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Multidimensional welfare in districts of Zambia

A first order dominance approach

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Abstract: In this paper we make welfare comparisons among districts of Zambia using multidimensional well-being indicators observed at the household level using the first order dominance approach developed by Arndt et al. in 2012. This approach allows welfare comparisons without making any assumptions about the relative importance of the indicators. Analysis of the 2010 Census of Population and Housing data has generated information on the poverty status of provinces and districts in Zambia and has ranked them from the relatively well-off to the worse-off. This information has been presented on a map showing the districts according to their poverty status. It is expected that this paper will contribute to fine-tuning geographic poverty targeting efforts in Zambia. The rationale is that with the availability of such analysis, it will be possible to make budgetary provisions that allow for the equitable distribution of public resources. The overriding objective of the government should be to channel public resources based on the spatial distribution of poverty.

Keywords: multidimensional poverty measurement, first order dominance, Zambia

JEL classification: I32, D63, O10

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1 Introduction

Poverty reduction remains an important policy objective of the Zambian government. Through various policies and programmes, the government endeavours to achieve broad based pro-poor growth. In the last decade, the country has experienced significant poverty reduction in urban areas whilst rural areas remain behind. To create a balance of development between the urban and rural areas, the government will need to formulate and implement programmes that deliberately target areas that are lagging behind. Since poverty is multidimensional in nature, dimensions where people are deprived will differ greatly from place to place. Areas where most people are deprived in energy require a different poverty reduction strategy compared to an area where most people are deprived in unemployment. Because of this, policy makers require adequate information on the state of poverty in order to formulate appropriate strategies to reduce it.

Past studies on poverty have based their analyses on one-dimensional measures such as income or consumption. Such analyses tend to assume homogeneity in the conditions driving poverty, while in reality factors such as demographic and geographic variations across a nation, provinces, or districts may play a crucial role in the composition of poverty. Because the complex composition of poverty is not incorporated in the analyses and spatial differences are not duly taken into account, the resulting poverty analyses may misinform policy makers, subsequently resulting in poor resource allocation within the country. The overall consequence is that public resources cannot be effectively used to fight poverty.

Therefore a study that recognizes that poverty is too complex of a condition to be captured by monetary measures alone and incorporates multidimensionality in its measures will have a greater ability to identify a complete picture of deprivation in Zambia. Furthermore, a study that maps Zambian poverty at a micro level, such as the district level, will contribute to fine tuning geographic poverty reduction efforts throughout the nation. The rationale is that with the availability of such an analysis, it will be possible to make budgetary provisions that allow for the effective distribution of public resources to strive for equality among regions. The overriding objective of the government should be to channel public resources based on the spatial distribution of poverty.

This study, therefore seeks to provide policy makers with reliable information that will make it possible to specifically identify poorer areas and to deliberately target resources based on the specific deprivations in these areas as a matter of national priority. The main objective of this study is to produce information on the welfare of Zambian households at a micro level with a view to informing formulation of policies and programmes for poverty interventions. In addition, by using multidimensional indicators of poverty to measure welfare, policy makers will have a clearer picture of the state of poverty. In this way, policy makers will be able to enhance the design of policies and implementation of poverty reduction programmes.

2 Methodology

Much of the poverty assessments in Zambia have been based on the data from the Central Statistics Office (CSO). Since 1996, the CSO has successfully conducted six rounds of Living Conditions and Monitoring Surveys (LCMS) with the latest being in 2010 (CSO 2010). The CSO uses the concept of income deprivation when measuring poverty, a concept that follows a process of identifying the poor on the basis of comparison of household disposable income to the cost of the basic needs basket (CSO 2010). The key poverty measures in the LCMS are based on the Foster-Greer-Thorbecke (FGT) class of poverty measurement (Foster et al. 1984). The poor in

this case are identified by setting a poverty line corresponding to a minimum poverty level below which a person is considered poor.

