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Utilising first order dominance methodology to evaluate Multidimensional Poverty in Mozambique

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Abstract

National assessments produced regularly from 1996/97 to 2019/20 provide standard estimates of poverty evolution in Mozambique. We rely on first order dominance (FOD) methodology to check their robustness and provide deeper insights into what happened in this country affected by extreme poverty. Maputo City and Maputo Province progressively came to dominate all other provinces; the provincial rankings from spatial FOD analysis are very stable over time. Areas, concentrated in the northern and central regions, are with few exceptions always at the bottom of the ranking. Moreover, our FOD temporal analysis reveals that 2019/20 dominates with a high degree of confidence the results from earlier years with one important exception. The comparison between 2019/20 and 2014/15 is indeterminate. The compelling need for concerted policy action to address the strong and persistent spatial gaps in welfare and poverty, including the capacity to respond to external and internal shocks stands out.

Keywords: Multidimensional poverty; First order dominance; Mozambique.

JEL Classification: I32; O55.

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Introduction

The Government of Mozambique (GoM) emphasizes in its current 5-year Government Plan (2020-2024) the need to improve welfare and living standards for its people, reducing at the same time social inequalities and poverty, and creating an environment of peace, harmony, and safety. For evidence-based policymaking in pursuit of these goals, the availability of detailed household data and in-depth analyses of the current state of the country are of the utmost importance. The national poverty assessments (DNPO, 1998; DNPO, 2004; DNEAP, 2010; DEEF, 2016; University of Copenhagen and UNU-WIDER, 2023) are key building blocks in this effort, providing estimates of the evolution of consumption and multidimensional poverty from 1996/97 to 2019/20. In the Fourth National Poverty Assessment (DEEF, 2016) we tentatively experimented with an innovative multidimensional poverty evaluation method, based on first order dominance (FOD). The contribution of the present paper is to develop and apply the FOD method to all the existing household budget survey data for Mozambique, with the objective of assessing how multidimensional poverty has evolved over time – and, in general, to test the robustness of the consumption poverty results.

We are motivated to use the FOD method as an analytical tool by some of the widely acknowledged constraints inherent to the Alkire-Foster (A-F) method for the estimation of a multi-dimensional poverty index (MPI) (Alkire et al., 2015). These constraints include the choice of weights attributed to each welfare dimension/indicator and the choice of the cut-off used to characterise people as multi-dimensionally poor or not. Arndt et al. (2018) argue that the A-F multidimensional poverty index is, in reality, inconsistent with the Universal Declaration of Human Rights principles of indivisibility, inalienability, and equality, due to the dependence on a weighting scheme and the underlying assumption about substitutability between the welfare indicators included. The FOD method implemented here does not impose such restrictive assumptions on utility or social welfare functions. Moreover, it allows us to rank welfare attainment in sub-populations without imposing a specific threshold to define households as poor. Rather, the only requirement we impose is that we rank the outcomes within each dimension from better to worse. Accordingly, the FOD method not only permits to make of spatial comparisons of multidimensional welfare between different provinces, regions or districts, but also temporal assessments between provinces, regions or districts over time. Arndt et al. (2018) also discuss how the FOD methodology maintains basic consistency with the Universal Declaration of Human Rights principles, and the authors note:

FOD comparisons are independent of any applied weighting schemes and hence are free from assumptions regarding substitutability between included welfare indicators (indivisibility). FOD cannot be established when welfare in any indicator is deteriorating, no matter how great the advancement is in other indicators (inalienability). Finally, FOD requires that domination occurs throughout the population (equality), implying that welfare gains among better-off groups never offset welfare losses among worse-off groups (Arndt et al., 2018).

This leads to the conclusion that the A-F MPI and FOD approaches are useful complements when analysing multidimensional welfare. This is the feature we utilise here, in combination with the notable availability of consistent household budget survey data for 1996/97, 2002/03, 2008/09, 2014/15 and 2019/20, allowing us to explore the long-term evolution of multidimensional poverty and well-being at national, urban/rural, and regional levels, using census data as well from 1997, 2007 and 2017. In addition to providing a different and analytically demanding perspective on the evolution of poverty in the country, applying the FOD methodology allows us to examine the sensitivity of A-F outcomes to the weights applied in the MPI approach. In addition, analysing multidimensional poverty with FOD is especially relevant in Mozambique because it allows comparing welfare attainments for different subpopulations. Indeed, Mozambique presents stark inequalities in multidimensional poverty along multiple dimensions. First, welfare attainment presents substantial variation at provincial level, with the southern provinces faring considerably better than northern and central provinces. In addition, Mozambique also faces a marked urban-rural divide.

The paper proceeds as follows. Section 2 describes poverty trends observed over time and relates to existing literature on the application of the FOD approach to multidimensional poverty measurement. Section 3 sets out our methodology, while Section 4 addresses data issues: the variables used for FOD estimation and their statistics. We present our results in Section 5, focusing on the temporal and spatial dominance at national, urban-rural, regional, regional-urban/rural and provincial level, while Section 6 concludes.

Context and literature review

In this section, we first summarize main results from official reports and additional studies that have analysed poverty (either consumption or multidimensional poverty) levels and trends in Mozambique. Subsequently, we review various studies that have used the FOD approach to analyse poverty measurement, concentrating on studies on multidimensional poverty, on the one hand, and those with a special focus on Mozambique and/or other developing countries, on the other.

Consumption and multidimensional poverty trends

In what follows we provide a comprehensive analysis of the series of four national poverty assessments in DNPO (1998), DNPO (2004), DNEAP (2010) and DEEF (2016), supplemented with the 2019/20 data analysed by University of Copenhagen and UNU-WIDER (2023). These data sets, known under the acronyms IAF96, IAF02, IOF08, IOF14 and IOF19, demonstrate that after a devastating conflict during the 1980s and the early 1990s, Mozambique experienced rapid economic growth. Excluding a drop in 2000, when a catastrophic flooding hit the country, the annual GDP growth rate was around 10 percent in the years 1996-2001, following the reconstruction of the country, and growth stabilized around 7.5 percent during 2002-2015 (World Bank 2018; 2020; 2021; 2023). The Fourth Poverty Assessment, produced in 2016 by the Ministry of Economics and Finance (MEF) with technical assistance from the University of Copenhagen and UNU-WIDER, and based on the 2014/15 Mozambican household budget survey, highlighted positive results in terms of poverty reduction and welfare improvements during 1996-2015 (DEEF, 2016). The headcount poverty rate fell from about 70 percent in 1996/97 to about 53 percent in 2002/03, 52 percent in 2008/09 and 46 percent in 2014/15, a notable gain in both regional and international comparative perspective (see DNPO, 1998; DNPO, 2004; DNEAP, 2010; DEEF, 2016; INE, 2004; 2010; 2015; Arndt et al., 2012; 2016; 2018). The trend included a substantial fall in poverty between 1996/97 and 2002/03, whereas the national poverty rate stagnated between 2002/03 and 2008/09, and poverty decreased again between 2008/09 and 2014/15 (DNPO, 1998; DNPO, 2004; DNEAP, 2010; DEEF, 2016).

However, starting from the second half of 2015, a significant economic slowdown occurred (Mahdi et al. 2018, 2019; World Bank, 2018; 2020; 2021; 2023; Egger et al., 2020; University of Copenhagen and UNU-WIDER, 2023). This turn-around was associated with a damaging combination of events. First, weakening global and regional economic performance became characteristic. Second, the disclosure of a hidden debt of approximately US\$ 2 billion contracted by three Mozambican state-owned companies and guaranteed by the Mozambican State caused havoc. Third, the fall in the prices of some of the most important export goods made macro-economic challenges acute. Fourth, a series of weather shocks, including two severe cyclones, Idai, and Kenneth, hit in 2019 and caused huge damage and distress in various areas of the country. Fifth, a series of violent attacks started occurring in the northern province of Cabo Delgado in late 2017, partially claimed by Islamist groups with other unknown actors involved, often targeting villages and thus creating insecurity and displacement for the local population. Sixth, the COVID-19 pandemic hit in 2020,

with its related health and economical costs. Finally, population numbers increased by 5 million people between 2014/15 and 2019/20.

The combination of these shocks led to a significant increase in the poverty rate between 2014/15 and 2019/20, from 46 percent to 68 percent (University of Copenhagen and UNU-WIDER, 2023). Table 1 shows the consumption poverty results for all household budget surveys at national level and at different levels of disaggregation (rural/urban, north, centre and south, and provinces). The most recent poverty study shows that poverty is higher in rural (76.5 percent) than in urban areas (52.8 percent) and it is higher in the North (78.1 percent) and Centre (68.4 percent) than in the South (50.6 percent). Moreover, the biggest increase in the poverty rate was in Cabo Delgado (+37.4 pp), most likely due to the insurgency in the province, but most other provinces also registered significant increases. In the same report, it emerges that economic inequality increased significantly, with a dramatic acceleration occurring in the last ten-twelve years (see also Barletta et al., 2022, Gradín and Tarp, 2019; World Bank, 2018).

