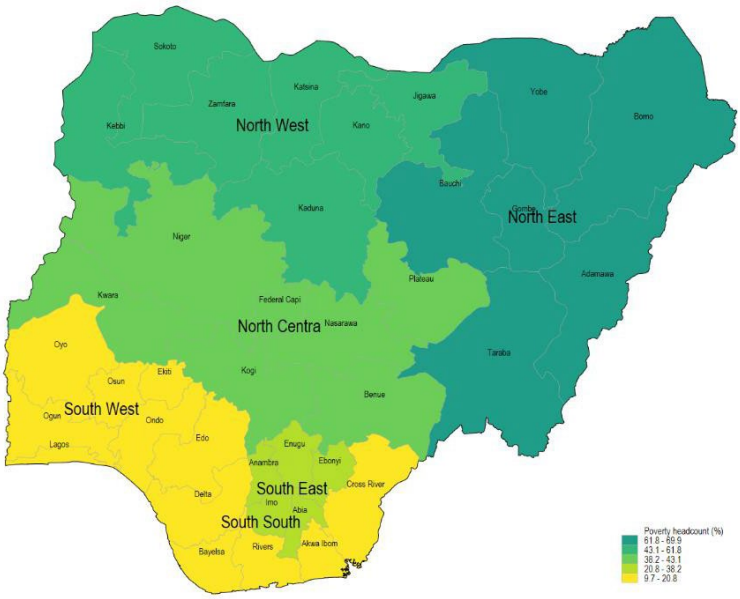

Figure 4: Prevalence of monetary poverty in Nigeria, per zone.

Source: Authors' estimates based on data from NLSS 2019
Note: The figure presents, for each zone, the share of individuals below the national poverty line.

Section 4.2: Incidence of low quality of life

We focus in this subsection on the fraction of multidimensionally poor individuals H. Our objective is to get a sense of the source of their (multidimensional) poverty both in terms of type of deprivation (extreme or moderate) and in terms of type of dimensions.

Incidence and geographic distribution of deprivations

We begin with results associated to the deprivation mapping for the baseline design. These basic results provide insights that will shed light on the respective impacts that alternative dimensions have in later results.

Figure 5 provides a first glance at the prevalence of different type of deprivations at the national level. The baseline design considers four dimensions. For each of these dimensions the histogram shows the fraction of individuals in each of the three deprivation statuses: extreme, moderate or not deprived. The figure immediately reveals that the monetary dimension is by far the most consequential dimension given our design. Not only the monetary dimension has the largest incidence of deprived individuals (40.5 percent), but by assumption all of them are extremely deprived. All the non-monetary dimensions have a smaller incidence of deprivation, and much smaller incidence of extreme deprivation. Among the non-monetary dimensions, housing is the most consequential. Observe that security has a larger deprivation incidence than health but a much smaller extreme deprivation incidence than health. Figure A1 in Appendix 1 provides the corresponding histogram for our preferred design.

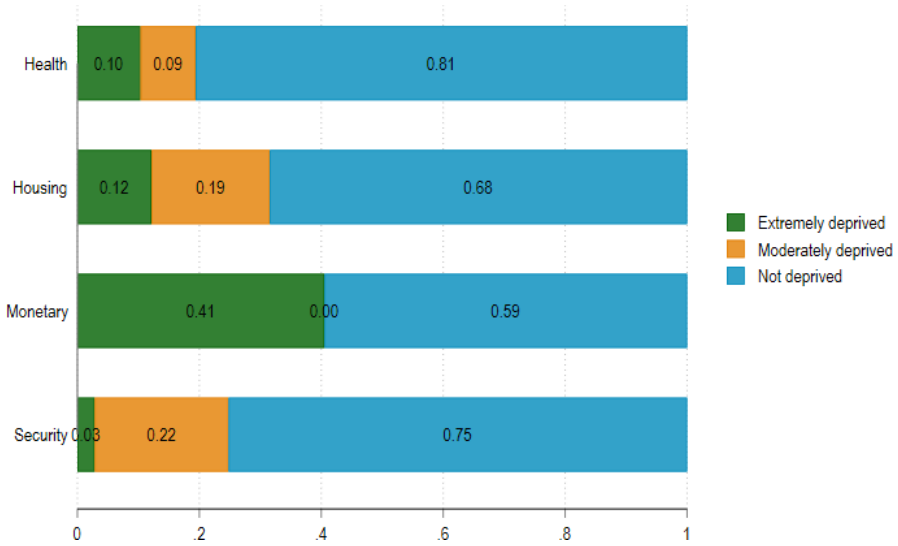

Figure 5: Prevalence of extreme and moderate deprivations per dimension for Nigeria, baseline scenario

Source: Authors' estimates based on data from NLSS 2019
Note: The figure presents, for each dimension considered in the baseline scenario -monetary, health, housing, security-, the share of individuals according to their state of deprivation: non deprivation, moderate deprivation, extreme deprivation.