In 2007, the CSO conducted the first ever Micro-level Estimates of Poverty in Zambia utilizing data from the 2000 census and the 2003 LCMS (CSO 2007). The study used the income approach to generate the FGT poverty indices, which were then used to map poverty at national, district, constituencies, and wards. In July 2011, the Food Security Research Project produced a report titled Factors Affecting Food Dynamics in Rural Areas (Chapoto et al. 2011). The study used nationally representative longitudinal data on 4,284 households sampled in Zambia in 2001, 2004, and 2008. The study also used household income as the measurement of welfare.

2.1 First order dominance approach

Recently, there has been an increasing emphasis on the use of multidimensional poverty measures to estimate poverty. In Zambia, a Multidimensional Poverty Index (MPI) has been estimated by the UNDP in the Human Development Report (UNDP 2010). The MPI is based on a class of multidimensional poverty measurements developed by Alkire and Foster (2009). The index uses dimensions which are internationally comparable, including education, health, and living standards. This methodology applies a weighting scheme to aggregate indicators; however the choice of weighting schemes is subjective with different weights possibly producing different outcomes.

In this paper, we employ a method developed for making welfare comparisons among populations using multiple indicators without the use of arbitrary weighting schemes. In particular, we apply the first order dominance (FOD) approach developed by Arndt et al. (2012) to make welfare comparisons. The methodology employs a procedure that uses available indicators of well-being to compare the welfare status of populations and to determine whether one population is better off than the other. The analysis is made possible by utilizing linear programming technique operationalized in General Algebraic Modeling System (Arndt et al. 2013).

Drawing upon the intuition behind FOD described in Arndt et al. (2013), they compare two populations A and B based on five binary indicators. The populations can be divided into $2^5 = 32$ states that describe whether A and B are deprived or not in various combinations of the indicators. Those who are not deprived in any dimension are best off and those who are deprived in all the dimensions are worst off. Furthermore, define 0 to be deprived and 1 to be not deprived and compare the combinations of indicators (0,1,1,0,0) and (0,0,1,0,0). The first combination is unambiguously better than the second because it is at least as well-off in all dimensions and is better in one dimension (Arndt et al. 2012). On the other hand, because the method imposes no assumptions about strengths of preferences among the indicators, some comparisons are indeterminate. For example, in the states (0,0,1,0,1) and (0,0,0,1,1) neither is unambiguously better than the other because we do not know if it is better to be not deprived in the third or fourth dimension. Likewise, considering the states (0,0,0,1,1) and (0,1,0,0,0) we cannot tell which state is better because there is no degree of relative importance attached to any of the indicators.

As highlighted in Arndt et al. (2012) the strength of the FOD mainly lies in the fact that it removes the need to use arbitrary weighting schemes. However, with its strict criteria come some challenges. As seen above, there are cases in which the method cannot determine which of two combinations of indicators are better. Furthermore, the lack of additional information prevents us from determining the extent of dominance between two populations. These challenges are, however, addressed through the application of a bootstrap approach. Through FOD analysis of repeated bootstrap samples, empirical probabilities are generated that yield significantly more information including the ability to estimate the extent to which one area dominates the other.

2.2 Data

The main data source used in this study is the 2010 National Census of Population and Housing. The census was conducted by the Central Statistics Office (CSO) and contains basic information on all households in the country (CSO 2012). Specifically, the census captured information related to housing conditions, health and sanitation, education, asset accumulation, employment, and agriculture activities.

We use five indicators which are inspired by the national development goals as outlined in the Sixth National Development Plan (GRZ 2011). These include sanitation, housing, energy, education, and employment creation. Given that the government has prioritized these areas in the development plan, it becomes imperative to use indicators that are directly associated with these expenditure priorities. In this way, the welfare comparisons will easily inform the allocation of public expenditure. (Arndt et al. 2013). Table 1 defines each indicator in terms of deprivations.