Multidimensional poverty decreased substantially during 1996/97-2014/15, and during 2014/15-2019/20 only improved modestly. We consider six indicators (education, water, sanitary conditions, housing coverage, electricity and possession of durable goods). It emerges that in 1996/97 close to half the population lived in households deprived across all dimensions. These families were characterized by not having any member of the household with complete primary education, not having access to safe water, having inadequate sanitation, having grass or similar materials covering their houses, not having access to electricity, and having a very limited supply of durable goods. Furthermore, only two percent of the population lived in a household where all these basic characteristics were present (zero deprivations). This situation improved significantly, so less than 13 percent of the population was deprived across all dimensions and over 16 percent of the population reported zero deprivations in 2019/20 (Table 2).

In Table 3, we present the multidimensional poverty incidence, H, estimated using the A-F method for the period 1996/97–2019/20 (Alkire et al., 2015; University of Copenhagen and UNU-WIDER, 2023). The multidimensional poverty incidence, H, was 55 percent in 2014/15, at a lower level than in 2008/09 and at a much lower level than 1996/97. However, multidimensional poverty incidence only reduced to 53 percent in 2019/20. The same table shows variations by areas/province, with multidimensional poverty being significantly worse for the northern and central regions of the country and for rural areas. The decreasing trend in multidimensional poverty is also confirmed when different data sources are used, such as the population censuses or the Demographic and Health Survey (DHS) data. Using essentially the same welfare indicators adopted in the evaluation of multidimensional poverty using the household budget surveys, and applying the A-F methodology, the census data show that multidimensional poverty decreased both between 1997 and 2007 and between 2007 and 2017, more substantially in the latter period. The multidimensional poverty

incidence, H, fell from about 87 percent to about 77 percent from 1997 to 2007, and it decreased to about 48 percent in 2017 (Cardoso et al., 2016; 2021; DNPED, 2020).

Table 1 Consumption poverty rates, national, urban/rural, regional and provincial level, 1996/97 -2019/20 (percent)

Area	1996/97	2002/03	2008/09	2014/15	2019/20*
National	69.7	52.8	51.7	46.1	68.2
Urban	61.8	48.2	46.8	37.4	52.8
Rural	71.8	55.0	53.8	50.1	76.5
North	67.3	51.9	45.1	55.1	78.1
Centre	74.1	49.2	57.0	46.2	68.4
South	65.5	59.9	51.2	32.8	50.6
Niassa	71.9	48.3	33.0	60.6	73.4
Cabo Delgado	59.1	60.3	39.0	44.8	82.2
Nampula	69.4	49.1	51.4	57.1	78
Zambezia	67.6	49.7	67.2	56.5	76.5
Tete	81.9	60.5	41.0	31.8	61.1
Manica	62.4	44.7	52.8	41.0	66.8
Sofala	87.8	41.3	54.4	44.2	60.3
Inhambane	83.0	78.1	54.6	48.6	66.6
Gaza	64.8	55.4	61.0	51.2	76.9
Maputo Province	65.6	59.0	55.9	18.9	36.4
Maputo City	47.1	42.9	29.9	11.6	22.4

Note: Percentage of people living in poverty over the total population for different areas and for all available household budget surveys. * Results for 2019/20 have been calculated using the same poverty computation methodology applied in all previous national poverty assessments for Mozambique, but they are not official.

Source: Authors' elaboration based on University of Copenhagen and UNU-WIDER (2023).

Table 2. Number of deprivations suffered, national level (percent)

Number of deprivations suffered	1996/97	2002/03	2008/09	2014/15	2019/20*	Difference 1996/97-2019/20
0	2.0	5.1	8.5	15.9	17.4	15.5
1	2.3	4.0	5.3	8.3	8.7	6.4
2	3.0	6.1	6.8	8.7	8.5	5.5
3	6.9	9.1	10.1	12.7	12.4	5.5
4	12.0	16.0	18.6	19.2	18.2	6.2
5	27.2	26.4	27.0	21.4	21.4	-5.8
6	46.6	33.3	23.7	13.7	13.4	-33.2

Note: Percentage of people experiencing different numbers of deprivations for all IAF/IOF. The deprivations considered are not having any member of the household with complete primary education (first cycle, EP1), not having access to potable water, having inadequate sanitation, poor quality coverage, not having access to electricity, and very limited possession of durable goods. * We calculated the 2019/20 results using the same poverty computation methodology applied in all previous national poverty assessments for Mozambique, but they are not official.

SOURCE: AUTHORS' ELABORATION BASED ON DEEF (2016) AND UNIVERSITY OF COPENHAGEN AND UNU-WIDER (2023).

¹ The northern region includes the provinces of Niassa, Cabo Delgado and Nampula; the central region Zambezia, Tete, Manica and Sofala; and the southern region Inhambane, Gaza, Maputo Province and Maputo City.

¹ DEEF (2016) estimates the consumption aggregate based on the cost of basic needs methodology, and the poverty measures belonging to the Foster et al. (1984) classes were subsequently applied. For multidimensional poverty, the A-L method was applied, taking into account six well-being indicators, with equal weighting (DEEF 2016; Alkire et al., 2015).

¹ The multidimensional poverty incidence results presented are from own calculations based on Cardoso et al. (2016; 2021) and DNPED (2020). Additional details with respect to multidimensional poverty indices computed on the basis of census data are in Section 5.

Table 3. Multidimensional poverty incidence, national, urban/rural, regional and provincial level, 1996/97–2019/20 (percent)

Area	1996/97	2002/03	2008/09	2014/15	2019/20*
National	0.86	0.76	0.69	0.54	0.53
Urban	0.50	0.41	0.31	0.18	0.19
Rural	0.95	0.92	0.86	0.71	0.71
North	0.95	0.87	0.81	0.67	0.65
Centre	0.93	0.84	0.80	0.63	0.61
South	0.64	0.48	0.33	0.19	0.15
Niassa	0.95	0.89	0.77	0.71	0.68
Cabo Delgado	0.97	0.90	0.83	0.62	0.65
Nampula	0.95	0.85	0.82	0.67	0.64
Zambezia	0.96	0.92	0.88	0.74	0.74
Tete	0.95	0.89	0.85	0.67	0.59
Manica	0.89	0.70	0.76	0.49	0.47
Sofala	0.86	0.71	0.62	0.46	0.50
Inhambane	0.83	0.81	0.60	0.43	0.37
Gaza	0.79	0.52	0.47	0.23	0.19
Maputo Province	0.73	0.38	0.18	0.07	0.05
Maputo City	0.18	0.13	0.03	0.01	0.00

Note: We computed the multidimensional poverty incidence (*H*) using the A–F method. A more detailed description is available in DEEF (2016). * We calculate the 2019/20 results using the same poverty computation methodology applied in all previous national poverty assessments for Mozambique, but they are not official.

SOURCE: AUTHORS' ELABORATION BASED ON UNIVERSITY OF COPENHAGEN AND UNU-WIDER (2023).

With respect to the DHS data, Egger et al. (2020) analysed the evolution of multidimensional poverty in Mozambique applying the A-F method and using the 2011 DHS, the 2009 and 2015 AIDS Indicator Surveys (AIS) and the 2018 Malaria Indicator Survey (MIS) data. Consistent with the evolution of poverty described in the four available national poverty assessments, they find that the multidimensional poverty reduction trend observed between 2009–11 and 2015 effectively halted between 2015 and 2018. However, the number of people, who were poor by this measure, increased, mainly in rural areas and in the central provinces (Egger et al., 2020).

Poverty analyses using the FOD approach also exist for Mozambique, mainly as part of the Fourth National Poverty Assessment (DEEF, 2016). From the spatial point of view, this assessment applied the FOD procedure at provincial level and it emerged that the rankings obtained until 2014/15 were very stable over time, contrary to what happened for the provincial rankings relative to the consumption poverty measures. Moreover, the provinces of Maputo City, Maputo Province, and Gaza always rank first, second and third, respectively, whereas the provinces of Niassa, Cabo Delgado, Nampula, Zambezia and Tete remained in the bottom five positions in all surveys until 2014/15.

In addition, regarding changes over time, the FOD method applied to the 1996/97, 2002/03, 2008/09 and 2014/15 surveys provided important indications on the probability for each province or region of the country to be in a better situation, from a multidimensional point of view, compared to previous years. From the same assessment, it emerges that for the country as a whole and up to 2014/15, the probability of advancement is equal to one (100 percent) in most comparisons. This result suggests, with a high level of confidence, that at the national level, the multidimensional well-being situation improved until 2014/15. Nevertheless, at the same time the north and, in particular, the rural areas of the north showed the lowest probabilities of improvement (DEEF, 2016).

