

Arndt, Channing; Leyaro, Vincent; Mahrt, Kristi

Working Paper

Multi-dimensional poverty analysis for Tanzania: First order dominance approach with discrete indicators

WIDER Working Paper, No. 2014/146

Provided in Cooperation with:

United Nations University (UNU), World Institute for Development Economics Research (WIDER)

Suggested Citation: Arndt, Channing; Leyaro, Vincent; Mahrt, Kristi (2014) : Multi-dimensional poverty analysis for Tanzania: First order dominance approach with discrete indicators, WIDER Working Paper, No. 2014/146, ISBN 978-92-9230-867-4, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki, <https://doi.org/10.35188/UNU-WIDER/2014/867-4>

This Version is available at:

<https://hdl.handle.net/10419/107997>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WIDER Working Paper 2014/146

Multi-dimensional poverty analysis for Tanzania

First order dominance approach with discrete indicators

Channing Arndt,¹ Vincent Leyaro,² and Kristi Mahrt³

November 2014

Abstract: As in much of sub-Saharan Africa, Tanzania has attained rapid economic growth accompanied by only marginal reductions in poverty. Is this mismatch between high economic growth and less significant poverty reduction due to how growth and poverty are measured and reconciled, or more substantial underlying factors? Applying the first order dominance approach to multi-dimensional welfare comparisons, this paper seeks to gain a greater understanding of the evolution of poverty in Tanzania over time and space. Analysis of welfare indicators among four population groups in the regions, zones, and urban/rural areas of Tanzania reveal broad-based improvements in well-being between 1990 and 2010.

Keywords: multi-dimensional poverty analysis, first order dominance, Tanzania

JEL classification: F15, F33, L80

¹University of Copenhagen and UNU-WIDER; ²University of Dar es Salaam; ³University of Copenhagen; corresponding author: kamahrt@gmail.com

This study has been prepared within the UNU-WIDER project ‘[Reconciling Africa’s Growth, Poverty and Inequality Trends: Growth and Poverty Project \(GAPP\)](#)’, directed by Finn Tarp.

Copyright © UNU-WIDER 2014

ISSN 1798-7237 ISBN 978-92-9230-867-4

Typescript prepared by Minna Tokkari at UNU-WIDER.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme from the governments of Denmark, Finland, Sweden, and the United Kingdom.

The World Institute for Development Economics Research (WIDER) was established by the United Nations University (UNU) as its first research and training centre and started work in Helsinki, Finland in 1985. The Institute undertakes applied research and policy analysis on structural changes affecting the developing and transitional economies, provides a forum for the advocacy of policies leading to robust, equitable and environmentally sustainable growth, and promotes capacity strengthening and training in the field of economic and social policy-making. Work is carried out by staff researchers and visiting scholars in Helsinki and through networks of collaborating scholars and institutions around the world.

UNU-WIDER, Katajanokanlaituri 6 B, 00160 Helsinki, Finland, wider.unu.edu

The views expressed in this publication are those of the author(s). Publication does not imply endorsement by the Institute or the United Nations University, nor by the programme/project sponsors, of any of the views expressed.

1 Introduction

Substantial empirical evidence lends support to the thesis that economic growth is good for poverty reduction. Countries that have opened up their economies and have grown rapidly, like East Asian countries, have also achieved significant poverty reduction, among other indicators of economic development. However, that is not always the case for every region or country, especially when considering sub-Saharan Africa (SSA). For the past two decades, Tanzania has reported impressive macro-economic performance with economic growth of more than 7 per cent since 2000, poverty reduction and income inequality have not followed suit. According to the Tanzania House Budget Surveys (HBS), poverty has fallen marginally. Between 1991 and 2007, poverty fell only by about 5.2 percentage points, from 38.6 per cent in 1991/92 to 35.6 per cent in 2000/01, and to 33.4 per cent in 2007 (National Bureau of Statistics 2002, 2008). Although poverty estimation methods for the 2011/12 HBS is slightly different from the methods used in the previous HBS, the recent poverty estimates for the 2011/12 HBS shows that poverty fell a further 5.2 percentage points between 2007 and 2012, to 28.2 per cent in 2012 (National Bureau of Statistics 2014). At the same time inequality, as measured by the Gini coefficient, rose slightly from 34.6 to 37.6. Another core feature of high economic growth in Tanzania has been the ‘growth without jobs’ problem: labour is attracted to urban areas because of increasing economic activity in urban areas rather than growing employment demand from the formal sector. The result is greater stress on the informal sector—effective unemployment rises and/or average earnings declines to accommodate the growing labour supply. Thus, despite sustained economic growth over the past decade as measured by national accounts, there has been very little impact on the incomes and well-being of the poor. Such a mismatch between high economic growth on the one hand and little impact on poverty reduction on the other hand has raised questions: is it due to the underlying determinants of economic growth or is it due to how growth, poverty, inequality, and other welfare indicators are measured, reconciled, and compared across space and time?

Measuring poverty and reconciling it with economic growth and other measures of welfare remains a complex and contentious issue. Poverty measurements are often inconsistent, certainly across countries, but also across time and space within countries. In Tanzania for instance, different measures of poverty have produced different results from those officially published. Though the most commonly preferred measure of poverty, the dollar-a-day poverty line has methodological issues and fails to capture the broader non-monetary complexities of poverty. Comparing monetary measures of poverty across space and time also poses serious methodological challenges, although some consensus has emerged on issues such as choosing between consumption versus income measures, accounting for differences in household composition other than levels of nominal income, and adjusting for temporal and spatial differences in prices.

Importantly, monetary-based poverty measures are narrowly focused and single dimensional, which ignore the non-monetary aspects of poverty. Indeed, poverty is multidimensional in nature, which should account for basic access to health and education (World Bank 1990). It is also about pronounced deprivations in well-being including vulnerability, voicelessness, and powerlessness (World Bank 2001), and a lack of capabilities—material, physical, social, security, and freedom of choice and action (Sen 1989; Narayan 2000). For these reasons, it is important to consider multi-dimensional measures of poverty as more encompassing measures. Multi-dimensional measures of poverty are, however, not without difficulties. They often require weighting schemes to aggregate across multiple indicators of well-being. Without a priori agreement on the appropriate values for weights, weighting becomes a subjective choice with

alternative schemes likely leading to different welfare rankings. For example, consider population A with better average indicators than population B, but a higher share of children deprived in most dimensions. The choice of weights could be the determining factor in how these populations are ranked. Correlations across indicators complicate the matter further. It is therefore desirable to seek a method of comparing the welfare status of populations without relying upon subjective weighting schemes.

In response to the challenge of limiting the imposition of subjective assumptions, a number of ‘robust’ methods for comparing population welfare, poverty, and/or inequality with multi-dimensional data have been developed (Atkinson and Bourguignon 1982; Duclos et al. 2007; Bourguignon and Chakravarty 2003; Batana and Duclos 2010). These methods rely on stochastic dominance concepts for comparisons that are valid for broad classes of underlying social welfare functions. Still, these contributions introduce new restrictions by applying conditions that are typically formulated in terms of specified signs on the second or higher order cross-derivatives of the underlying social welfare functions.