Table 1: FOD indicators

Indicators	Definitions
Access to sanitation	Deprived if the household has no toilet or uses a bucket and other facilities
Employment	Deprived if the household head is unemployed or an unpaid family worker
Housing	Deprived if the house has flooring made of mud or wood (not wooden tiles or other)
Electricity	Deprived if the household's fuel source is wood, cow dung, charcoal or none
Education	Deprived if the head of household has no education

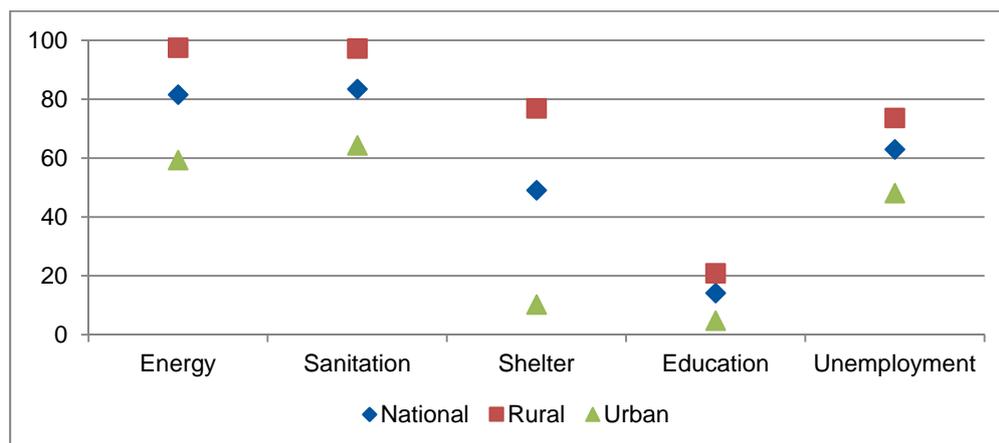
Source: Author's own definitions based on the Bristol indicators and Gordon et al. (2003).

3 Results

3.1 Deprivation by dimensions

Figure 1 presents statistics on how the country is faring in the five indicators under consideration. At the national level, the extent of deprivation across the five indicators is relatively high for energy, sanitation, and unemployment. Eighty-three per cent of households lack access to sanitation, 80 per cent lack access to electricity, and 63 per cent do not have decent employment. The proportion of households headed by people who have never been to school is only 14 per cent, and that of households without a floor is 49 per cent. Figure 1 also shows the depth of deprivations across regions. For most of the indicators, the disparity between urban and rural areas is high. Housing has the largest disparity (66 per cent) between the rural and urban areas. The smallest difference between the two regions is in education (17 per cent).

Figure 1: Levels of deprivations for the five dimensions



Source: Author's computations from CSO (2010).

3.2 Deprivations by province

Table 2 compares the share of households deprived in each welfare indicator across the provinces. For each indicator, the highest level of deprivation is circled and the lowest is underlined. Luapula has the highest levels of deprivation in three dimensions: energy (97.58 per cent), sanitation (96.78 per cent), and shelter (85.79 per cent). The highest levels of deprivation in education and unemployment are in Eastern (29.26 per cent) and Western (78.27 per cent) provinces, respectively.

Lusaka fares best in three dimensions, namely energy (53.33 per cent), housing (6.55 per cent), and unemployment (43.23 per cent). The Copperbelt province leads in sanitation and education with deprivations in only 53.41 per cent and 5.47 per cent of households.

Table 2: Deprivation shares across provinces

	Energy	Sanitation	Shelter	Education	Unemployment
Central	89.23	89.19	58.14	13.20	64.87
Copperbelt	64.77	<u>53.41</u>	16.71	<u>5.47</u>	54.10
Eastern	96.05	96.10	65.52	<u>29.26</u>	69.99
Luapula	<u>97.58</u>	<u>96.78</u>	<u>85.79</u>	16.03	70.74
Lusaka	<u>53.33</u>	74.21	<u>6.55</u>	5.51	<u>43.23</u>
Muchinga	96.69	95.66	77.41	16.33	71.41
North -					
Western	93.88	94.76	63.91	20.40	73.34
Northern	96.57	95.91	83.51	16.68	72.78
Southern	87.08	87.80	52.44	12.15	68.91
Western	95.81	96.35	80.50	26.45	<u>78.27</u>

Source: Author's computations from CSO (2010).