Literature review

In this sub-section, we review the studies that used the FOD approach to analyse poverty measurement, focusing on the few that have used the FOD approach to analyse multidimensional poverty and that had a special focus on Mozambique and/or other developing countries. Based on small area estimation techniques and applying the (FOD) approach, Arndt et al. (2016) used the 1997 and 2007 population censuses for Mozambique and the 1996/97 and 2007/08 Mozambican household budget survey data to analyse well-being at the district level. Their results, based on 146 districts, indicated that the districts ranked as most deprived are those located in the northern and central areas. None of the southern districts appears in the lowest-ranked group. Also, as it emerged in the headcount ratio analysis (poverty mapping), the FOD results showed that disaggregating the analysis to the district level provided additional information on intra-province welfare differences. In 2007, most of the FOD lowest-ranked districts were again located in the central and Northern provinces, while most of the southern districts were confirmed as the FOD best-ranked ones. Looking at the FOD temporal index, no 1997 district dominated itself in 2007. There were 76 districts (out of 146), for which the probability of experiencing welfare improvement was higher than 50 percent. Given the strictness of the FOD criterion, this is a salient result confirming broad-based advances in living conditions between 1997 and 2007.

Egger et al. (2020) suggested that the poverty reduction trend observed between 2009–11 and 2015 decelerated rapidly, and that the poorest provinces had generally not improved their rankings over time. They reached these results using the standard A–F multidimensional poverty index and the FOD method, both applied to Demographic and Health Survey (DHS), AIDS Indicator Survey (AIS) and Malaria Indicator Survey (MIS) data for Mozambique. Moreover, they found that the percentage of people with zero deprivations only slightly increased between 2015 and 2018, whereas the percentage of people with the maximum number of deprivations reduced modestly at the national level and it increased in urban areas, even if only slightly. The estimated probability of advancement between 2015 and 2018, as measured by the temporal FOD approach, was practically zero for most areas and provinces. These results pointed to a troubling intensification of poverty when focusing on absolute numbers of people. Indeed, the study found that the number of people experiencing multi-dimensional poverty had increased, mainly in rural areas and in the central provinces.

Comparing Mozambique with Vietnam, Arndt et al. (2012) used the FOD approach to analyse child poverty in the two countries. The results indicated that in Vietnam advance in well-being took place at the national level, in rural zones and in two regions. There was essentially no probability of regression through time in any region. These results provided evidence that gains over the 2000–06 period were reasonably broad-based. Conversely, Mozambique registered fewer gains: as in Vietnam, there was essentially no evidence of regression through time, but there was a positive probability of advancement only at the national level, in rural zones and in six of the 11 provinces. However, these probabilities tended to be quite small.

Permanyar and Hussain (2017) undertook a broader analysis of multidimensional welfare in developing countries using the FOD methodology and applying it to 48 DHS data, mostly from the period 2006-12. Their results suggested that the highest observed number of dominations was for Ukraine, which dominated 45 countries. Eleven countries, including Mozambique, did not dominate other countries (Burkina Faso, Benin, Burundi, Ethiopia, India, Liberia, Moldova, Mali, Mozambique, Niger and Rwanda). The highest number of times for dominating a country was 31 (Mali), while 28 other countries dominated Ethiopia and Liberia. Only two countries did not experience dominance by other countries (Ukraine and Armenia).

In summary, most of the existing analyses of multidimensional wellbeing, either focusing on Mozambique or including Mozambique among the countries considered, indicate that achieving robust poverty reduction and, in particular, inclusive growth in the country remains a major challenge. The central and northern provinces, and especially rural areas, lag behind in terms of poverty and well-being; moreover, convergence between better-off and more deprived areas and provinces remains elusive.

Methodology

Poverty is a multidimensional phenomenon. As such, analyses relying on standard methods based on income or consumption cannot stand-alone. Non-monetary deprivation is key. Alongside the A-F method, the FOD approach, in particular, is among those methods that compute multidimensional poverty based on the joint distribution of deprivations. This requires that the information with respect to each dimension or indicator of deprivation is available for each unit of analysis (household or individual) (Alkire et al., 2015; DNPED, 2020).

The methodology implemented here relies on the availability of data on several welfare indicators, which are relevant for the multidimensional poverty analysis, but it is also rooted in previous studies, mainly the national poverty assessments for Mozambique, to provide a comparable assessment of multidimensional poverty and deprivation for the country. Therefore, the present analysis uses as welfare components the same set of indicators used in the Fourth National Poverty Assessments (DEEF, 2016) and in University of Copenhagen and UNU-WIDER (2023), as a basis for evaluating multidimensional poverty spatially and over time. The six welfare indicators considered are education, water, sanitation, housing coverage, electricity and possession of durable goods. Further detail follows in the data section.

As is the case for the more standard A-F method for deriving an MPI (Alkire and Foster, 2011; 2015), the FOD approach is based on a series of binary deprivation indicators where the population is divided into those considered deprived and those considered not deprived for each indicator. In the MPI approach, each indicator receives a weight, after which households deprived in indicators whose weights sum up to a value greater than a pre-determined cut-off fall in the category of the multi-dimensionally poor. Finally, the analyst combines this multidimensional poverty incidence or headcount with a measure of poverty intensity and the product of the headcount and the poverty intensity measure form the A–F multidimensional poverty index. The A–F method has been widely used, especially because it is flexible, intuitive and relatively simple to apply. Nonetheless, it requires explicit weights, which are in many ways arbitrary, as well as assumptions regarding the cut-off point, for which there is no clear theoretical guidance. The FOD approach attempts to overcome some of these constraints, relying only on the proposition that a not deprived state is better than being-deprived, for any dimension considered. Indeed, it is possible to identify, using multiple binary indicators, states that are arguably better and states that are arguably worse (e.g., being not deprived in all dimensions versus being deprived in all dimensions).

We now turn to details on the FOD comparison in practice, and available choices on how to deal with indeterminate comparisons, with some examples, including only a summary of the methodology. The intuition behind the FOD approach can be illustrated in the following way: suppose we have data for six binary deprivation indicators, relative to populations A and B; then, suppose we want to determine, based on these indicators, whether A is unambiguously better-off than B. As a first step, the populations A and B divide into $2^6=64$ different possible states: each state corresponds to a combination of deprivation/non-deprivation with respect to the various indicators. If we define 0 as deprived and 1 as not deprived, we can define, for example, the state

(0,0,1,0,1,0) or the state (1,0,1,1,1,0). Belonging to the former are those households deprived in the first, second, fourth and sixth indicator, whereas belonging to the latter are those deprived only in the second and sixth indicator. Among the different possible states, households belonging to the state (1,1,1,1,1,1) are clearly best-off, while those in the state (0,0,0,0,0,0) are worst-off. As a further step, assume that the state (0,1,1,0,0,0) is unambiguously better than the state (0,0,1,0,0,0) because the former state is always at least equivalent with the latter, and it is superior to the latter in one instance (second indicator). So far, this is quite straightforward. Nonetheless, complications arise when we attempt to compare, for example, the states (1,0,1,0,0,0) and (1,1,0,0,0,0); in this case, the comparison would be indeterminate, because none of the states can be considered unambiguously better than the other. Indeed, given that we do not rely on any judgement with respect to the relative importance of the various indicators, we cannot say upfront that being deprived in the second indicator is, in terms of welfare, better than being-deprived in the third indicator, and vice-versa.

Following Arndt et al. (2012; 2016) and Arndt and Tarp (2017), we say that in some situations population A first-order dominates population B. This is so if, starting with the shares of the population in each state found in A, one can generate the shares of the population in each state found in B, by only shifting probability mass within population A from states that are unambiguously better to states that are unambiguously worse. When we compare more than two populations, relating to, for example, different regions in a country, then the question arises about how to create complete welfare rankings. Here we follow Copeland (1951), who argues that complete welfare rankings of regions can be generated by, for example, counting the number of times a given region dominates other regions and subtracting the number of times the same region is dominated by other regions, and subsequently generating a score in the interval $[-99,99]$. In this way, regions can be ranked, from the highest to the lowest score, and a Copeland index can subsequently be defined, with all the scores normalised to fall within the interval $[-1,1]$.

Getting back to the issue of indeterminate comparisons discussed above, suppose again that we have two populations, A and B, and that neither A dominates B nor does B dominate A. In such a situation, ranking of A and B may still be possible. Relying on comparisons by means of bootstrapping methods, one may obtain various illustrative outcomes. First, occasionally population A dominates population B and occasionally the inverse occurs, but most of the time the results are indeterminate. Second, population A almost without exception dominates B. Third, the probability that A dominates B is high while the probability that B dominates A is very low or zero. In these cases, we interpret the first situation as rough equality between A and B, the second as solid dominance of population A over B, and the third as likely dominance of population A over B. More pointedly, using bootstrapping methods we can derive a series of outcomes, which are probabilities of domination (the probability that one population will dominate another). These probabilities are more informative and could mitigate the disadvantage emerging from the relatively high likelihood of obtaining indeterminate comparisons in the FOD framework. As a final remark, if one is willing to accept the probability that A dominates B as a cardinal measure of welfare, one can then derive measures that yield cardinal welfare rankings across multiple populations.

Clearly, populations A and B can be different regions within a country or different countries, but they can also represent the same region or country at different points in time. In this way, the FOD criterion also permits to assess temporal advancements in terms of multidimensional poverty. Moreover, in this case as well the use of bootstrapping methods can help to mitigate the problem arising from the likelihood of obtaining indeterminate comparisons, allowing us to compute probabilities of advancement.