To get around this problem, we employ the first order dominance (FOD) approach developed by Arndt et al. (2012). The FOD approach is suitable for making welfare comparisons between populations where only ordinal information is available at the micro level. In particular, it allows comparison of populations using multi-dimensional (discrete) well-being indicators, without arbitrary weighting schemes and other subjective judgements, or ad hoc simplifying assumptions about the social welfare function. The FOD criteria simply assert that it is better to be non-deprived than deprived in any given dimension. No assumptions are made about the strength of preference for each dimension, or about the relative desirability of changes between levels within or between dimensions, or the complementarity/substitutability between the dimensions.

Tanzania is a relevant case to apply FOD in SSA. Not only has the high economic growth attained in the recent past not seen poverty (measured in monetary term) subsiding substantially, but, at the same time, different methods of poverty calculations have produced different results (Minot et al. 2006). The main purpose of this paper, therefore, is to apply FOD using the Tanzania’s Demographic Health Surveys (DHS) for the years 1991/92, 1996, 2004/05, and 2010, where we define four population categories (households, children, children under five, and young women 18 to 30 years) and for each of these we identify five binary welfare indicators. The FOD results are compared across space and over time. The remainder of this paper is organized as follows. Section 2 provides an intuitive review of the multi-dimensional first order dominance methodology. Section 3 describes and presents the choice of binary welfare indicators employed to measure and compare welfare. Section 4 presents results, and Section 5 presents concluding remarks and directions for future research.

2 Multi-dimensional first order dominance approach

Arndt et al. (2012) develop the use of FOD theory in the context of multi-dimensional welfare comparisons among populations. As noted, compared to other multi-dimensional poverty measures, FOD has the advantage of not imposing a weighting scheme or imposing ad hoc restrictions to the social welfare function. Rather, in the context of binary well-being indicators, FOD simply requires that it is better to be not deprived than deprived.

FOD analysis in the context of multiple discrete welfare indicators draws upon a well-established literature of distributional dominance where the criteria for one distribution to be deemed better than another is referred to as first order dominance or usual (stochastic) dominance, (see for

example Müller and Stoyan 2002 or Shaked and Stanthikumar 2007). FOD can be characterized by a set of mathematical conditions in both the single and multi-dimensional context (see Lehmann 1955).

In order to intuitively present the FOD criteria, first consider two individuals, A and B, about whom information is available for a set of five binary well-being indicators. There are $2^5=32$ possible combinations of outcomes for each individual. Not deprived in an indicator is expressed as 1 and deprived as 0. It is clear that individual A dominates B if A is not deprived in any indicator (1,1,1,1,1) and B is deprived in all indicators (0,0,0,0,0). Furthermore, a combination of indicators such as (0,1,0,1,0) dominates (0,1,0,0,0) because the first case is clearly equal to or better than every outcome in the second case. However, we cannot determine domination in comparing a combination of indicators such as (1,1,0,0,0) to (0,1,1,0,0) without further assumptions because we cannot determine if it is better to be not deprived in the first indicator or the third indicator. Even in more extreme cases such as (1,1,1,1,0) compared to (0,0,0,0,1), dominance cannot be determined because we do not know if being not deprived in the first four indicators is better or worse than being not deprived only in the last. In addition to this indeterminate domination, FOD does not provide a sense of the extent of domination. For instance, we have no way of knowing if (1,0,0,0,0) is only slightly or significantly better than (0,0,0,0,0).

Next, let us expand from two individuals to two populations, again A and B, where the shares of individuals (or households) are calculated for each of the 32 possible outcomes (e.g., Y% is not deprived in any dimension while X% is deprived in all dimensions and the sum of the 32 shares is one). Is population A better off than population B? We say that population A first order dominates population B if one can generate distribution B by transferring probability mass from better to worse outcomes within A where better and worse are defined as in the preceding paragraph. Note that, moving probability mass amounts to moving individuals (or households) from better to worse outcomes. Suppose we have 1,000 households each in population A and B. Population A and B have identical welfare distributions except population A has 31 individuals in (0,1,1,1,0) and 29 in (0,1,1,0,0) while population B has 30 individuals in each of these two particular welfare combinations. The distribution of population B can be created from A by making one individual strictly worse off, that is by moving one individual in population A from (0,1,1,1,0) to (0,1,1,0,0). Therefore, population A first order dominates population B.

While FOD analysis allows for comparison across populations without imposing subjective restrictions, this generality comes with a cost. The FOD criteria are strict leading to indeterminate outcomes and no sense of the extent of domination. Arndt et al. (2012) describe how these costs can be mitigated by conducting FOD analysis on repeated bootstrap samples drawn from each population. The subsequent FOD results can be interpreted as empirical probabilities of domination providing significantly more information than FOD in the static case. We can now use probabilities to estimate the extent one area dominates another. Furthermore, one can define a measure of total net domination (the probability an area dominates all other populations minus the probability that area is dominated by all other populations) can be interpreted as a cardinal measure of welfare. This measure provides a basis to rank populations.

3 Data sources and choice of welfare indicators

The Tanzania Demographic and Health Survey (TDHS) for the years 1991/92, 1996, 2004/05, and 2010 is the main data source used for this paper (National Bureau of Statistics and Macro

1993, 1997, 2005, 2011). These TDHS are conducted by the National Bureau of Statistics (NBS) in collaboration with the Office of the Chief Government Statistician—Zanzibar, the Reproductive and Child Health Section and the Policy and Planning Department of the Ministry of Health, and the Safe Motherhood Initiatives at the Ministry of Health and Social Welfare—Zanzibar. The principal objective of the TDHS is to collect data on household characteristics, fertility levels and preferences, awareness and use of family planning methods, childhood and adult mortality, maternal and child health, breastfeeding practices, antenatal care, childhood immunization and diseases, nutritional status of young children and women, malaria prevention and treatment, women’s status, female circumcision, sexual activity, knowledge and behaviour regarding HIV/AIDS and other STIs, and prevalence of domestic violence.

The TDHS aims to provide estimates for the entire country, for urban and rural areas, and regions. The 1991/92 and 1996 TDHS samples were drawn in a three-stage design, with the goal of selecting 500 households each in Dar es Salaam and Zanzibar, and 300 households in the remaining regions. Using the 1998 Census sampling frame, 357 enumeration areas (EAs) were first selected from wards/branches and then within wards/branches such that rural and urban EAs were selected proportionally within each region. In the third sampling stage, households were selected from complete household listings in each EA. The sampling design for the 2004/05 and 2010 TDHS involved two stages where in the first stage 475 clusters were selected from a list of EAs based on the 2002 Census with 18 clusters selected in each region except Dar es Salaam where 25 clusters were selected. In the second stage, households were then systematically selected from complete household listings in each EA. Representative samples include 8,327, 7,969, 9,735, and 9,623 households for 1991/2, 1996, 2004/5, and 2010, respectively.

From this micro data we capture the non-monetary multi-dimensional nature of poverty by first defining four population categories: households, children under five (0 to 4 years old), children (7 to 17 years old), and young women (18 to 30 years old). Then for each of these population groups we identify five binary welfare indicators based on the Bristol Indicators (cf. Gordon et al. 2003a, 2003b), which when permuted generate 32 possible welfare indicator combinations.

For the Household Population Group, we have identified water, sanitation, shelter, education, and information as the five welfare indicators. A household is water deprived if the main source of drinking water is not from a pipe, tap, or well. For sanitation, the household is deprived if it has no flush toilet or ventilated improved pit toilet. A household is shelter deprived if the main floor material is dirt, sand, dung, or planks. A household is education deprived if the household head has not completed at least primary school. The household is information deprived if it does not have a functioning radio or television.