To provide a sense of the respective importance of dimension-specific indicators, Table A1 in Appendix 1 provides the incidence in the population for each of these dimension-specific indicators. For instance, 10 percent of the population suffers from an extreme health deprivation. This percentage results from the fact that 2.9 percent suffers from a heavy disability, 2.3 percent is an underweight woman between 15 and 49 years old and 5.5 percent is a stunted child. Also, a sense of the correlation between deprivation status in the three non-monetary dimension is given in the Venn diagram A3 in Appendix 1. For instance, this diagram shows that 1.7 percent of the population is deprived in the three non-monetary dimensions.

Figure 6 provides an idea of the distribution across zones of these deprivations. As illustrated in Figure 4, the monetary deprivation is very heterogeneously distributed across zones, with south regions having low and north regions having high monetary deprivation. The same holds for the housing dimension. Importantly, the geographic distribution of housing deprivation is roughly the same as that of the monetary deprivation. In contrast, the incidence of health deprivation is approximately equally distributed across zones. Interestingly, the geographic distribution of extreme health deprivation is positively correlated with that of monetary deprivation while that of moderate health deprivation is negatively correlated with that of monetary deprivation.[17] Finally, the security deprivation is geographically distributed in a way that seems uncorrelated to the monetary deprivation. The correlation between the distribution across states of alternative deprivations is illustrated in Figure A2 provided in appendix 1.

[17] One reason that could explain the negative geographic correlation between monetary deprivation and moderate health deprivation is that the latter mostly reflects mild disabilities, which may afflict older individuals (who are typically more numerous in richer regions).

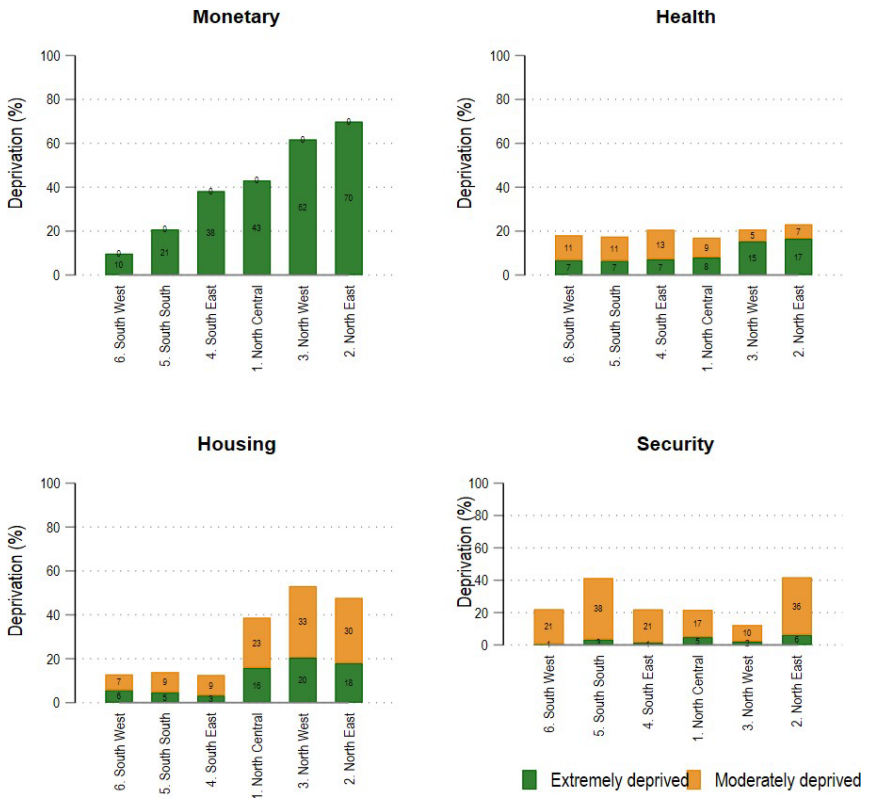

Figure 6: Prevalence of extreme and moderate deprivations per dimension per zone, baseline scenario

Source: Authors' estimates based on data from NLSS 2019

Note: The figure presents, for each dimension considered in the baseline scenario -monetary, health, housing, security-, the prevalence in % of moderate deprivation, extreme deprivation within each of the six Nigeria's zones classified in ascending order of monetary deprivation.