Given its relatively high degree of complexity in application and interpretation, the FOD approach has been less widely used than the A-F approach. Nevertheless, the fact that it does not require any assumptions with respect to the relative importance of the different dimensions/indicators of multidimensional poverty represents a noteworthy advantage with respect to other methods. Moreover, from the discussion above, it emerges that the FOD criterion is certainly stricter than other methods in registering domination between different populations or registering progress over time. Indeed, methods such as the A-F approach that assign relative weights to deprivation indicators might register progress in multidimensional deprivation even in cases where this is debatable. This would happen due to the underlying substitution assumption where progress in some other indicator(s) outweighs declines in some indicator. Conversely, within the FOD framework, there is no complementarity/substitutability between the different welfare dimensions/indicators. Therefore, consistency between the FOD results and the more standard A – F method is not automatic. As an additional complication, assessing dominance using the FOD approach just outlined is computationally demanding, so only a limited number of welfare indicators are considered.

Table 4. Welfare indicators and condition of deprivation

Indicator	Condition of deprivation for the household
Schooling	If no one completed Primary Education 1 st Grade (5 years)
Safe Water Source	If the household does not use piped water (indoors, outside the house/backyard), fountain water, borehole or well water with a mechanical or manual pump, mineral water or bottled water
Safe Sanitation	If household uses unimproved latrine, or does not have any type of toilet or latrine
Conventional Material Coverage	If the household does not have as roof/coverage a concrete slab, tiles or sheets of asbestos or zinc
Access to electricity	If the household does not have access to electricity
Possession of Durable Goods	If the household does not own at least three durable goods from a list of the most common durable goods (bicycle, car, motorcycle, television, radio, computer printer, bed, refrigerator, freezer, sound system, landline or cell phone)

Note: Welfare indicators and deprivation condition considered in the Fourth National Poverty Assessment (DEEF, 2016) and in University of Copenhagen and UNU-WIDER (2023) for the multidimensional poverty assessment, 1996/97-2019/20.

SOURCE: AUTHORS' ELABORATION BASED ON DEEF (2016) and UNIVERSITY OF COPENHAGEN AND UNU-WIDER (2023).

Data and welfare indicators

We use data from the five existing Mozambican household budget surveys (Inquéritos aos Agregados Familiares sobre Orçamento Familiar, abbreviated as IAF or IOF, depending on the year). They were designed and implemented by the National Statistics Institute (Instituto Nacional de Estatística, INE), and we refer to the various surveys as IAF96, IAF02, IOF08, IOF14 and IOF19, respectively. The surveys are similar in many of their characteristics, with relatively minor differences in the structure of the questionnaires. They are representative at national, rural/urban, regional and provincial levels. With respect to their structure, the IAF96, IAF02, IOF08, and IOF19 interviewed households once over four quarters, whereas IOF14 interviewed households three times between 2014 and 2015, though maintaining a high degree of comparability with the other surveys. The number of surveyed households varies between 8,250 for IAF96 and 13,343 for IOF19. All the surveys contain information on general household characteristics, employment, education, access to basic services, daily, monthly and annual household expenditures and information on household consumption from own production, possession of durable goods, housing conditions, receipts and transfers received and paid, income from various sources, as well as less frequent expenses. The consumption aggregate is computed using daily, monthly, and annual household expenditures; expenditures obtained from specific modules on education, health and tourism; individual expenditures not captured in the household module; receipts in-kind; imputed house rents; and imputed use value for durable goods.

With respect to multidimensional welfare, we selected six indicators in the framework of the Fourth National Poverty Assessment, and subsequent analyses (DEEF, 2016; University of Copenhagen and UNU-WIDER, 2023) rely on the same indicators. The selection of the dimensions of deprivation, of the indicators corresponding to each dimension and of the assigned weights depended mainly on four factors. First, the relevance of the dimensions and indicators about well-being, also based on the relevant literature. Second, the availability of similar information in all surveys. Third, the comparability of the questions included in the questionnaires across all the surveys, as well as the comparability of the categories listed in each question, to ensure consistently assessing deprivation and non-deprivation status. Fourth, a consultative process was undertaken in all the regions of the country, conducted in collaboration with UNDP and UNICEF prior to the publication of the Fourth National Poverty Assessment (DEEF, 2016). The first and third criteria, in particular, greatly limited the choice of available indicators, mainly due to the lack of comparability between older surveys – the IAF96 (and, to a lesser extent, the IAF02) – and subsequent surveys, and mainly with regard to the questions on access to basic services.

The six selected indicators are described in more detail in Table 4, taking into account the criteria used by INE in defining safe water sources, safe sanitation, house coverage/roofing of conventional material and access to electricity. Given the relevance of each of the chosen indicators, in the Fourth National Poverty Assessment and in University of Copenhagen and UNU-WIDER (2023) we assigned the same weight to all indicators when applying the A-F method for computing multidimensional poverty. In the FOD framework, we do not need to assign weights.

Results

We now proceed to our results, beginning with the descriptive statistics for all indicators in all surveys. Hereafter we introduce the spatial and temporal FOD results respectively, discussing them in relation to the existing poverty results reported for Mozambique. We end with our robustness check with respect to the assessment of multidimensional poverty, using the census data for 1997, 2007 and 2017 instead of the household budget survey data.

Descriptive statistics

In Table 5 we show the deprivation levels for each selected indicator in 1996/97, 2002/03, 2007/08, 2014/15 and 2019/20, for the total national population and differentiated at urban/rural, and regional level. In general, the results show a reduction in the level of deprivation over the period under review for all indicators, with some exceptions with respect to water source and possession of durable goods in the last period. Furthermore, there are differences in the speed of reduction or increase between the analysed indicators, at the regional level and by area of residence (rural and urban), with access to education, to electricity and to quality sanitation standing out among the indicators of rapid improvement.

It is clear in Figure 1 that a large part of the population remains deprived in some indicators, mainly those referring to housing conditions, such as access to safe water and sanitation, electricity, good quality housing coverage and possession of durable goods, particularly in rural areas. Nonetheless, the deprivation status of the rural population in relation to sanitation (which is also considered an important determinant of health), and housing conditions (type of coverage, electricity) in 2019/20 has improved compared to the levels recorded in 2014/15. Conversely, and despite the difference in deprivation in terms of area of residence, deprivation in water and in durable goods increased, only slightly with respect to the former and more markedly with respect to the latter. In particular, the increase in durable goods deprivation in 2019/20 is only in rural areas; this may indicate that some rural households could have been selling durable goods to sustain consumption/living standards in response to consumption shocks or that climate shocks destroyed some durable goods. Another explanation could come from the fact that radios and bicycles, the two items for which ownership decreased the most, are not anymore as relevant as they were in previous years. However, while in urban areas it seems as though they were replaced by better substitute items, like TVs/computers and/or motorbikes/cars, this was not the case in rural areas, where it appears as they were simply abandoned.

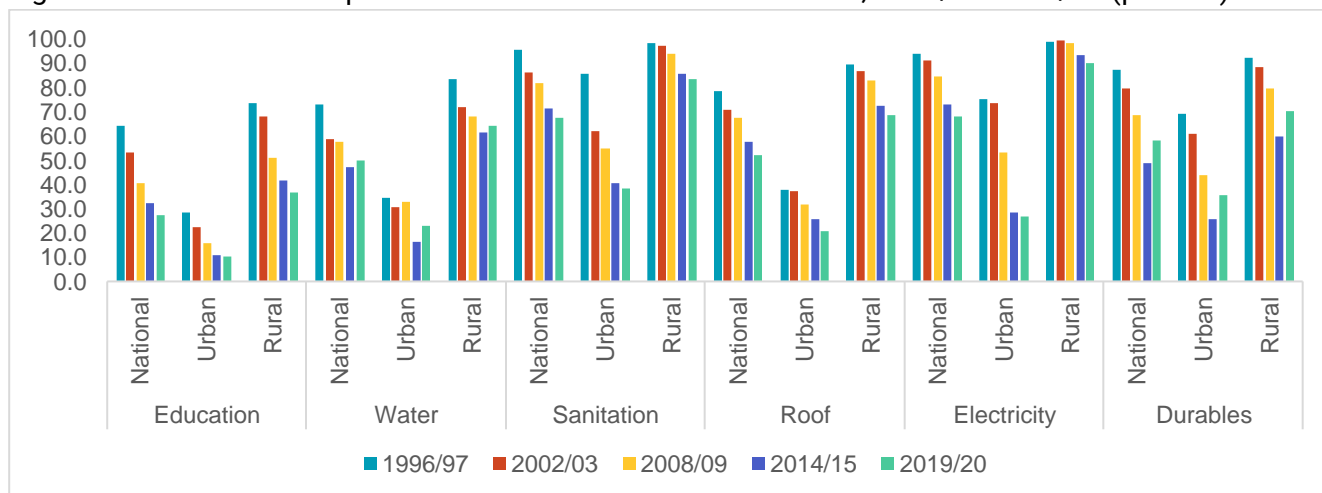
Table 5. Prevalence of deprivation for selected welfare indicators, 1996/97-2019/20 (percent)