Table 1 presents the percentage of households not deprived in each dimension, over time, and across space. Although significant heterogeneity exists when comparing urban to rural areas or across zones and regions, with the exception of water, all welfare indicators experienced substantial improvements between 1992 and 2010. At the national level there has been a 6 percentage points’ improvement in water access from 65 to 71 per cent. This figure is sensitive to constraints on the time it takes to retrieve water. When we restrict not deprived in water to households within 30 minutes of the water source, water access only improves from 53 to 55 per cent, equivalent to only a 2 percentage point improvement. The story changes completely when not deprived in water is restricted to sources within 15 minutes, as water access is now worsening from 39 per cent in 1992 to 35 per cent in 2010. The situation is even worse in urban areas.

Table 1: Households not deprived by welfare indicator (%)

	Water		Sanitation		Shelter		Education		Information	
	1992	2010	1992	2010	1992	2010	1992	2010	1992	2010
Nation	64.5	71.2	2.9	11.7	18.6	30.5	31.8	56.2	36.7	64.3
Rural	56.3	67.0	1.3	3.1	9.0	16.6	27.1	49.4	29.6	59.5
Urban	92.3	85.3	8.2	40.3	51.6	76.7	47.7	78.5	60.8	80.4
Western	56.6	77.1	3.2	6.5	9.6	15.0	23.4	45.6	30.5	64.5
Northern	57.8	62.8	3.9	11.0	26.3	36.8	38.3	62.5	48.0	64.2
Central	73.5	63.3	2.5	4.9	12.3	13.0	29.4	51.4	27.9	50.9
S. Highlands	60.0	66.5	1.2	9.8	13.9	32.0	33.2	59.4	32.5	65.7
Lake	51.2	70.7	2.7	12.7	12.0	25.7	30.4	51.1	32.9	64.1
Eastern	84.9	79.0	4.5	23.8	38.9	59.1	40.3	69.0	50.4	77.3
Southern	72.4	69.2	1.0	6.7	12.5	19.1	25.2	58.8	24.6	52.1
Zanzibar	90.3	98.4	3.3	27.6	34.0	66.5	33.3	50.1	55.1	75.5

Source: Authors' own compilation based on the 1992 and 2010 TDHS (National Bureau of Statistics and Macro 1993, 2011).

Other indicators have shown significant improvement between 1992 and 2010. Sanitation facilities improved by 9 percentage points from 3 to 12 per cent, shelter by 12 percentage points from 19 to 31 per cent, education by 24 percentage points from 32 to 56 per cent, and information by 27 percentage points from 37 to 64 per cent. Changes in these indicators were more pronounced in urban areas compared to rural areas. Significant heterogeneity is also experienced across zones, with some zones such as Western, Northern, Southern Highlands, Lake, and Zanzibar seeing improvement, while others such as Central, Eastern, and Southern zones seeing deterioration to water access.

Table 2 presents the share of households deprived in a given number of welfare indicators. The first row of the table shows the share of severely deprived households with deprivations in all dimensions, the second row those deprived in four of the five indicators, and so forth to the sixth row which shows the probability that households are not deprived in any dimension. There have been substantial reductions in severely deprived households from 20 per cent in 1992 to 7 per cent in 2010 (13 percentage points). This was largely driven by a 17 percentage point reduction in rural areas from 25 to 9 per cent compared to the urban areas that saw a mere 2 percentage point drop from 3 to 1 per cent.

Table 2: Households by number of deprivations in welfare indicators (%)

Welfare deprivations	National			Urban			Rural		
	1992	2010	Change	1992	2010	Change	1992	2010	Change
5	20.14	6.88	-13.26	3.42	1.35	-2.07	25.03	8.54	-16.49
4	36.60	22.50	-14.10	21.33	6.67	-14.66	41.06	27.26	-13.81
3	22.16	29.04	6.88	20.52	11.79	-8.73	22.64	34.22	11.58
2	12.32	20.59	8.27	25.90	18.15	-7.76	8.35	21.32	12.97
1	7.37	13.43	6.06	23.65	33.68	10.04	2.61	7.34	4.73
0	1.40	7.56	6.16	5.18	28.35	23.17	0.30	1.32	1.02

Source: As for Table 1.

At the same time, there has been a 6 percentage point gain to households not deprived in any dimension from 1 per cent in 1992 to 7 per cent in 2010. Unlike severely deprived households where rural areas drove the improvements, the gain for households not deprived in any single dimension was derived from urban areas with a 23 percentage point improvement from 5 per cent in 1992 to 28 per cent in 2010. In contrast, rural areas improved slightly from 0.3 per cent in 1992 to 1.32 per cent in 2010. The key message here is that, while the poor in the rural areas are

exiting from severe poverty, the number of non-poor in urban areas is simultaneously increasing. This potentially suggests rising inequality between rural and urban areas, as well as within urban areas.

For the Children (7-17 years old) Population Group, we have almost the same welfare indicators as for the household population group, that is: water, sanitation, shelter, education, and information. However, a child is defined to be deprived in education if he/she is not in school and/or has not completed at least primary school. With the exception of the education indicator, as shown in Table 3, the trend and pattern for the percentage of children not deprived by welfare indicator is similar to the household population category, with most indicators seeing significant improvement between 1992 and 2010.¹ Children fare significantly better with respect to education than the heads of households; however as with households, the percentage of children not deprived in education at the national level increases by 23 percentage points with a similar story for the other areas. Table 4 shows that the share of children deprived in a given number of welfare indicators is largely comparable to the household population group. However, the share of severely deprived households fell by 13 percentage points at national level and by 17 percentage points in rural areas, whereas the share of severely deprived children fell by only 8 and 10 percentage points respectively. As for the household population, the gain for children not deprived in any single dimension was derived from urban areas with a 24 percentage point improvement.

Table 3: Children (7-17 years) not deprived by welfare indicator (%)

	Water		Sanitation		Shelter		Education		Information	
	1992	2010	1992	2010	1992	2010	1992	2010	1992	2010
Nation	63.7	71.2	3.0	11.0	19.2	29.5	60.2	83.0	37.7	63.5
Rural	55.8	67.1	1.5	3.0	9.5	16.7	58.4	80.2	30.4	58.9
Urban	91.2	86.2	8.0	40.3	52.8	76.1	66.5	93.2	63.0	80.6
Western	57.0	78.4	3.6	6.9	11.0	15.5	58.2	75.7	32.1	65.2
Northern	57.8	61.5	3.2	9.3	27.7	35.8	68.9	88.8	48.9	61.5
Central	73.4	64.9	2.8	5.0	13.4	13.3	56.5	76.6	29.8	48.0
S. Highlands	56.6	66.4	1.6	9.0	14.0	31.1	64.1	85.9	32.6	66.2
Lake	50.3	71.9	3.2	12.6	12.0	25.8	56.0	80.5	33.6	63.8
Eastern	85.7	77.7	4.2	22.4	38.4	54.4	58.8	88.7	51.7	76.2
Southern	70.2	68.3	1.6	7.1	12.7	20.8	57.8	86.4	24.9	52.9
Zanzibar	92.1	99.0	3.5	26.7	33.8	65.9	56.5	85.7	55.6	74.6

Source: As for Table 1.