3.3 Share of deprivations per province

Table 3 provides statistics on the number of deprivations faced by households in each province. Overall, households in all provinces suffer from one deprivation or another. However, there are relatively more households in Copperbelt (16 per cent) followed by Lusaka (13 per cent) who are not deprived in any of the five dimensions. In contrast six provinces, Eastern, Luapula, Muchinga,

North-Western, Northern, and Western, have a very small proportion of households who are not deprived in any of the five dimensions. The proportion of households who suffer only one deprivation is highest in Lusaka (26 per cent) and Copperbelt (24 per cent). In Lusaka among households that face only one deprivation, the most common deprivation is sanitation (15 per cent) and unemployment (9 per cent). In Copperbelt, it is mainly unemployment (15 per cent) and energy (7 per cent). Again six provinces, Eastern, Luapula, Muchinga, North-Western, Northern, and Western have at most 5 per cent of households who are deprived only in one of the five dimensions.

Northern (56 per cent), Luapula (56 per cent), Muchinga (51 per cent), and Western (51 per cent) provinces have the highest proportion of households who suffer multiple deprivations with over half of households deprived in four out of five dimensions. The proportion of households deprived in four dimensions is also relatively high in Eastern (40 per cent), Southern (38 per cent), and North-Western (32 per cent) provinces. Lusaka has the lowest number of people suffering The deprivations in four dimensions at 5 per cent followed by Copperbelt at 12 per cent.

Western province has the highest number of households deprived in all the five dimensions at 21 per cent. Compared to other provinces, the proportion for Eastern province is also high at 17 per cent. Luapula, Muchinga, and Northern provinces have 11 per cent of households deprived in all the five dimensions. The proportion for Central, North-Western, and Southern provinces is 7 per cent, 8 per cent, and 7 per cent, respectively. Lusaka and Copperbelt have very few households suffering in all five dimensions.