	Education					Water				
	1996/97	2002/03	2008/09	2014/15	2019/20	1996/97	2002/03	2008/09	2014/15	2019/20
National	64.1	53.3	40.4	32.4	27.5	73.1	58.6	57.5	47.2	49.8
Urban	28.6	22.4	16.1	10.8	10.4	34.5	30.4	32.9	16.5	23.1
Rural	73.6	67.8	51.0	42.6	36.7	83.4	71.9	68.3	61.4	64.1
North	72.1	64.0	49.4	43.1	39.4	80.1	57.5	60.7	56.8	58.8
Centre	70.2	58.5	44.0	35.1	27.5	78.5	67.3	64.9	53.9	58.2
South	45.4	31.2	21.5	11.9	8.6	56.4	45.4	39.9	20.4	16.8
	Sanitation					Housing coverage				
National	95.5	86.0	82.0	71.6	67.6	78.3	70.9	67.3	58.0	52.1
Urban	85.4	61.8	54.9	41.1	38.2	38.0	37.3	31.8	25.3	20.9
Rural	98.3	97.4	93.9	85.9	83.4	89.0	86.7	82.8	73.3	68.8
North	98.6	92.8	90.6	79.3	76.3	95.9	90.4	85.8	77.1	69.3
Centre	98.3	91.0	89.1	80.0	74.4	90.4	83.6	78.3	65.7	58.7
South	87.9	69.2	57.5	44.3	38.4	38.9	25.5	22.0	15.2	8.7
	Electricity					Durable goods				
National	93.9	91.1	84.8	72.9	67.9	87.3	79.5	68.7	49.8	58.0
Urban	75.2	73.2	53.3	28.8	26.7	92.2	88.3	79.6	60.7	35.3
Rural	98.9	99.5	98.6	93.5	89.9	69.2	60.8	43.8	26.4	70.2
North	96.6	93.6	90.9	79.8	73.5	93.8	83.2	78.3	55.4	64.6
Centre	97.3	95.0	91.4	82.8	77.2	91.2	87.3	75.0	59.7	64.3
South	85.5	81.4	64.7	43.9	38.8	72.8	63.6	43.0	24.6	33.9

Note: Prevalence of deprivation (in percentage) for each deprivation indicator considered in the multidimensional poverty assessment, 1996/97-2019/20.

Source: Authors' elaboration based on University of Copenhagen and UNU-WIDER (2023).

Figure 1. Prevalence of deprivation for selected welfare indicators, 1996/97-2019/20 (percent)



Note: Prevalence of deprivation (in percentage) for each deprivation indicator considered in the multidimensional poverty assessment, 1996/97-2019/20. National and urban/rural level.

Source: Authors' elaboration based on University of Copenhagen and UNU-WIDER (2023).

Spatial FOD comparisons and rankings

In Table 6 we present the rankings obtained applying the FOD procedure to the comparison of different spatial aggregates, providing a more detailed overview of the evolution of relative welfare in the country. In this table, we use spatial bootstrap FOD results to compare different area aggregates based on the net probability of domination, that is, the average probability that an area dominates all others minus the average probability of domination by all other areas.¹

From the net probability of domination and ranking results, we conclude that they largely confirm the general trends and spatial divide outlined in Section 2. A marked division between the urban areas and the three most southern provinces (Gaza, Maputo Province and Maputo City) and the rest of the country is evident, especially when compared to the provinces of the North (Cabo Delgado, Niassa, Nampula) and to Zambezia, and particularly to their rural areas. This split is consistent over the years, and most area aggregates show no change in their ranking, compared to either 1996/97 or 2014/15, or change it by only ± 1 - ± 2 positions. The rankings based on the net domination probability are thus very stable over time.

In particular, Maputo City dominates all other provinces and areas (the net domination probability is close to or equal to one in all years), but Maputo Province markedly improved its ranking over time, becoming the second best-off area in 2019/20. Together with Maputo Province, also the province of Tete and the rural areas of the southern region improved their ranking significantly over time (by five and four positions, respectively). For Tete, this reflects developments subsequent to the discovery of important coal reserves in the last 10-15 years; and for the rural areas of the South, this links to the fact that rural areas in the south are being progressively urbanised, and are thus assuming more urban characteristics with respect to other rural areas of the country. To this comes the relative closeness to the capital area that has had a positive effect in terms of improvement of some of the welfare indicators selected (easier access to services, increased availability of durable goods and of better-quality construction materials, among others).

¹ Due to the randomness introduced by bootstrapping, some care is required in the interpretation of rankings.

Table 6. Spatial net first order dominance (FOD), net domination probability (PND) (percent) and respective rankings, national, urban/rural, regional, regional-urban/rural and provincial level, 1996/97-2019/20

Area	PND 1996/97	Rank 1996/97	PND 2002/03	Rank 2002/03	PND 2008/09	Rank 2008/09	PND 2014/15	Rank 2014/15	PND 2019/20	Rank 2019/20	Change 1996/97- 2019/20	Change 2014/15- 2019/20
Maputo City	0.997	1	0.876	1	0.998	1	1.000	1	0.989	1	0	0
Maputo Province	0.394	6	0.612	5	0.765	3	0.845	3	0.868	2	-4	-1
South urban	0.910	2	0.792	2	0.874	2	0.870	2	0.864	3	1	1
South	0.593	4	0.556	6	0.615	5	0.559	5	0.569	4	0	-1
Urban	0.707	3	0.669	3	0.642	4	0.568	4	0.523	5	2	1
Centre urban	0.583	5	0.645	4	0.595	6	0.488	6	0.502	6	1	0
Gaza	0.198	7	0.412	7	0.249	7	0.459	7	0.428	7	0	0
North urban	0.092	9	0.384	8	0.185	8	0.273	8	0.270	8	-1	0
South rural	-0.159	13	-0.173	12	-0.125	11	0.076	10	0.116	9	-4	-1
Manica	-0.156	12	0.068	10	-0.193	13	-0.004	12	0.075	10	-2	-2
Sofala	-0.127	11	0.075	9	0.051	9	0.113	9	0.045	11	0	2
Inhambane	0.048	10	-0.175	13	-0.172	12	-0.024	13	0.023	12	2	-1
National	0.131	8	-0.001	11	0.030	10	0.011	11	-0.033	13	5	2
Tete	-0.429	19	-0.440	19	-0.335	16	-0.424	16	-0.277	14	-5	-2
Centre	-0.329	15	-0.277	15	-0.301	15	-0.314	14	-0.331	15	0	1
Cabo Delgado	-0.306	14	-0.431	18	-0.360	18	-0.443	18	-0.397	16	2	-2
Nampula	-0.364	17	-0.265	14	-0.408	19	-0.394	15	-0.412	17	0	2
North	-0.373	18	-0.322	17	-0.355	17	-0.432	17	-0.438	18	0	1
Niassa	-0.364	16	-0.312	16	-0.253	14	-0.496	19	-0.491	19	3	0
Rural	-0.446	20	-0.594	21	-0.556	20	-0.630	21	-0.659	20	0	-1
Zambezia	-0.451	21	-0.566	20	-0.559	21	-0.621	20	-0.691	21	0	1
Centre rural	-0.603	23	-0.734	22	-0.739	23	-0.649	22	-0.696	22	-1	0
North rural	-0.546	22	-0.797	23	-0.647	22	-0.831	23	-0.848	23	1	0

Note: PND = net domination probability (i.e. the probability of dominating other areas minus the probability of being dominated by other areas).

Source: Authors' elaboration based on University of Copenhagen and UNU-WIDER (2023).

Conversely, the national average is in 2019/20 in a much worse position with respect to past surveys, with important stability at the bottom of the list. The central region, the provinces of Cabo Delgado and Nampula, the northern region, the province of Niassa, the rural areas, the province of Zambezia, the rural areas of the central region and the rural areas of the northern region are low performers with few changes in their respective position between one survey and the other.

Given the strictness of the FOD approach, it is remarkable that such a clear and consistent ranking structure emerges. Even though we cannot have, in the FOD framework, an absolute measure of how distant (or how much worse-off) the lower-ranking areas are in terms of multidimensional deprivation compared to the better-off areas, these findings depict a situation of persistent spatial gaps in deprivation. If not addressed, they will certainly become problematic and hamper future broad-based developments, including peace and stability. We also note that these results are largely comparable to those obtained by University of Copenhagen and UNU-WIDER (2023) using the A-F method. For example, in 2019/20, while the incidence of multidimensional poverty was just slightly above zero percent in Maputo city, it still exceeded or was close to 60 percent in Cabo Delgado, Niassa, Nampula, Zambezia and Tete.