Table 4: Children by number of deprivations in welfare indicators, 7-17 years (%)

Welfare deprivations	National			Urban			Rural		
	1992	2010	Change	1992	2010	Change	1992	2010	Change
5	11.17	2.89	-8.28	1.86	0.31	-1.55	13.85	3.59	-10.26
4	32.57	16.10	-16.47	15.92	3.22	-12.70	37.35	19.62	-17.73
3	29.69	31.06	1.37	21.56	12.76	-8.80	32.03	36.07	4.03
2	16.05	27.40	11.35	26.06	17.07	-8.99	13.17	30.22	17.05
1	8.96	14.89	5.94	28.76	36.75	7.98	3.26	8.92	5.66
0	1.57	7.67	6.10	5.84	29.90	24.06	0.34	1.59	1.25

Source: As for Table 1.

¹ While the indicators are the same in four of five cases, the population differs (all households versus children between the ages of 7 and 17); hence, the values for all indicators are different.

For the Under-Fives (0-4 years old) Population Group, we identify water, sanitation, nutrition, mothers' education, and location of delivery as the main welfare indicators. Children under five are education deprived if their mothers have not completed at least primary school. Children under five are nutrition deprived if the child is more than two standard deviations below the median of the reference population in at least one of the following anthropometric measures: weight-for-age, height-for-age, and/or weight-for-height. Children under five are delivery deprived if the child was delivered in a home rather than a health facility. Sanitation is as defined before.

Table 5 shows that the percentage of the under-fives not deprived in each dimension has improved significantly for all indicators except for delivery, which has deteriorated over time. Between 1992 and 2010, water improved by 7 percentage points from 64 to 71 per cent, sanitation by 6 percentage points from 3 to 9 per cent, nutrition by 13 percentage points from 45.5 to 59 per cent, and education by 13 percentage points from 47 to 60 per cent. In contrast, delivery has worsened by 5 percentage points from 55 to 50 per cent suggesting the number of women delivering in home has increased. Examination of zones reveals substantial heterogeneity in the performance of the awareness and delivery indicators ranging from significant deteriorations to significant improvements.

Table 5: Children under five (0-4 years) not deprived by welfare indicator (%)

	Water		Sanitation		Nutrition		Education		Delivery	
	1992	2010	1992	2010	1992	2010	1992	2010	1992	2010
Nation	64.0	70.6	2.5	8.6	45.5	59.0	46.9	59.6	55.0	49.6
Rural	56.9	67.5	1.1	2.0	44.1	56.7	42.7	55.1	46.7	41.8
Urban	91.4	83.7	8.0	36.4	50.9	68.8	63.3	78.3	86.5	82.6
Western	57.0	76.4	2.4	4.6	50.7	61.8	33.0	48.3	50.8	35.2
Northern	58.6	59.0	5.5	7.7	47.3	57.1	60.5	66.2	63.9	51.2
Central	72.2	59.9	1.7	2.9	41.3	49.3	51.3	58.1	57.5	46.9
S. Highlands	61.5	65.6	1.2	9.5	40.7	52.7	50.2	66.4	53.1	50.0
Lake	53.4	71.8	1.9	9.1	51.0	63.5	39.2	57.5	40.6	44.4
Eastern	80.8	79.9	3.2	18.4	45.7	66.0	53.7	67.0	65.4	74.4
Southern	73.3	71.1	0.7	6.0	34.2	55.6	47.7	65.6	70.0	69.0
Zanzibar	88.9	98.3	2.7	26.3	39.1	60.8	42.8	57.2	32.5	48.8

Source: As for Table 1.

Table 6 presents the share of under-fives experiencing a given number of welfare deprivations. Nationally, the share of severely deprived under-fives has modestly declined by 3.4 percentage points from 7.5 per cent in 1992 to 4.1 per cent in 2010. As in the case of households and children, this decline was primarily influenced by improvement in the well-being of under-fives in rural areas. At the same time, there has been a modest improvement for the under-fives not deprived in any of the five welfare indicators, from 1.1 per cent in 1992 to 4.9 per cent in 2010. As is the case for households and children, this change was driven by urban areas with an improvement of 17.6 percentage points compared to only 0.5 percentage points for the rural areas during this period.

Table 6: Children by number of deprivations in welfare indicators, 0-4 years (%)

Welfare deprivations	National			Urban			Rural		
	1992	2010	Change	1992	2010	Change	1992	2010	Change
5	7.56	4.15	-3.41	0.61	0.98	0.37	9.38	4.91	-4.48
4	23.39	17.64	-5.75	6.40	5.14	-1.26	27.84	20.61	-7.23
3	31.37	30.35	-1.02	25.59	14.22	-11.37	32.89	34.18	1.29
2	23.95	27.21	3.26	31.49	24.37	-7.12	21.97	27.89	5.91
1	12.60	15.78	3.18	31.62	33.37	1.75	7.62	11.61	3.98
0	1.12	4.86	3.74	4.30	21.92	17.63	0.29	0.81	0.52

Source: As for Table 1.

For the Young Women (18-30 years old) Population Group, in addition to shelter and sanitation, which are defined as before, we have a source of information about family planning methods, education of the respondent, and attitudes regarding violence toward women as our five binary welfare indicators. A woman is education deprived if the woman has not completed at least primary school. A woman is family planning deprived if in the last six months she has not heard about family planning from a reliable source: radio, television, newspaper, family planning worker, or health facility. A woman is violence deprived if she believes any form of wife-beating is justified.

Due to the lack of consistency for the relevant variables that can be deployed for the analysis of young women between the 1992/1996 and 2004/2010 TDHS, we only use the 2004 and 2010 TDHS in assessing the welfare of young women. Table 7 presents the share of young women not deprived in each dimension in 2004 and 2010. With the exception of the family planning indicator that has experienced deterioration between 2004 and 2010, most other welfare indicators have shown significant improvement. Much improvement has been experienced in urban areas compared to rural areas. There are, as well, significant performance differences when comparing zones, with for example Lake zone experiencing worsening attitudes about violence between 2004 and 2010.

Table 7: Young women not deprived by welfare indicator (%)

	Shelter		Sanitation		Education		Family planning		Violence	
	2004	2010	2004	2010	2004	2010	2004	2010	2004	2010
National	26.9	38.1	5.9	16.2	59.6	67.4	70.3	68.3	37.7	44.6
Rural	10.4	19.8	1.0	3.8	53.4	60.5	64.0	63.2	34.0	39.9
Urban	65.5	79.6	17.5	44.3	74.3	83.0	85.0	79.7	46.4	55.3
Western	14.9	18.7	4.6	8.2	49.9	56.7	74.2	68.7	18.9	42.3
Northern	28.9	49.4	9.3	17.0	68.7	77.5	71.6	68.0	32.8	54.5
Central	12.9	15.9	4.6	8.2	54.5	57.4	70.9	75.5	32.1	38.6
S. Highlands	22.0	41.2	1.3	12.8	62.9	70.7	68.8	57.8	37.1	42.1
Lake	18.6	28.7	6.6	15.6	56.0	61.0	52.6	62.7	48.1	26.3
Eastern	60.4	70.3	10.2	31.4	68.1	76.2	86.8	76.8	51.0	56.3
Southern	14.8	23.0	2.7	11.0	54.1	70.9	68.9	77.6	31.3	49.6
Zanzibar	52.8	72.2	8.5	32.7	54.4	77.3	78.2	58.5	61.2	74.9

Source: As for Table 1.