Table 3: Welfare indicator combinations

Welfare Indicator Combinations					Nat.	Rural	Urban	C.	Copperbelt	E.	Luapula	Lusaka	Muchinga	N.	N.W.	S.	W.
0	0	0	0	0	8.32	13.66	0.87	7.42	1.87	16.96	10.83	0.74	11.40	11.63	14.19	6.57	20.55
0	0	0	0	1	2.57	4.12	0.42	2.64	0.60	5.75	4.29	0.37	3.19	3.98	2.83	2.03	4.36
0	0	0	1	0	28.06	44.64	4.96	33.79	9.50	30.96	50.64	2.77	46.70	50.90	36.96	33.66	45.01
0	0	0	1	1	9.21	13.52	3.20	13.22	3.57	11.19	18.75	1.87	14.81	15.96	9.19	9.43	9.99
0	0	1	0	0	1.89	2.08	1.63	1.84	1.51	4.62	0.47	1.83	0.99	0.61	2.49	2.16	1.07
0	0	1	0	1	0.89	0.77	1.05	0.89	0.68	1.57	0.16	1.54	0.45	0.23	0.61	1.01	0.29
0	0	1	1	0	14.12	11.37	17.94	15.57	16.18	14.75	6.30	17.14	9.46	6.87	16.11	18.72	8.77
0	0	1	1	1	11.65	5.70	19.95	10.73	15.51	8.54	3.90	22.79	7.08	4.21	9.60	9.97	4.40
0	1	0	0	0	0.06	0.10	0.02	0.08	0.02	0.10	0.13	0.01	0.14	0.11	0.10	0.04	0.04
0	1	0	0	1	0.02	0.04	0.01	0.04	0.01	0.03	0.04	0.00	0.07	0.05	0.02	0.01	0.02
0	1	0	1	0	0.28	0.39	0.12	0.39	0.19	0.22	0.58	0.05	0.62	0.49	0.23	0.30	0.19
0	1	0	1	1	0.14	0.17	0.10	0.24	0.17	0.09	0.26	0.04	0.24	0.17	0.06	0.14	0.07
0	1	1	0	0	0.11	0.04	0.21	0.07	0.34	0.08	0.03	0.12	0.02	0.02	0.03	0.09	0.02
0	1	1	0	1	0.05	0.02	0.10	0.04	0.16	0.03	0.01	0.07	0.01	0.01	0.01	0.06	0.01
0	1	1	1	0	2.23	0.45	4.70	1.16	7.83	0.63	0.60	2.02	0.70	0.67	0.71	1.60	0.53
0	1	1	1	1	1.97	0.44	4.10	1.11	6.64	0.52	0.59	1.97	0.81	0.68	0.74	1.27	0.50
1	0	0	0	0	0.02	0.04	0.01	0.02	0.01	0.04	0.04	0.00	0.03	0.02	0.06	0.02	0.06
1	0	0	0	1	0.01	0.02	0.00	0.01	0.00	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02
1	0	0	1	0	0.09	0.12	0.04	0.10	0.04	0.09	0.15	0.04	0.12	0.12	0.12	0.10	0.15
1	0	0	1	1	0.07	0.07	0.05	0.14	0.04	0.05	0.06	0.09	0.05	0.05	0.05	0.05	0.04
1	0	1	0	0	0.08	0.02	0.16	0.04	0.04	0.03	0.01	0.30	0.00	0.01	0.03	0.05	0.02
1	0	1	0	1	0.07	0.03	0.13	0.05	0.02	0.02	0.01	0.31	0.00	0.00	0.01	0.03	0.00
1	0	1	1	0	2.55	0.34	5.63	1.02	1.57	0.65	0.51	9.34	0.59	0.59	1.04	1.78	0.81
1	0	1	1	1	3.89	0.73	8.30	1.71	2.27	0.86	0.64	15.06	0.78	0.71	1.49	2.20	0.83
1	1	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1	0	0	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1	0	1	0	0.09	0.01	0.20	0.02	0.29	0.01	0.01	0.18	0.01	0.00	0.02	0.03	0.01
1	1	0	1	1	0.15	0.02	0.32	0.03	0.39	0.01	0.00	0.38	0.01	0.01	0.07	0.04	0.01
1	1	1	0	0	0.05	0.00	0.12	0.03	0.14	0.01	0.00	0.10	0.00	0.00	0.01	0.04	0.00
1	1	1	0	1	0.04	0.01	0.08	0.02	0.07	0.01	0.00	0.10	0.00	0.00	0.00	0.03	0.00
1	1	1	1	0	5.05	0.39	11.54	3.33	14.57	0.86	0.43	8.57	0.61	0.74	1.24	3.74	1.06
1	1	1	1	1	6.28	0.68	14.07	4.26	15.77	1.31	0.53	12.17	1.08	1.15	1.99	4.81	1.19

Notes: C.= Central; E.=Eastern; N.=Northern; N.W.= North-Western; S.=Southern; W.=Western.

Source: Author's computations from CSO (2010).

3.4 Dominance comparisons

Following Arndt et al. (2012), we employ FOD techniques to determine the degree of domination at the provincial and district levels using 2010 Census data. In Table 4, the row averages show the fraction of times a row region dominates all other regions. The column averages indicate the fraction of times a column region is dominated by all other regions. The row averages for relatively well-off regions are large and the column averages for the relatively poor regions are also large. FOD results are also presented at the national, urban, and rural levels. Copperbelt and Lusaka provinces and urban areas are shown to be relatively better off areas. Rural areas and Muchinga, Luapula, Northern, North-Western, and Western provinces are relatively worse off. The Western province is shown to be the poorest province.

Table 4: Spatial FOD comparisons for Zambia, 2010

Area	National	Rural	Urban	Central	Copperbelt	Eastern	Luapula	Lusaka	Muchinga	Northern	N. Western	Southern	Western	Avg.
National		1				1	1		1	1	1		1	0.58
Rural														0.00
Urban	1	1		1		1	1		1	1	1	1	1	0.83
Central		1				1	1		1	1	1		1	0.58
Copperbelt	1	1		1		1	1		1	1	1	1	1	0.83
Eastern														0.00
Luapula														0.00
Lusaka	1	1		1		1	1		1	1	1	1	1	0.83
Muchinga														0.00
North-Western													1	0.08
Northern														0.00
Southern		1				1	1		1	1	1		1	0.58
Western														0.00
Average	0.25	0.50	0.00	0.25	0.00	0.50	0.50	0.00	0.50	0.50	0.50	0.25	0.58	

Source: Author's computations from CSO (2010).