Temporal FOD comparisons

Temporal domination, as discussed in the methodology section, measures the probability of advancement in the area examined between two time-periods. Table 7 reports temporal net FOD comparisons between 1996/97, 2002/03, 2008/09, 2014/15 and 2019/20 using the six welfare indicators described. As for the spatial FOD comparisons, we present the probabilities of advancement computed using bootstrapping methods. The numbers in Table 7 represent in this case the average net probability of domination computed across all bootstrap iterations. That is, the probability for each area dominating itself in a past survey (i.e. the probability of advancement between the two years analysed) minus the probability for each area being dominated by itself in a past survey (i.e. the probability of regression between the two years analysed).²

The analysis of the temporal FOD provides important indications on the probability for each area of the country to be in a better situation, from a multidimensional point of view, compared to previous years. When the comparison is indeterminate, we show no probability (in the table). This means that it is not possible to state whether the area considered is in a better situation compared to the previous surveys. We observe immediately that, for the country as a whole, the probability of advancement is equal to one (100 percent) in most comparisons: 2002/03-1996/97, 2008/09-1996/97, 2014/15-1996/97, 2014/15-2002/03, 2014/15-2008/09, 2019/20-1996/97, 2019/20-2002/03, and 2019/20-2008/09.

² Importantly, there is no evidence of regression between the years analysed, so the net probability of domination is equal to the gross, i.e. one, in virtually all cases.

This suggests, with a high level of confidence, that at the national level the multidimensional well-being situation improved over time, which can be interpreted as an improvement, on average, in every indicator in almost every spatial aggregate between 1996/97 and 2019/20. Before 2014/15, the lowest probability of improvement is found in the comparison between 2008/09 and 2002/03 (51 percent), which supports those analyses based on consumption poverty in which it was reported that poverty had mostly stagnated between 2002/03 and 2008/09. Similar trends are obtained when probabilities of improvements are calculated for provinces only (DEEF, 2016).

Table 7. Temporal net first order dominance (FOD) comparisons, probability of advancement (percent), national, urban/rural, regional, regional-urban/rural and provincial level, 1996/97-2019/20

Area	Survey comparisons									
	2002/0 31996/ 97	2008/0 9 1996/9	2008/0 9 2002/0 3	2014/1 5 1996/9	2014/1 5 2002/0 3	2014/1 5 2008/0 9	2019/2 0 1996/9	2019/2 0 2002/0 3	2019/2 0 2008/0 9	2019/2 0 2014/1 5
National	1	1	0.51	1	1	1	1	1	1	
Rural	0.02	0.6	0.6	1	1	0.97	1	1	0.96	
Urban	0.24	0.3	0.01	1	0.82	1	0.99	0.64	1	
Centre	1	1	0.41	1	1	1	1	0.99	0.98	
North	0.89	1	0.13	1	0.4	0.73	1	0.36	0.71	0.02
South	0.89	1	0.67	1	1	1	1	1	1	
Centre rural	0.01	0.04		0.99	0.97	0.97	1	0.99	0.82	
Centre urban	0.52	0.34	0.06	0.94	0.77	0.94	0.9	0.74	0.86	
North rural		0.01	0.88	0.84	0.74	0.02	0.99	0.85	0.25	
North urban	0.61	0.56		0.99	0.37	0.96	0.89	0.07	0.85	0.01
South rural	0.27	0.93	0.29	1	1	0.97	1	1	1	
South urban	0.01	0.11	0.16	0.94	0.93	0.89	1	0.99	0.99	
Cabo Delgado	0.01	0.64	0.04	0.91	0.34	0.71	0.76	0.21	0.7	0.01
Gaza	0.86	0.94	0.01	1	0.93	0.99	1	1	0.66	
Inhambane		0.52	0.24	1	1	0.61	1	1	0.93	0.02
Manica	0.88	0.49		1	0.21	0.98	1	0.45	0.98	
Maputo City		0.51		0.66			0.67			
Maputo Province	1	1	0.29	1	0.92	0.66	1	1	0.99	
Nampula	0.59	0.98	0.12	1	0.33	0.52	1	0.44	0.66	0.07
Niassa	0.63	0.83	0.08	1	0.69	0.1	1	0.65	0.04	
Sofala	0.89	0.9	0.21	1	0.92	0.61	1	0.88	0.59	
Tete	0.46	0.98	0.37	1	0.95	0.33	1	0.94	0.5	0.05
Zambezia	0.64	0.97	0.43	1	0.98	0.89	1	0.95	0.77	

Notes: The numbers presented here represent the average net probability of domination computed across all bootstrap iterations. That is, the probability for each area of dominating itself in a past survey (i.e. the probability of advancement between the two years analysed) minus the probability for each area being dominated by itself in a past survey (i.e. the probability of regression between the two years analysed). Nevertheless, there is virtually no evidence of regression between the years analysed, so that the net probability of domination is equal to the gross one in the vast majority of cases.

Source: Authors' elaboration based on University of Copenhagen and UNU-WIDER (2023).

However, the most striking result is probably the one concerning the comparisons between 2019/20 and 2014/15. Consistently in-determined results appear for most area aggregates, and for those areas for which it is possible to establish a FOD comparison, the probability is very low and close to zero. Because of the inherent characteristics of FOD comparisons, one or two indicators following a pattern that diverges from the general trend may cause in-determination. For example,

in a scenario such as the Mozambican one, where almost every indicator follows a constant upwards trend over the years, regression or stagnation in just a single indicator can lead to such a result. Hence, it does appear as if the situation at national level and for most areas in 2019/20 was clearly better than it was in 1996/97, 2002/03 and 2008/09 (the net probability of domination is equal to one in most comparisons). However, it stands out that using the FOD approach we cannot conclude that the multidimensional deprivation status in 2019/20 was better than it was in 2014/15.

When applying the FOD technique, obtaining results as clear-cut as the ones discussed here is not common. However, this is as might be expected in the context of Mozambique. In 1996/97, the year of the first survey considered here, Mozambique had just emerged from an armed conflict, which had torn the country apart. Then followed sustained economic growth and relatively broad-based improvements in household welfare, which spanned twenty years after the end of the conflict. The magnitude of these advancements is highlighted in the Fourth National Poverty Evaluation and other analyses (DEEF, 2016; Egger et al., 2020). The Fourth National Poverty Evaluation revealed substantial improvements across all the indicators used. Accordingly, it found that the multidimensional poverty index, computed using the A-F method, had decreased steadily in all the subpopulations considered. Painfully, from 2014/15 to 2019/20 a combination of complex shocks hit. They brought a major increase in consumption poverty and stagnation in the A-F multidimensional poverty index. Our application of the FOD approach reinforces this insight considerably. Indeed, our results show that the comparison between 2019/20 and 2014/15 fails determination for most area aggregates. Moreover, for those areas for which it is possible to establish a comparison, the probability is close to zero. This is consistent with a situation of stagnation in multidimensional deprivation, one in which two populations are not clearly dominating one another.

Robustness checks using census data

To check robustness, we apply the FOD method to all the existing census data for Mozambique performed after the end of the conflict in 1992. They include the population census data for 1997, 2007 and 2017.³ As done for the household budget survey data, we assess multidimensional poverty, applying the spatial and temporal FOD approach at national, urban/rural, regional, regional-urban/rural and provincial levels.

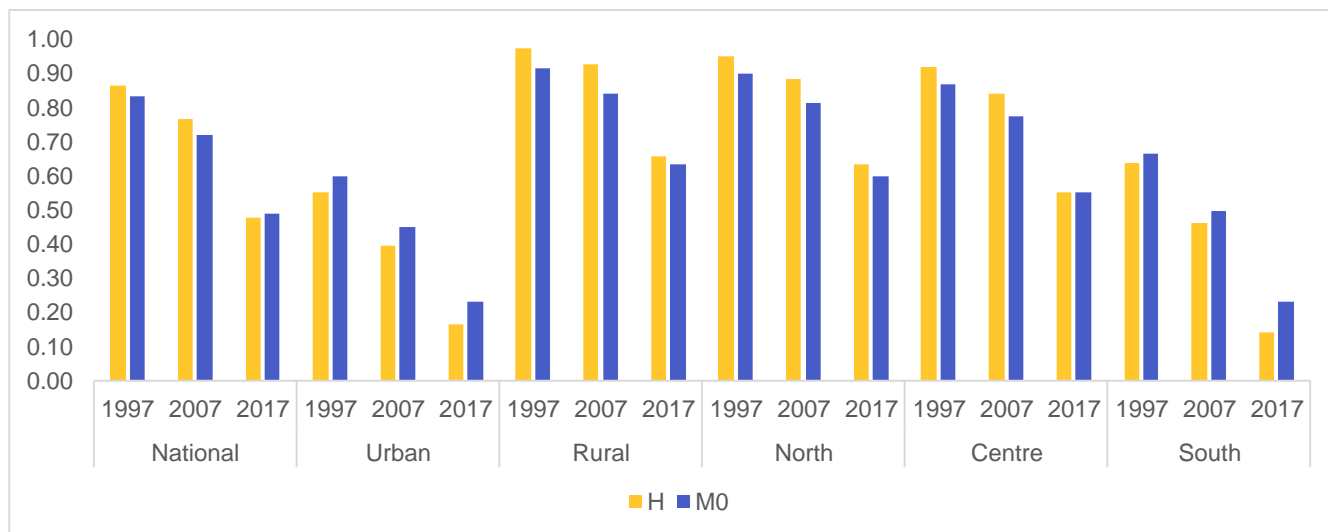
INE conducts the Mozambican censuses (Recenseamento Geral da População e Habitação) every ten years. They cover a wide variety of topics, including economic activity, education, births and mortality, housing, and durable goods. However, they do not include information on consumption and expenditures, which prevents the computation of consumption poverty measures; nevertheless, it is possible to compute a variety of multidimensional poverty indices, given the relatively broad availability of welfare-related indicators. Moreover, the wide coverage of the