Table 8 presents the share of young women deprived in a given number of welfare indicators, as is the case with other population categories above. There has been virtually no reduction in severely deprived between 2004 and 2010, except for a slight reduction in rural areas. However, there have been improvements for young women not deprived in all five welfare indicators, from

2 per cent in 2004 to 7 per cent in 2010 (equivalent to a 5 percentage point increase). As for the case of other population categories, this was significantly derived by the improvement in urban areas, as urban areas saw an improvement of 14 percentage points compared to only of 1 percentage point for the rural areas during this period.

Table 8: Women by number of deprivations in welfare indicators (%)

Welfare deprivations	National			Urban			Rural		
	2004	2010	Change	2004	2010	Change	2004	2010	Change
5	8.70	8.05	-0.64	1.70	2.15	0.45	11.68	10.66	-1.02
4	27.23	21.40	-5.83	12.28	4.96	-7.32	33.61	28.66	-4.95
3	32.94	27.26	-5.69	20.19	15.69	-4.49	38.38	32.36	-6.02
2	19.48	21.85	2.38	34.68	24.77	-9.91	13.00	20.56	7.57
1	9.38	14.11	4.74	23.81	30.88	7.07	3.22	6.71	3.49
0	2.27	7.32	5.05	7.34	21.54	14.20	0.11	1.05	0.94

Source: As for Table 1.

To summarize, most welfare indicators for all population categories and areas have shown significant improvement between 1990 and 2010. Notable exceptions to this improvement include access to water, especially in urban areas for the household and child populations, place of delivery for the under-five population, and family planning for the young women population, which have deteriorated over time in most areas. For the majority of welfare indicators, a larger improvement has occurred in urban areas compared to rural areas, and in some zones compared to the others. However, considering those severely deprived in all dimensions, rural areas have seen a significant reduction in deprivations compared to urban areas, while examining those not deprived in any dimension, urban areas have seen a significant increase compared to rural areas. Though many poor in rural areas are exiting out of poverty, the number of non-poor in urban areas is also increasing at high rates, potentially suggesting a rise in inequality between rural and urban areas. Furthermore, the implied rise of an urban middle-income class also suggests increasing inequality within urban areas, as the number of the poor is relatively larger than non-poor.

4 Results and discussion

We start by discussing the temporal FOD results for three population categories between 1992 and 2010 in Tables 9-11 (results for young women between 2004 and 2010 are in Appendix Table A.1). The tables show net domination, which is the probability one year dominates another year minus the probability it is dominated by the other year. FOD comparisons provide heterogeneous evidence of reduction in deprivation and improvement in welfare over time and across space throughout Tanzania.

Table 9 illustrates temporal net dominance comparisons for the household population group. For most areas, FOD comparisons provide evidence of advancement in welfare with both net domination in the static case and significant probability of net domination in the bootstrap. Advancement in welfare between 1992 and 2004 or 2010 is registered at the national level, in rural areas, and in more than half of the zones (Lake, Northern, Southern, Southern Highlands, Western, and Zanzibar) using the static approach. The bootstrap supports these results with a solid probability of advancement in most of these areas. Only in urban areas and Central and Eastern zones do neither 2004 nor 2010 net dominate 1992 in the static case, nor have significant probability of net domination in the bootstrap. The results are similar between 1996 and 2004 or 2010, with the addition of Western region showing no net domination in the static case and fairly low probabilities of net domination in the bootstrap. 1996 net dominates 1992 at

the national level, in rural and urban areas, and only in three zones (Western, Eastern, and Zanzibar) in the static case, however, the bootstrap does not provide strong evidence of this dominance. There is little evidence of advancement between 2004 and 2010 with no static net domination or more than weak probabilities of domination in the bootstrap in any area. There is essentially no probability of regression through time in any of these areas.

Table 9: Temporal net FOD comparisons, households (probabilities)

	1996 FOD		2004 FOD		2010 FOD		2004 FOD		2010 FOD		2010 FOD	
	1992		1992		1992		1996		1996		2004	
	Static	Boot	Static	Boot	Static	Boot	Static	Boot	Static	Boot	Static	Boot
National	1	0.3	1	0.99	1	0.96	1	0.95	1	0.98		0.10
Rural	1	0.28	1	0.71	1	1.00		0.45	1	0.82		0.13
Urban	1	0.22		0.11		0.07		0.03		0.04		0.11
Western	1	0.27		0.23	1	0.66		0.12	1	0.44		0.22
Northern		-0.03	1	0.68	1	0.68	1	0.85	1	0.85		
Central		0.14		0.14		0.12		0.13		0.07		0.04
S. Highlands		0.12	1	0.67	1	0.74	1	0.46	1	0.59		0.11
Lake			1	0.62	1	0.99		0.17	1	0.85		0.16
Eastern	1	0.35		0.42		0.22		0.18		0.11		0.14
Southern		0.06	1	0.55		0.30	1	0.69	1	0.75		0.01
Zanzibar	1	0.22	1	0.99	1	0.99	1	0.86	1	0.79		

Notes: A '1' in the static case indicates that the most recent year net FODs the earlier year's welfare level, while an empty cell indicates no domination. In the bootstrap case a '1' indicates that all 100 bootstrap replications resulted in the net domination. A negative value in the 'Boot' column indicates positive probability of regress through time.

Source: Authors' own compilation based on the 1991/2, 1996, 2004/5, 2010 TDHS (National Bureau of Statistics and Macro 1993, 1997, 2005, 2011).

Table 10 presents results for children 7-17 years old for the same welfare indicators and over the same years as Table 9. The overall trend and pattern is not substantially different between households and children. Using the static approach, only urban areas advance between 1992 and 1996. Though when bootstrapped most show positive, albeit quite small, empirical probabilities of advancement, FOD comparisons indicate the possibility of regression in the Northern zone. 2004 and 2010 net dominate both 1992 and 1996, respectively, using the static and bootstrap approaches for generally the same areas as in the household population. In the static case, the Eastern zone now shows signs of advancement between 1996 and 2004. While the probabilities of domination in the bootstrap vary somewhat between the households and children, the overall results are similar.

Table 10: Temporal net FOD comparisons, children 7-17 years (probabilities)

	1996 FOD 1992		2004 FOD 1992		2010 FOD 1992		2004 FOD 1996		2010 FOD 1996		2010 FOD 2004	
	Static	Boot	Static	Boot	Static	Boot	Static	Boot	Static	Boot	Static	Boot
National		0.09	1	0.99	1	1.00	1	0.99	1	0.98		0.15
Rural		0.05	1	0.51	1	0.98	1	0.50	1	0.91		0.14
Urban	1	0.29		0.26		0.12		0.17		0.05		0.07
Western		0.20		0.14	1	0.71		0.08	1	0.59	1	0.33
Northern		-0.16	1	0.50	1	0.50	1	0.91	1	0.89		
Central		0.18		0.17		0.09		0.12		0.04		0.03
S. Highlands		0.02	1	0.74	1	0.89	1	0.80	1	0.64		0.09
Lake			1	0.68	1	0.98		0.22	1	0.85		0.20
Eastern		0.18		0.36		0.13	1	0.41		0.22		0.11
Southern		0.01	1	0.49		0.29	1	0.70	1	0.69		
Zanzibar		0.15	1	0.96	1	0.98	1	0.94	1	0.97		

Notes: As for Table 9.

Source: As for Table 9.