The FOD process derives measures that yield cardinal welfare rankings across the provincial and district levels. The average probability of net domination is the probability an area dominates all other areas minus the probability it is dominated by all other areas. Looking at Table 4, the probability of net domination is the province's row average minus its column average. Using this number, we are able to rank populations by welfare status without imposing weights on the various chosen binary welfare indicators. In the section that follows, we extend the analysis to the districts to derive the ranking of the districts in Zambia based on net domination.

3.5 Ranking of districts¹

The FOD rankings for districts in Zambia are presented in Tables 5a-e. The rankings are grouped in quintiles with the fifth quintile representing the relatively well-off districts and the first quintile representing the relatively poorest districts in Zambia. From the tables, the Livingstone district is ranked highest of all 73 districts in Zambia. Livingstone dominates all other districts 90 per cent of the time. The relatively poorest district is Shangombo in Western province, which is ranked the seventy-fourth with a net domination of -72 per cent.

¹ This data represent the districts that existed in 2010 and do not include the new ones created since 2011.

Table 5a: Fifth quintile: spatial FOD ranking and probability of net domination

District	Domination	Rank
Livingstone	0.90	1
Kitwe	0.88	2
Chililabombwe	0.87	3
Chingola	0.87	4
Lusaka	0.86	5
Ndola	0.83	6
Mufulira	0.83	7
Kafue	0.83	8
Luanshya	0.82	9
Kabwe	0.81	10
Kalulushi	0.80	11
Mazabuka	0.51	12
Chongwe	0.44	13
Solwezi	0.35	14

Source: Author's computations from CSO (2010).

Table 5b: Fourth quintile: spatial FOD ranking and probability of net domination

District	Domination	Rank
Kasama	0.32	15
Kapiri	0.26	16
Choma	0.25	17
Chibombo	0.23	18
Mkushi	0.21	19
Luangwa	0.20	20
Mansa	0.19	21
Nakonde	0.17	22
Mongu	0.16	23
Itezhi-tezhi	0.12	24
Sinazongwe	0.11	25
Mpika	0.09	26
Chipata	0.09	27
Siavonga	0.08	28
Mumbwa	0.08	29

Source: Author's computations from CSO (2010).

Table 5c: Third quintile: spatial FOD ranking and probability of net domination

District	Domination	Rank
Monze	0.04	30
Chinsali	0.02	31
Namwala	-0.02	32
Masaiti	-0.05	33
Mambwe	-0.05	34
Chienge	-0.09	35
Mpongwe	-0.09	36
Sesheke	-0.10	37
Mpulungu	-0.14	38
Kasempa	-0.14	39
Kazungula	-0.16	40
Mporokoso	-0.17	41
Kalomo	-0.17	42
Kawambwa	-0.18	43
Mwense	-0.21	44

Source: Author's computations from CSO (2010).

Table 5d: Second quintile: spatial FOD ranking and probability of net domination

District	Domination	Rank
Serenje	-0.23	45
Katete	-0.24	46
Mbala	-0.25	47
Lufwanyama	-0.27	48
Gwembe	-0.27	49
Nchelenge	-0.27	50
Petauke	-0.28	51
Lundazi	-0.31	52
Kabompo	-0.32	53
Nyimba	-0.33	54
Mwinilunga	-0.34	55
Luwingu	-0.34	56
Isoka	-0.34	57
Samfya	-0.34	58
Mufumbwe	-0.36	59

Source: Author's computations from CSO (2010).