³ We exclude from our analysis the first population census performed in Mozambique, in 1980, for lack of available data and comparability issues with subsequent censuses.

censuses allows for micro-level estimations, although some variables need adjustment for adequate comparison among the years (INE, 1999; 2019; 2023). Using the censuses, we consider the same six welfare indicators as in previous sections.⁴

We introduce the multidimensional poverty incidence and index first. Results are in Figures 2 and 3.5 They show that the multidimensional poverty incidence went from about 87 to about 77 percent from 1997 to 2007, decreasing to about 48 percent in 2017. In 1997, the incidence of multidimensional poverty was overall very high exceeding 75 percent in every province except Maputo Province and Maputo City. In 2007 improvements occurred in all provinces, especially in Gaza and Maputo Province, while in 2017 the decrease in the incidence of multidimensional poverty was more marked and more broad-based, exceeding 30 percentage points in Cabo Delgado, Tete, Manica, and Sofala, and 40 percentage points in Inhambane and Gaza. Yet, it remained high in some areas of the North and Centre of the country, being close to or exceeding 60 percent in Cabo Delgado, Niassa, Nampula, and Zambezia. These insights are broadly consistent with the figures displayed in Table 3.

Figure 2. Multidimensional poverty incidence (percent) and multidimensional poverty index (M0), national, urban/rural and regional level, 1997-2017



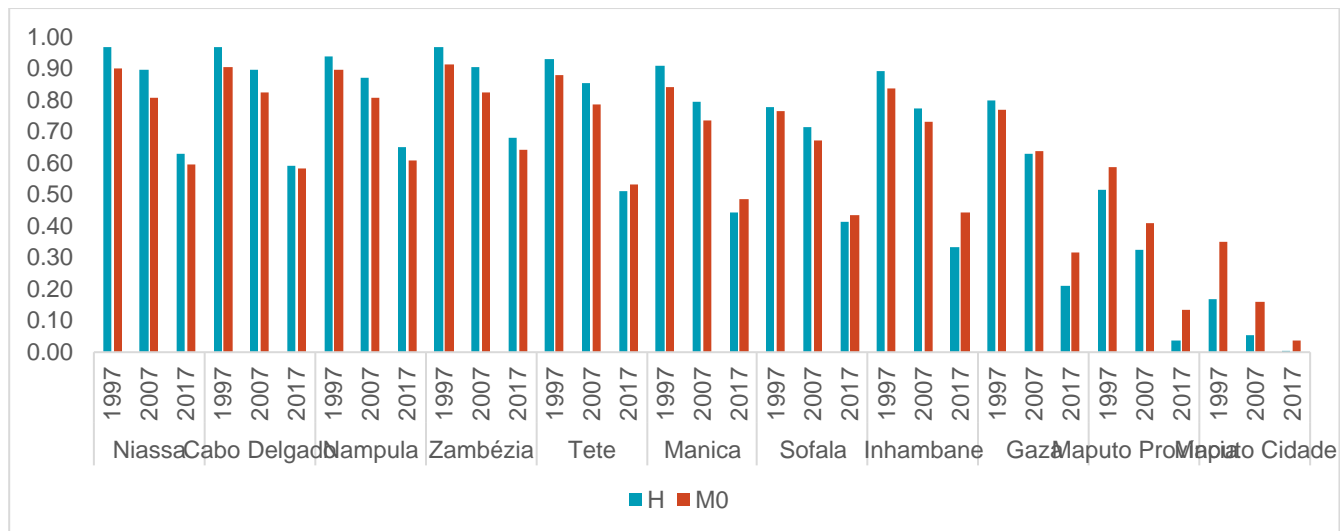
Notes: We compute the multidimensional poverty incidence (H) and the multidimensional poverty index (M0) using the Alkire–Foster method with six equally weighted welfare indicators: educational attainment, access to safe water, quality sanitation, quality of housing coverage, access to electricity and possession of some basic durable goods. We undertook some adjustment of the definitions for the welfare indicators depending on the differences in definitions found in the census data with respect to the household budget survey data.

Source: Authors' elaboration based on census data from 1997, 2007 and 2017, and on Cardoso et al. (2016; 2021) and DNPED (2020).

⁴ Some of the definitions for the welfare indicators were adjusted depending on the differences in the definitions found in the census data with respect to the household budget survey data.

⁵ As introduced, the multidimensional poverty results presented, which are computed using the A-F method, are authors' elaboration based on census data from 1997, 2007 and 2017, and on Cardoso et al. (2016; 2021) and DNPED (2020).

Figure 3. Multidimensional poverty incidence (percent) and multidimensional poverty index (M⁰), provincial level 1997-2017



Notes: We compute the multidimensional poverty incidence (H) and the multidimensional poverty index (M⁰) using the Alkire–Foster method with six equally weighted welfare indicators: educational attainment, access to safe water, quality sanitation, quality of housing coverage, access to electricity and possession of some basic durable goods. We undertook some adjustment of the definitions for the welfare indicators depending on the differences in definitions found in the census data with respect to the household budget survey data.

Source: Authors’ elaboration based on census data from 1997, 2007 and 2017, and on Cardoso et al. (2016; 2021) and DNPED (2020).

Next, we turn to the spatial and temporal FOD results (Tables 8 and 9). Table 8 presents area rankings for the different spatial aggregates. Here as well, we obtain the spatial FOD results using bootstrap methods to compare different area aggregates based on the net probability of domination. The conclusions from the census-based ranking largely confirm the general trends and spatial divide discussed above. A marked division between the South (especially Maputo City, Maputo Province and Gaza) and urban areas, on one side, and the rest of the country, on the other, is evident. This emerges even more clearly when we compare the southern region and the urban areas to the provinces of the North (Niassa, Cabo Delgado, and Nampula) and to the poorest provinces of the Centre (Zambezia and Tete). This split is consistent over the years, and most area aggregates do not change their ranking or do so by only ± 1 – ± 2 positions. Once more, the biggest improvement over the period 1997-2017 is for the rural South. It is of particular interest that Cabo Delgado seemed to be on a positive poverty reduction trend until 2017, which then halted from the beginning of the armed insurgency towards the end of the same year.

Table 8. Spatial net FOD and respective rankings, national, urban/rural, regional, regional-urban/rural and provincial level, 1997-2017

Area	1997		2007		2017		Change 2017- 1997	Change 2017- 2007
	PND	Rank	PND	Rank	PND	Rank		
Maputo City	0.990	1	0.984	1	0.999	1	0	0
South Urban	0.888	2	0.905	2	0.870	2	0	0
Maputo Province	0.658	4	0.735	3	0.849	3	-1	0
South	0.589	6	0.610	6	0.633	4	-2	-2
Urban	0.692	3	0.693	4	0.574	5	2	1
Centre Urban	0.617	5	0.612	5	0.538	6	1	1
Gaza	0.236	9	0.276	7	0.436	7	-2	0
North Urban	0.283	7	0.180	9	0.239	8	1	-1
South Rural	-0.173	14	-0.116	11	0.181	9	-5	-2
Sofala	0.281	8	0.184	8	0.106	10	2	2
Inhambane	-0.123	12	-0.129	12	0.106	11	-1	-1
Manica	-0.087	11	-0.136	13	0.008	12	1	-1
National	0.125	10	0.065	10	-0.022	13	3	3
Centre	-0.128	13	-0.195	14	-0.316	14	1	0
Tete	-0.227	15	-0.271	15	-0.361	15	0	0
Cabo Delgado	-0.507	18	-0.538	20	-0.447	16	-2	-4
Niassa	-0.521	19	-0.348	16	-0.514	17	-2	1
North	-0.402	17	-0.415	18	-0.517	18	1	0
Nampula	-0.355	16	-0.387	17	-0.525	19	3	2
Rural	-0.587	21	-0.624	21	-0.643	20	-1	-1
Zambezia	-0.578	20	-0.525	19	-0.656	21	1	2
Centre Rural	-0.718	22	-0.670	22	-0.689	22	0	0
North Rural	-0.952	23	-0.892	23	-0.850	23	0	0

Notes: PND = net domination probability (i.e. the probability of dominating other areas minus the probability of being dominated by other areas).

Source: Authors' elaboration based on census data from 1997, 2007 and 2017.