Temporal net FOD results for children under five are presented in Table 11. Under-fives register significantly fewer gains through time compared to households and children. Unlike the household and child population groups, only Zanzibar registered advancements between 1992 and 2004, and Zanzibar and Lake between 1992 and 2010. Only Zanzibar advanced from 1996 to 2004. In contrast, the period between 1996 and 2010 had the greatest signs of improvements, with 2010 dominating 1996 at the national level, and in Northern, Southern Highlands, Lake, Southern, and Zanzibar zones, though the bootstrap provides weaker evidence of domination in the Northern, Southern Highlands, and Southern zones. Similar to the relatively stagnant results for child population between 1992 and 1996, and both the child and household populations between 2004 and 2010, there is no evidence of improvement in any area for under-fives for these periods. However, for the young women population presented in Table A1, both the static and bootstrap comparisons indicate that 2010 dominates 2004 in the Southern zone. Despite the weak results, there is no significant evidence of regression through time in any area for young women or children under five.

Table 11: Temporal net FOD comparisons, children 0-4 years (probabilities)

	1996 FOD 1992		2004 FOD 1992		2010 FOD 1992		2004 FOD 1996		2010 FOD 1996		2010 FOD 2004	
	Static	Boot	Static	Boot	Static	Boot	Static	Boot	Static	Boot	Static	Boot
National				0.01		0.02		0.13	1	0.60		0.21
Rural		0.02				0.04		0.02		0.21		0.13
Urban						0.03				0.04		0.09
Western		0.02						0.02		0.03		
Northern		-0.08				0.02		0.28	1	0.36		-0.01
Central		0.04				0.04				-0.02		0.02
S. Highlands		-0.01		0.06		0.19		0.04	1	0.26		0.11
Lake		0.01		0.13	1	0.72		0.06	1	0.68		0.24
Eastern		0.24		0.19		0.44				0.15		0.11
Southern						0.06		0.02	1	0.37		0.01
Zanzibar		0.04	1	0.74	1	0.90	1	0.67	1	0.72		0.02

Notes: As for Table 9.

Source: As for Table 9.

FOD comparisons are also possible across areas at a point in time. Tables 12a–14a show the static area comparisons for 2010 for three population groups while Tables 12b–14b show their

respective bootstraps (Appendix Tables A.2a and A.2b show results for young women). In each case, the row and column averages are provided. The row (column) average provides the probability that an area dominates (is dominated by) all other areas. Thus, using these metrics, relatively well-off areas should have relatively large rows' averages while relatively poor areas should have relatively large column averages.

Table 12a presents spatial dominance comparisons for the household population group; here urban areas and Eastern zone (which includes the Dar es Salaam region) are shown to be relatively well off. On the other hand, the rural areas and Central and Western zones are shown to be relatively poor. This is largely consistent in all years, as 1992, 1996, and 2004 compare well with the 2010 spatial results, with several key differences. In 1992, both Zanzibar and the Eastern zone dominate 70 per cent of other areas; however, while Eastern zone maintains its dominance, Zanzibar becomes relatively less well off with each survey. Initially Central zone is only dominated by 20 per cent of areas but this number increases gradually as Central becomes relatively less well off. In contrast, Southern, Southern Highlands, and Lake zones become relatively less poor over time. Bootstrap results closely correspond to the static results in that, areas with probabilities of dominating greater than .5 also dominated in the static case.

Table 12a: 2010 Spatial FOD comparisons, households

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1				1						0.20
Rural												0.00
Urban	1	1		1	1	1	1	1	1	1		0.90
Western												0.00
Northern												0.00
Central												0.00
S. Highlands						1						0.10
Lake		1										0.10
Eastern	1	1		1	1	1	1	1		1		0.80
Southern						1						0.10
Zanzibar		1		1								0.20
Average	0.20	0.50	0.00	0.30	0.20	0.50	0.20	0.20	0.10	0.20	0.00	0.22

Notes: In the spatial FOD comparisons, row averages show the probability an area is dominated by other areas and column averages show the probability an area is dominated by other areas.

Source: Authors' own compilation based on the 2010 TDHS (National Bureau of Statistics and Macro 2011).

Table 12b: 2010 Bootstrap spatial FOD comparisons, households (probabilities)

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1.00				0.82	0.04	0.04		0.18		0.21
Rural						0.01						0.00
Urban	1.00	1.00		0.96	1.00	1.00	1.00	1.00	0.75	0.99		0.87
Western		0.01				0.03						0.00
Northern		0.05				0.30	0.08	0.01		0.05		0.05
Central												0.00
S. Highlands	0.05	0.39		0.01	0.11	0.51		0.02		0.18		0.13
Lake		0.56		0.01		0.34	0.01			0.01		0.09
Eastern	0.93	0.99		0.61	0.87	0.97	0.89	0.86		0.84		0.70
Southern						0.25						0.03
Zanzibar	0.01	0.59		0.83		0.31	0.02	0.28				0.20
Average	0.20	0.46	0.00	0.24	0.20	0.45	0.20	0.22	0.08	0.23	0.00	0.21

Notes: As for Table 12a.

Source: As for Table 12a.

Table 13a presents 2010 spatial dominance comparisons results for the child population group, and though the trend and patterns are similar to the household population groups, there are some differences. Here, in addition to urban areas and Eastern zone, Zanzibar zone also is shown to be relatively well off. These results are generally consistent over time. In contrast with the household results, Zanzibar is not a dominant area in 1992 but dominates 60, 70, and 50 per cent of areas in 1996, 2004, and 2010 respectively. As in the case of households, Central zone is increasingly relatively poor over time. Bootstrap results support these trends.

Table 13a: 2010 Spatial FOD comparisons, children 7-17 years

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1				1						0.20
Rural												0.00
Urban	1	1		1	1	1	1	1	1	1		0.90
Western												0.00
Northern												0.00
Central												0.00
S. Highlands						1						0.10
Lake		1				1						0.20
Eastern	1	1				1	1	1		1		0.60
Southern						1						0.10
Zanzibar	1	1		1		1		1				0.50
Average	0.30	0.50	0.00	0.20	0.10	0.70	0.20	0.30	0.10	0.20	0.00	0.24

Notes: As for Table 12a.

Source: As for Table 12a.

Table 13b: 2010 Bootstrap spatial FOD comparisons, children 7-17 years (probabilities)

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1.00				0.87	0.01	0.08		0.03		0.20
Rural						0.10						0.01
Urban	1.00	1.00		0.96	0.97	1.00	0.99	1.00	0.52	1.00		0.84
Western						0.27						0.03
Northern		0.08				0.29	0.01	0.02		0.03		0.04
Central												0.00
S. Highlands	0.04	0.35			0.04	0.46		0.05		0.11		0.11
Lake	0.01	0.44		0.01		0.59	0.01			0.01		0.11
Eastern	0.94	0.99		0.40	0.53	0.98	0.71	0.71		0.74		0.60
Southern		0.01				0.36						0.04
Zanzibar	0.94	1.00		0.99	0.07	1.00	0.39	0.96	0.02	0.39		0.58
Average	0.29	0.49	0.00	0.24	0.16	0.59	0.21	0.28	0.05	0.23	0.00	0.23

Notes: As for Table 12a.

Source: As for Table 12a.

Table 14a presents spatial dominance comparison results for the under-fives population group; as was the case with the household population group, urban areas and the Eastern zone are shown to be relatively well off. Though the urban areas and the Eastern zone are consistent over time, Zanzibar was not relatively better off in previous years. On the other hand, rural areas and Central, and to a lesser extent Northern, Southern Highlands, and Western, are shown to be relatively poor. Again, Central zone is increasingly relatively poor over time. In 1992, Central, Northern, Southern Highlands, and Western zones are only dominated by urban areas. When bootstrapped these results are largely robust.