Fraction and types of multidimensionally poor individuals

The theory in Section 2.1 defines two types of (multidimensionally) poor: extremors and cumulators. By assumption, all individuals who are monetary deprived are extremors. However, some extremors are not monetary deprived, like for instance individuals whose sole extreme deprivation is in a non-monetary dimension. To answer question 1, it is interesting to consider a second classification of (multidimensionally) poor individuals. We call **monetary poor** the (multidimensionally) poor individuals who have an extreme monetary deprivation. We call **other-dimensions poor** the (multidimensionally) poor individuals who do *not* have an extreme monetary deprivation. We further distinguish other-dimensions poor individuals into two categories. First, the **consistently poor** are both monetary poor and other-dimensions poor.[18] Then, the **omitted poor** are other-dimensions poor but they are not monetary poor. As the latter taxonomy suggests, the national consumption poverty indicator, which only accounts for the monetary dimension, makes exclusion error on the individuals that we call omitted poor. Finally, we call **only monetary poor** the monetary poor who are not other-dimensions poor.

Both classifications of (multidimensionally) poor individuals are policy-relevant in different ways. First, distinguishing extremors from cumulators is relevant because the policies to fight these two kinds of poverties are different. For instance, no extremor can exit (multidimensionally) poverty when government

[18] The "consistently poor" terminology is borrowed from Whelan et al. (2003) and Bolch et al. (2022).

policies only reduce moderate deprivations. Second, distinguishing monetary poor from other-dimensions poor is not only useful for our purpose to contrast our well-being indicators with monetary poverty. As shown by Bolch et al. (2022), cross section data on non-monetary dimensions of deprivation help distinguish between transient and chronic monetary poor individuals. Their results suggest that the consistently poor are more likely to be chronic monetary poor than the only monetary poor. Again, the best policies to tackle chronic and transient monetary poverty are different.

The Venn diagram in Figure 7 illustrates the prevalence of these four types of (multidimensionally) poor in Nigeria. The diagram reveals that the fraction of (multidimensionally) poor individuals in Nigeria in 2019 is 51.9 percent. The fraction of monetary poor is (again) 40.5 percent and the fraction of other-dimensions poor is 27.9 percent. The fraction of other-dimensions poor is by definition the sum of the fractions of consistently poor and omitted poor, respectively 16.5 percent and 11.4 percent.

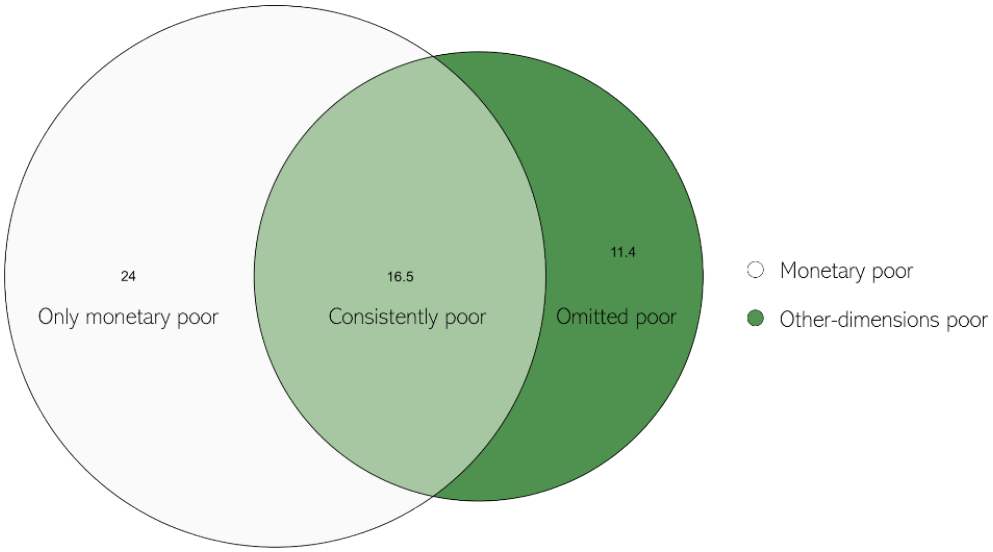

Figure 7: Classification of multidimensionally poor individuals in Nigeria, baseline scenario

Source: Authors' estimates based on data from NLSS 2019
Note: Using a Venn diagram, the figure shows the decomposition of multidimensional poverty, defined within the baseline scenario, into "Only monetary poverty" (transparent area), "Other dimensions-additional poor" for individuals multidimensionally poor without being monetary poor (dark green) and "Other dimensions – twice poor) for individuals cumulating monetary and other dimensions (light green).