Table 5e: First quintile: spatial FOD ranking and probability of net domination

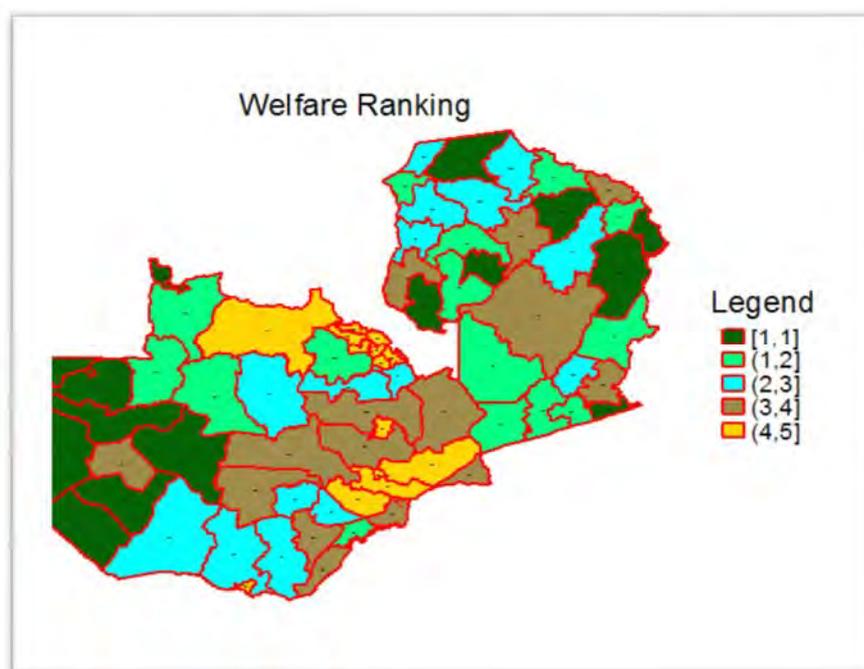
District	Domination	Rank
Kaputa	-0.37	60
Kaoma	-0.38	61
Chilubi	-0.40	62
Chavuma	-0.40	63
Senanga	-0.40	64
Mungwi	-0.41	65
Zambezi	-0.43	66
Chadiza	-0.43	67
Lukulu	-0.46	68
Chama	-0.48	69
Mafinga	-0.48	70
Milenge	-0.55	71
Ikelenge	-0.58	72
Kalabo	-0.67	73
Shang'ombo	-0.72	74

Source: Author's computations from CSO (2010).

3.6 Poverty status map

The welfare comparisons at district levels are presented in Figure 2. The well-off regions in the fifth quintile are represented by gold. The fourth quintile is represented by brown and the third quintile by cyan. The well-off regions are primarily clustered in the Copperbelt and Lusaka provinces. Livingstone, Kabwe, and Solwezi are the other well-off districts in the first quintile. The relatively poor regions in the second and first quintiles are represented by light green and dark green, respectively. These are concentrated mainly in the Western province with Eastern, Northern, Luapula, and North-Western provinces contributing a share as well.

Figure 2: The welfare comparisons at the district level



Note: The legend colours and numbers represent quintile categories. The fifth quintile (4,5) coloured gold represents the regions that are relatively well-off and the first quintile (1,1) and colored dark green represents the relatively worse-off regions.

Source: Author's computations from CSO (2010).

4 Conclusion

In this paper, we analysed the welfare status of provinces and districts based on five indicators, which relate to key areas of focus of the Zambian Government. In this way, the paper has provided a fairly clear picture of how economic development and development policies have shaped the welfare of people across the country. The information on the level of development of provinces and districts, ranked from the best to the worst, will help policy formulation and resource allocation in the country. At the very least, targeted policy intervention should be devised with a view to enabling the regions that are worse-off to begin to improve their welfare status. This study has shown that at the provincial level, the welfare status of the Western province falls below the average for rural areas. This is an important indication that this area may need particular attention to advance from its current levels. At the district level, most districts in the Western province are among the worst faring districts, falling in the first quintile. The analysis has further revealed that overall, areas are primarily deprived in four indicators, energy, sanitation, housing, and unemployment.

The analysis in this paper has been restricted to the 2010 Census data. However, the application of the FOD methodology on past surveys and indeed future surveys will provide an important monitoring and evaluation framework for public policy, specifically as it relates to the implementation of the national development plans and similar policies and strategies.

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