For the young women population group, Tables A.2a and A.2b in the appendix show urban areas and Eastern and Zanzibar zones to be relatively well off. Zanzibar performs better in 2004 and is hardly better off in 2010. On the other hand, the rural areas and Central, Western, Southern Highland, and Lake zones are shown to be relatively poor. Southern zone is among the better-off provinces in 2010 and among the worst-off provinces in 2004. When bootstrapped these results are largely robust.

Table 14a: 2010 spatial FOD comparisons, children 0-4 years

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1										0.10
Rural												0.00
Urban	1	1		1	1	1	1	1	1	1		0.90
Western												0.00
Northern												0.00
Central												0.00
S. Highlands												0.00
Lake		1										0.10
Eastern	1	1			1	1	1					0.50
Southern						1						0.10
Zanzibar		1										0.10
Average	0.20	0.50	0.00	0.10	0.20	0.30	0.20	0.10	0.10	0.10	0.00	0.16

Notes: As for Table 12a.

Source: As for Table 12a.

Table 14b: 2010 bootstrap spatial FOD comparisons, children 0-4 years (probabilities)

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1.00			0.01	0.07						0.11
Rural												0.00
Urban	1.00	1.00		0.78	1.00	1.00	0.99	0.85	0.45	0.91		0.80
Western												0.00
Northern						0.06						0.01
Central												0.00
S. Highlands						0.16						0.02
Lake		0.50		0.09		0.04						0.06
Eastern	0.54	0.76		0.38	0.39	0.76	0.30	0.23		0.34		0.37
Southern	0.01	0.18			0.02	0.44	0.03					0.07
Zanzibar	0.10	0.57		0.34	0.01	0.05		0.08				0.12
Average	0.17	0.40	0.00	0.16	0.14	0.26	0.13	0.12	0.05	0.13	0.00	0.14

Notes: As for Table 12a.

Source: As for Table 12a.

Another way to consider spatial dominance comparisons is to examine the probability of net domination, i.e., the probability an area dominates all other areas minus the probability that the area is dominated by all other areas. Using the household bootstrap comparisons, probability of net domination can be interpreted as a measure of welfare and provides a basis for ranking areas. Positive net domination implies an area dominates more than it is dominated, while the reverse is true for negative net domination. Better performing areas have higher probabilities of net domination and are ranked higher, where 1 is the highest ranking. In other words, households in zones with high ranks are relatively better off than households in lower ranked zones. Appendix Tables A.3 and A.4 rank the zones and regions respectively for the household population category. The last column shows the changes in ranking between 1992 and 2010, and gives a sense of how households in each zone or region have performed over time relative to other

zones or regions. A negative change reflects a movement to a higher rank and therefore a relative improvement in well-being. These rankings of the zones and regions are similar for children 7-17 and children under five, particularly at the extremes.

5 Summary and implications

In spite of the impressive macro performance recorded for Tanzania in recent years, with the economy growing at around 7 per cent since 2000, poverty reduction (as measured in monetary terms) and income inequality have not followed suit. According to the Tanzania House Budget Surveys (HBS), poverty has fallen only marginally, by about 5.2 percentage points between 1991 and 2007, and another 5.2 percentage points between 2007 and 2012. At the same time inequality, as measured by the Gini coefficient, rose slightly from 34.6 to 37.6 and unemployment, especially among youth has worsened. Such a mismatch between impressive macro performance and high economic growth on the one hand and no impact on poverty reduction on the other hand has raised questions: is it due to the underlying determinants of economic growth or is it due to how growth, poverty, inequality, and other welfare indicators are measured, reconciled, and compared across space and time?

Cognizant of the fact that there is more to poverty than money and that the monetary-based measures of poverty are narrowly-focused and single dimensional, this paper uses non-monetary multi-dimensional welfare indicators of well-being observed at the micro level and applies FOD approach to make welfare comparisons between four populations categories (households, children, under-fives, and young women) across space and time. FOD assumes that, for each indicator, the levels can be ranked ordinally from worse to better; however, no assumptions are made about relative importance of any dimension or about complementarity/substitutability relationships between dimensions. It also employs an efficient algorithm for determining dominance and a bootstrap approach that permits rankings of populations. These approaches are applied to multi-dimensional welfare indicators of well-being derived from the TDHS.

In spite of some heterogeneity when comparing the urban to rural areas or even across zones and regions, there have been significant improvements for most welfare indicators (shelter, sanitation, education, information, water, family planning, and violence) between 1990 and 2010. A few indicators, however, have experienced deterioration, including water access in urban areas, delivery for under-fives, and violence against women in some zones. While the poor in the rural areas have significantly exited from extreme poverty (severely deprived in all dimensions), the number of non-poor (not deprived in any dimension) in urban areas is also increasing significantly suggesting widening inequality between rural and urban areas, and within urban areas. FOD comparisons provide heterogeneous evidence of reduction in deprivation and improvement in welfare across time and space throughout Tanzania. For most areas, FOD provides evidence of advancement in welfare with both net domination in the static case and significant probability of net domination in the bootstrap. Advancement in welfare between 1992 and 2004 or 2010 is registered for households at the national level, in rural areas, and in more than half of the zones (Lake, Northern, Southern, Southern Highlands, Western, and Zanzibar) using the static approach. Spatially, we see a consistent story across population groups with urban areas and Eastern zone consistently dominating most other areas. Zanzibar also tends to dominate many other areas though results varied over time and across population groups. At the other extreme, rural areas are consistently the worst performing area, and the Central zone became relatively worse off over time.

The emerging conclusion from this paper is that while poverty measured in terms of household consumption fell only modestly between 1990 and 2010, using multi-dimensional measures of poverty as a more encompassing measure of poverty, Tanzania has experienced noticeable improvements for most welfare indicators (shelter, sanitation, education, information, family planning, and violence) over approximately the same period.