Two facts are worth emphasizing here. First, being monetary poor is positively correlated to being other-dimensions poor. An intuitive quantitative sense of this correlation is provided by the coefficient of overlap between monetary and other-dimensions poverty, which is defined as

$$coefficient\ overlap = \frac{fraction\ of\ monetary\ poor\ indiv.\ who\ are\ other-dimensions\ poor}{fraction\ of\ not\ monetary\ poor\ indiv.\ who\ are\ other-dimensions\ poor}$$

and whose value is 2.1 in the Nigerian population. Loosely speaking, a monetary poor individual is 2.1 times as likely to be other-dimensions poor than an individual who is not monetary poor. Second, ignoring non-monetary dimensions of quality of life leads to a significant bias in terms of properly capturing low well-being. Indeed, 11.4 percent of the Nigerian population is not monetary poor but still has a well-being level that our indicator deems too low. Conversely, ignoring the monetary dimension of quality of life leads to an even greater bias in terms of properly capturing low quality of life. Indeed, 24 percent of the Nigerian population is only monetary poor, that is, not other-dimensions poor but monetary poor.

The Venn diagrams in Figure 8 further study the 11.4 percent of omitted poor, who are other-dimensions poor but not monetary poor. This diagram sheds light on the non-monetary dimensions and types of deprivations that make these individuals (multidimensionally) poor. Among the 11.4 percent who are omitted poor, 8.2 percent are extremors and 3.2 percent are cumulators. The left panel focuses on the 8.2 percent of omitted poor individuals who are extremors, which implies that the sum of all percentages in that panel is equal to 8.2 percent. The three bubbles each capture *extreme* deprivation status for one of the three non-monetary dimensions considered in the baseline design. The diagram reveals that 0.7 percent of the population (0.7=0.5+0.1+0.1+0) are omitted poor who suffer from at least two extreme forms of non-monetary deprivations. The right panel focus on the 3.2 percent of omitted poor individuals who are cumulators, which implies that the sum of all percentages in the intersections of the right panel is equal to 3.2 percent (3.2=0.1+1.5+0.4+1.2). The three bubbles each captures *moderate* deprivation status in one of the three non-monetary dimensions considered in the baseline design. These diagrams reveal that health and housing the most consequential extreme form of deprivation for omitted extremors while security is the most consequential moderate form of deprivation for omitted cumulators.

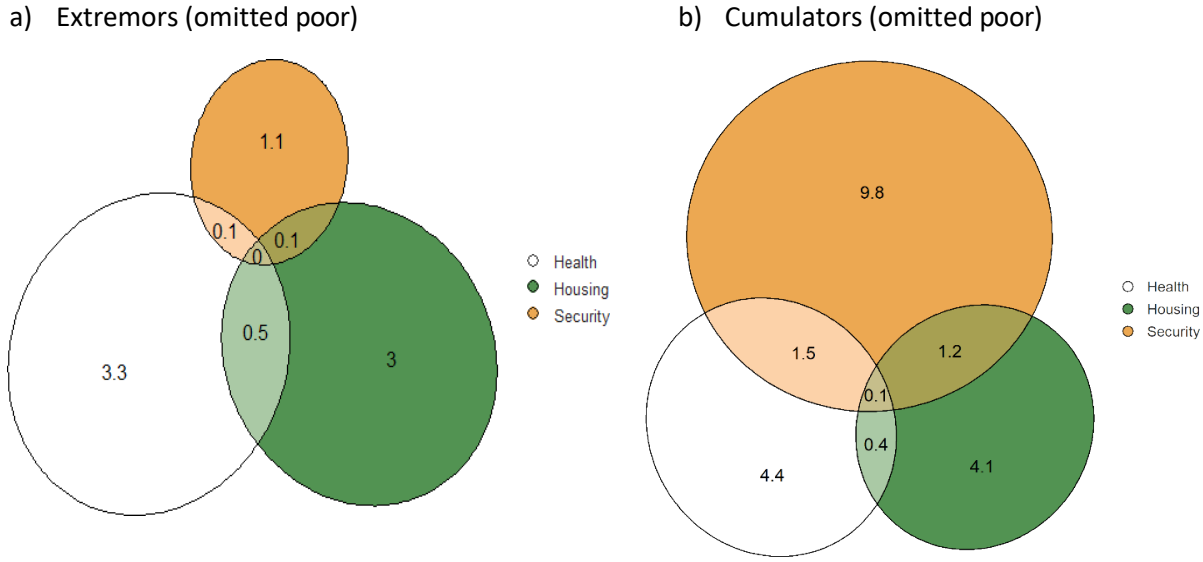

Figure 8: Overlap of the non-monetary deprivations suffered by omitted poor, baseline scenario