We also computed the FOD spatial results breaking down each province into urban and rural areas (results not shown but available upon request), which allow for a more detailed understanding of the interaction between the urban-rural divide and the differences in welfare occurring at the provincial level. In broad terms, the recurring pattern over the years seems to be that of the urban area of every province ranking above the national average. This is true also for those provinces ranked at the bottom in the rankings, indicating a strong divide between the rural and urban areas even within poorer provinces themselves. Only the rural areas of Maputo Province and Gaza rank above the national aggregate, and above some of poorer provinces' urban areas. This depends also on the way urban and rural areas are classified. Indeed, the classification of many recently urbanised areas in Maputo Province continue to be "rural", though they have evident urban characteristics. At the bottom of the list, we find, as expected, the rural areas of the five poorest provinces shown in Table 8, that is, Niassa, Cabo Delgado, Nampula, Zambezia and Tete.

Table 9 reports the temporal net FOD comparisons between 1997, 2007, and 2017 using the same welfare indicators described above. The results in Table 9 reflect the probability of advancement between the years considered. The last two columns highlight that there is a very high probability that 2017 dominates both 1997 and 2007 for virtually all area aggregates. In particular, the probability of advancement is equal or very close to 100 percent at national and urban/rural level for both the period between 1997 and 2017, and the one between 2007 and 2017. This reflects clear, evident, improvement on average in every indicator in almost every spatial aggregate, including the poorest provinces, between 1997 and 2017, and between 2007 and 2017.

Table 9. Temporal net FOD comparisons, probability of advancement (percent), national, urban/rural, regional, regional-urban/rural and provincial level, 1997-2017

Area	2007-1997	2017-1997	2017-2007
National	0.77	1	1
Rural	0.85	1	1
Urban	0.24	1	0.99
Centre	0.44	0.75	0.74
North	0.66	0.75	0.73
South	0.23	0.75	0.75
Centre Rural	0.51	0.75	0.75
Centre Urban	0.28	0.73	0.70
North Rural	0.42	0.75	0.75
North Urban	0.56	0.74	0.55
South Rural	0.04	0.75	0.75
South Urban	0.09	0.75	0.75
Cabo Delgado	0.73	0.99	0.89
Gaza		1	1
Inhambane	0.48	1	0.99
Manica	0.62	0.99	0.97
Maputo City	0.10	0.99	0.70
Maputo Province	0.31	1	1
Nampula	0.85	1	0.92
Niassa	0.62	1	0.90
Sofala	0.14	0.94	0.87
Tete	0.59	0.83	0.88
Zambezia	0.81	0.96	0.88

Notes: The numbers presented in the table represent the average net probability of domination computed across all bootstrap iterations. That is, the probability for each area of dominating itself in a past survey (i.e. the probability of advancement between the two years analysed) minus the probability for each area of being dominated by itself in a past survey (i.e. the probability of regression between the two years analysed). Nevertheless, there is no evidence of regression between the years analysed, so that the net probability of domination is equal to the gross, i.e. one, in virtually all cases.

Source: Authors' elaboration based on census data from 1997, 2007 and 2017.

As discussed, it is uncommon, when applying the FOD technique, to obtain results as clear as the ones we just presented. However, in the context of Mozambique they do appear realistic. In 1997,

the year of the first census considered in this study, Mozambique had just emerged from a 17-year-long conflict, and then the country experienced about 20 years of fast economic growth and improvements in household welfare. The shocks faced by the country starting from 2015 significantly deteriorated household consumption levels and brought a fast increase in the consumption poverty rate, which continued after the time the census data were collected (August 2017). Indeed, the two major cyclones Idai and Kenneth only hit the country in 2019, the armed insurgency in Cabo Delgado only started to escalate in late 2017, and the Covid-19 pandemic began in early 2020.

In sum, our results using census data are in line with those using the household budget surveys. Multidimensional deprivation improved up to 2014/15 (see Table 7) and in 2017 the multidimensional poverty situation was probably much better than in 2007 and in 1997 (see Table 9). At the same time, it is also very likely that this improvement started to decelerate after 2015 and halted in later years, as shown here in Table 7, and consistent with Egger et al. (2020), employing data up to 2018. In the case of FOD analyses, the indeterminate results with respect to the probability of advancement likely relates to regression or stagnation in a single indicator. At the same time, it is reassuring that this stagnation in the reduction of multidimensional deprivation corresponds with results from the A-F analyses available.

Conclusions

A series of detailed and rich poverty assessments is available for Mozambique, based on the existing household budget surveys. They have provided reviews of the evolution of both consumption and multidimensional poverty, at national and sub-national levels. With respect to multidimensional poverty, evaluations are available from 2014/15, using the popular A-F method. In this study, we applied an alternative method based on FOD to: i) assess multidimensional poverty over the entire 1996/97-2019/20 period, and ii) test the robustness of both the consumption and the multidimensional poverty results obtained using the A-F approach. Our headline result is that our findings confirm the poverty trends identified in the national poverty assessments and other studies. This is so even though the underlying method is different. The FOD does not rely on a set of weights for the welfare indicators, it does not compute a synthetic welfare index, and it is much stricter when assessing the domination of one distribution of welfare attributes over another. In this sense, the Mozambican poverty experience is now on much firmer ground.

From the spatial FOD analysis, it emerges that Maputo City has always dominated all other areas, as expected, but also that Maputo Province progressively has become the second-best province in terms of net domination probability. This improvement in ranking is one of the few exceptions recorded. Otherwise, our results show that the rankings obtained from the spatial FOD analysis are very stable over time. Between 1996/97 and 2019/20, and between 2014/15 and 2019/20, most area aggregates only changed their position by one or two positions. The areas that improved the most are Maputo Province and the province of Tete, together with the rural areas of the southern region. On the other hand, the national average worsened its relative ranking markedly, decreasing by five positions. Among the lowest-ranked areas, we found the central region, the northern region, the provinces of Cabo Delgado, Nampula, Niassa and Zambezia, and the rural areas at the national level and in the northern and central regions. Not only do these areas lie at the bottom of the ranking in all years, but they also register almost no changes between one survey and the other.

We also performed a temporal FOD analysis. Our estimates confirm, with a high degree of confidence that the welfare situation consistently improved in Mozambique over time. In particular, the comparisons between the 2014/15 surveys and the preceding ones show very high probabilities of advance, for most areas. A similar degree of temporal domination emerges when comparing the 2019/20 survey with the 1996/97, 2002/03 and 2008/09 surveys, for most areas. Conversely, when we compare 2019/20 with 2014/15, comparisons are indeterminate for virtually all areas. This entails that it is not possible to state if multidimensional deprivation improved or not between the two latest surveys. Indeed, for those areas for which it was possible to establish a comparison, the probability is very low and close to zero. This, as argued, is likely due to regression in a single indicator or two, especially given that the safe water indicator stagnated and the durable goods indicator worsened at the national level. However, this analysis points to more broad-based stagnation in terms of welfare and general deprivation, at any level, and it confirms the findings from the A-F multidimensional poverty calculations.

When we use 1997, 2007 and 2017 census data as a basis for our multidimensional poverty estimations, we find that a marked division between the South and urban areas, on the one side, and the rest of the country, on the other, is evident. This split is consistent over the years, and most area aggregates do not change their ranking or do so by only a few positions. Over time, we find a very high probability that 2017 dominates both 1997 and 2007 in terms of multidimensional deprivation, for virtually all area aggregates. Once more, this is clear evidence of improvement on average in every indicator in almost every spatial aggregate, including the poorest provinces, between 1997 and 2017, and between 2007 and 2017. While economic shocks started hitting already from 2015, which led to deteriorating household consumption levels and an increasing consumption poverty rate, the full effect of the shocks was building up at the time the census data were collected (August 2017). Indeed, the two major cyclones Idai and Kenneth only hit the country in 2019, the armed insurgency in Cabo Delgado only started to escalate in late 2017, and the Covid-19 pandemic began in early 2020.

We aimed from the outset at addressing with our FOD approach some of the analytical limitations inherent to the widely applied and popular A-F method. It is reassuring that the two alternative methods pursued here arrive at consistent results. This is so both when they confirm expected trends and when they highlight nuances in the results, or when they point to lack of advancement. Moreover, the FOD by being stricter puts previous results on a stronger analytical foundation. The main policy recommendation emerging from the spatial and temporal analyses performed here points to the need for Mozambique to address decisively the strong and persistent spatial gaps in welfare and poverty. Existing spatial inequality reflect deep-seated differences in deprivation levels between the southern region and the rural areas of the North and the Centre, and inequality has been widening over time. Most southern provinces, and both urban and rural areas, have improved their deprivation levels while the central and northern provinces have been lagging. Moreover, our study points to the urgent need for Mozambique to improve its capacity to respond to external and internal shocks and increase resilience at all levels. The poverty reduction and welfare improvements from the early 1990s first decelerated and then came to a halt when shocks hit in 2015. Importantly, though the A-F method pointed to some small improvement in the multidimensional poverty incidence and index from 2015, the FOD approach could not establish a positive probability of advancement for most of the area aggregates considered, and for those areas for which it was possible to establish a comparison, the probability was close to zero. This is disheartening and reflects that Mozambique has not been able during the last decade to capture the potential benefits of having become a natural resource-rich country.

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