References

- Arndt, C., R. Distant, L.P. Osterdal, P.L. Huong, and M. Ibraimo (2012). 'Ordinal Welfare Comparisons with Multiple Discrete Indicators: A First Order Dominance Approach and Applications to Child Poverty'. *World Development*, 40(11): 2290-301.
- Atkinson, A.B., and F. Bourguignon (1982). 'The Comparison of Multi-Dimensioned Distributions of Economic Status'. *Review of Economics Studies*, 49(2): 183-201.
- Batana, Y.M., and J.-Y. Duclos (2010). 'Comparing Multidimensional Poverty with Qualitative Indicators of Well-Being'. Working Paper 10-04. Montréal: CIRPÉE.
- Bourguignon, F., and S. Chakravarty (2003). 'The Measurement of Multidimensional Poverty'. *Journal of Economic Inequality*, 1(1): 25-49.
- Duclos, J.-Y., D.E. Sahn, and S.D. Younger (2007). 'Robust Multidimensional Poverty Comparisons with Discrete Indicators of Well-Being'. In S.P. Jenkins, and J. Micklewright (eds), *Inequality and Poverty Reexamined*. Oxford: Oxford University Press.
- Gordon, D., S. Nandy, C. Pantazis, S. Pemberton, and P. Townsend (2003a). *Child Poverty in the Developing World*. Bristol: Policy Press.
- Gordon, D., S. Nandy, C. Pantazis, S. Pemberton, and P. Townsend (2003b). *The Distribution of Child Poverty in the Developing World*. Bristol: Centre for International Poverty Research.
- Lehmann, E.L. (1955). 'Ordered Families of Distributions'. *The Annals of Mathematical Statistics*, 26(3): 399-419.
- Minot, N., K. Simler, T. Benson, B. Kilama, E. Luvanda, and A. Makbel (2006). 'Poverty and Malnutrition in Tanzania: New Approaches for Examining Trends and Spatial Patterns'. Washington, DC: International Food Policy Research Institute.
- Müller, A., and D. Stoyan (2002). *Comparison Methods for Stochastic Models and Risks*. Chichester: John Wiley and Sons Ltd.
- Narayan, D. (2000). *Voice of the Poor: Can Anyone Hear Us?* Washington, DC: The World Bank.
- National Bureau of Statistics (Tanzania) (2002). *Tanzania Household Budget Survey 2001/02*. Dar es Salaam: NBS.
- National Bureau of Statistics (Tanzania) (2008). *Tanzania Household Budget Survey 2007*. Dar es Salaam: NBS.
- National Bureau of Statistics (Tanzania) (2014). *Tanzania Household Budget Survey 2011/12*. Dar es Salaam: NBS.
- National Bureau of Statistics (NBS) and Macro International Inc. (1993). *Tanzania Demographic and Health Survey 1991/1992*. Columbia, MD: NBS and Macro International.
- National Bureau of Statistics (NBS) and Macro International Inc. (1997). *Tanzania Demographic and Health Survey 1996*. Calverton, MD: NBS and Macro International.

- National Bureau of Statistics (NBS) and ORC Macro (2005). *Tanzania Demographic and Health Survey 2004-05*. Dar es Salaam: NBS and ORC Macro International.
- National Bureau of Statistics (NBS) and ICF Macro (2011). *Tanzania Demographic and Health Survey 2010*. Dar es Salaam: NBS and ICF Macro.
- Sen, A.K. (1989). *The Standard of Living*. Cambridge: Cambridge University Press.
- Shaked, M., and J.G. Shanthikumar (2007). *Stochastic Orders*. New York: Springer.
- World Bank (1990). *World Development Report 1990: Poverty*. New York: Oxford University Press.
- World Bank (2001). *World Development Report 2000/2001: Attacking Poverty*. New York: Oxford University Press.

Appendix A: Some more results

Table A.1: Temporal net FOD comparisons, young women (probabilities)

	2004 FOD 2010	
	Static	Boot
National		
Rural		0.03
Urban		
Western		0.11
Northern		0.16
Central	1	0.21
S. Highlands		
Lake		
Eastern		
Southern	1	0.69
Zanzibar		

Notes: As for Table 9.

Source: As for Table 9.

Table A.2a: 2010 spatial FOD comparisons, young women

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1						1				0.20
Rural												0.00
Urban	1	1		1	1	1	1	1				0.70
Western												0.00
Northern		1					1	1				0.30
Central												0.00
S. Highlands												0.00
Lake												0.00
Eastern	1	1		1		1	1	1				0.60
Southern		1		1		1						0.30
Zanzibar							1					0.10
Average	0.20	0.50	0.00	0.30	0.10	0.30	0.40	0.40	0.00	0.00	0.00	0.20

Notes: As for Table 12a.

Source: As for Table 12a.

Table A.2b: 2010 bootstrap spatial FOD comparisons, young women (probabilities)

Area	National	Rural	Urban	W	N	C	SH	L	E	S	Z	Avg
National		1		0.33			0.1	0.55				0.20
Rural												0.00
Urban	1	1		1	0.58	0.82	1	1	0.37	0.25		0.70
Western		0.06						0.02				0.01
Northern	0.18	0.81		0.31			0.45	0.51				0.23
Central		0.01		0.01				0.01				0.00
S. Highlands		0.02		0.01				0.08				0.01
Lake												0.00
Eastern	0.99	1		0.95	0.17	0.45	0.88	0.96		0.04		0.54
Southern		0.64		0.51		0.31		0.15				0.16
Zanzibar		0.04		0.01			0.51	0.18				0.07
Average	0.22	0.46	0.00	0.31	0.08	0.16	0.29	0.35	0.04	0.03	0.00	0.18

Notes: As for Table 12a.

Source: As for Table 12a.

Table A.3: Spatial FOD ranking and probability of net domination by zone and year, households

	1992		1996		2004		2010		Change
	Domination	Rank	Domination	Rank	Domination	Rank	Domination	Rank	
Eastern	0.57	1	0.75	1	0.74	1	0.72	1	0
Zanzibar	0.37	2	0.22	2	0.30	2	0.21	2	0
Southern Highlands	-0.21	5	-0.17	5	-0.22	6	-0.02	3	-2
Northern	0.14	3	-0.11	4	0.05	3	-0.08	4	1
Lake	-0.26	7	-0.19	7	-0.14	5	-0.11	5	-2
Southern	-0.30	8	-0.24	8	-0.09	4	-0.12	6	-2
Western	-0.22	6	-0.17	6	-0.27	7	-0.20	7	1
Central	-0.09	4	-0.10	3	-0.37	8	-0.39	8	4

Source: As for Table 9.

Table A.4: Spatial FOD ranking and probability of net domination by region and year, households

	1992		1996		2004		2010		Change
	Domination	Rank	Domination	Rank	Domination	Rank	Domination	Rank	
Zanzibar	0.65	2	0.73	2	0.83	1	0.71	1	-1
Dar es Salaam	0.77	1	0.86	1	0.64	2	0.66	2	1
Kilimanjaro	0.17	3	0.15	4	0.24	3	0.25	3	0
Coast	-0.02	9	0.08	5	0.00	9	0.08	4	-5
Unguja	0.09	4	0.36	3	0.08	4	0.08	5	1
Morogoro	-0.06	13	-0.11	15	0.05	5	0.05	6	-7
Mbeya	-0.03	11	-0.02	7	-0.06	12	0.05	7	-4
Ruvuma	-0.11	17	-0.02	6	0.04	6	0.02	8	-9
Pemba	-0.02	8	-0.10	13	0.01	8	0.02	9	1
Mwanza	-0.07	14	-0.09	11	0.00	11	-0.03	10	-4
Iringa	-0.26	22	-0.26	22	-0.12	18	-0.04	11	-11
Mara	-0.18	21	-0.14	17	-0.09	14	-0.06	12	-9
Tabora	-0.03	10	-0.09	10	-0.11	16	-0.07	13	3
Shinyanga	-0.15	20	-0.15	20	-0.09	13	-0.08	14	-6
Arusha & Manyara	0.04	5	-0.15	19	0.00	10	-0.11	15	10
Rukwa	-0.01	6	-0.14	18	-0.18	19	-0.11	16	10
Tanga	-0.01	7	-0.11	16	-0.10	15	-0.13	17	10
Singida	-0.05	12	-0.07	8	-0.39	23	-0.16	18	6
Kagera	-0.14	18	-0.15	21	-0.24	22	-0.17	19	1
Kgoma	-0.14	19	-0.10	12	-0.21	21	-0.20	20	1
Lindi	-0.07	15	-0.10	14	0.02	7	-0.20	21	6
Mtwara	-0.28	23	-0.32	23	-0.21	20	-0.25	22	-1
Dodoma	-0.11	16	-0.08	9	-0.11	17	-0.32	23	7

Source: As for Table 9.