Source: Authors' estimates based on data from NLSS 2019
Note: The left panel shows the fraction of the Nigerian population that is simultaneously (i) not monetary poor and (ii) suffers from an extreme non-monetary deprivation. The right panel shows the fraction of the Nigerian population that is simultaneously (i) not monetary poor, (ii) does not suffer from an extreme non-monetary deprivation and (iii) suffers from a moderate non-monetary deprivation.

Table 2 provides a sense of the geographic distribution of different types of (multidimensional) poverty. Each of the three zones in the North have a larger fraction of (multidimensionally) poor individuals than each of the three zones in the South. This pattern is no surprise given that monetary poverty has the same geographical distribution and monetary poverty has a larger incidence than other-dimensions poverty in Nigeria. A more interesting insight of Table 2 is that other-dimensions poverty is less heterogeneously distributed across space than monetary poverty. Indeed, the fraction of other-dimensions poverty varies between 16.2 percent and 45.6 percent while the fraction of monetary poor individuals varies between 9.7 percent and 69.9 percent. This is confirmed by comparing the respective coefficient of variations for these two forms of poverty. One implication of this different heterogeneity across space is that ignoring

non-monetary dimensions leads to a larger bias when evaluating the *incidence* of low well-being in the south zones than in the north zones. For instance, the two zones with the largest fraction of omitted poor are in the south. This finding may be surprising given that (1) zones in the south have a smaller fraction of other-dimensions poor than zones in the north and (2) other-dimensions poverty has a similar correlation with monetary poverty in the north as in the south, as suggested by the coefficient of overlap. A key reason for this larger bias in south regions is that other-dimensions poverty is less heterogeneously distributed across space than monetary poverty. Another fact worth highlighting in Table 2 is that consistent poverty is the type of poverty most heterogeneously distributed across space. Consistently poor individuals are highly concentrated in north zones. Clearly, this follows from the fact that north zones both have higher monetary poverty rates and higher other-dimensions poverty rates. This potentially suggests that chronic monetary poverty might be largely concentrated in the north zones (Bolch et al. 2022).

Table 2: Prevalence of different types of multidimensionally poor individuals, per zone, baseline scenario

		Zones						
	National	**South West**	**South South**	**South East**	**North Central**	**North West**	**North East**	**Coefficient of variation across states**
Multidimensionally poor	51.9%	23.3%	36.1%	45.1%	54.2%	71.7%	80.5%	0.44
Monetary poor	40.5%	9.7%	20.8%	38.2%	43.1%	61.8%	69.9%	0.61
Other- dimensions poor	27.9%	16.2%	20.9%	15.4%	30.0%	37.0%	45.6%	0.47
Omitted poor	11.4%	13.5%	15.3%	6.9%	11.1%	10.0%	10.6%	0.52
Consistently poor	16.5%	2.6%	5.6%	8.4%	18.9%	27.0%	34.9%	0.79
Coefficient of overlap	2.1	1.8	1.4	2.0	2.2	1.7	1.4	0.30
Life expectancy at birth	49	52	50	50	49	49	45	0.06

Source: Authors' estimates based on data from NLSS 2019

Note: The table shows different poverty rates: multidimensional poverty, monetary poverty, and non-monetary poverty at the national level and within Nigeria's six zones. The table also shows the level of overlap between monetary poverty and other dimensions poverty, materialized by the overlap coefficient and the life expectancy at birth. The variability of each of the above measures is compared using the coefficient of variation across stated presented in the last column.

Impact of assumptions on the fraction of poor

We further study the sources of (multidimensional) poverty by using another method. We slightly change the assumptions of our design to study the impact of these assumptions.

First, we look at the respective impact of the three non-monetary dimensions of our baseline design (health, housing and security). More precisely, we contrast the fraction of other-dimensions poor and omitted poor when removing one of these three dimensions from our design. Table 3 provides the results. The results reveal that the importance of one dimension not only depends on the fraction of deprived individuals but also on the correlation between that dimension and monetary poverty. Indeed, for our baseline design, housing has the largest incidence of deprivation and removing it has the largest impact on the fraction of other-dimensions poor. However, housing is much more correlated with monetary poverty than health. As a result, health has the largest impact on the fraction of omitted poor. Table 3

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