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Multidimensional measures of deprivation in Tunisia

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The multidimensional apprehension of poverty is largely accepted today given the considerable contribution to understanding and acting against the manifestations of this phenomenon. Amartya Sen's capability approach is the basis of the recent developments on the subject. In this perspective, the present work aims to study the application of multidimensional deprivation measures on Tunisian data. This paper investigates the nature of deprivations in the country using the measures proposed by Alkire and Foster, based on a two-threshold identification method. Our work proposes measures of deprivation in four dimensions. In addition to the dimension of economic resources, we consider the deprivations in terms of housing, education and health. The study employed the national survey on household budget, consumption and standard of living 2010. The results are useful in identifying the most widespread deprivations and the most vulnerable population groups. In fact, with the monetary approach it is not possible to target all vulnerable groups and to detect all the deprivations suffered by the population. According to the results of this work, the western and southern regions of the country record the highest deprivation rates. The results are also indicative of the most widespread deprivations and the most affected socio-economic groups.

Key words: Capability approach, monetary poverty, deprivation, poverty measurement, Alkire and Foster measures, Tunisia.

INTRODUCTION

Nowadays, the multidimensional understanding of poverty is universally recognized by the work on Amartya Sen's approach to capabilities, which places a central value on the notion of positive liberty (Sen, 1985, 1987, 2003). The influence of this approach has affected not only the study of deprivations, but also the areas of education, health, gender inequality, sustainable development as well as the protection of the environment.

Poverty cannot be reduced to the lack on monetary resources, but must take into account the dimensions of a dignified and respectable human life. Alkire and Santos

(2013) discussed three reasons to consider income to be inadequate indicator of poverty. First, the existence of needs met by non-market or institutional goods (access to services: water, education). Secondly, the ability of individuals to transform income into functioning depends on their physical states, activity, location, level of education. Finally, participatory surveys show that poor people identify in priority other dimensions of deprivation such as: nutrition, health, access to drinking water, exclusion, violence. At this level, the exploration of other facets of deprivation helps to complete the image drawn

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and offers a better view of the disadvantages suffered by the poorest individuals.

Studies on multidimensional poverty continue to grow. Many of these works link poverty to several dimensions of human life. We refer here, for example, to Brandolini and D'Alessio (1998), Chiappero-Martinetti (2000), Lelli (2001) and Maitre et al. (2014). The results reveal the contribution of multidimensional perception to the understanding of poverty.

In the same perspective, the construction of multidimensional measures has largely developed. Deutsch and Silber (2005) presented a comparison of four approaches based on fuzzy set theory, information theory, efficiency analysis and axiomatic approach. In 2010, the United Nations Development Program (UNDP), in collaboration with the Oxford Poverty and Human Development Initiative (OPHI), launched the Multidimensional Poverty Index calculated for a hundred countries.

Official statistics in Tunisia show that poverty in the country is in constant decline. However, this regression cannot hide the existence of a very significant differential, particularly according to the region and the area of residence (Institut National de la Statistique INS, 2010 and 2015). In addition, the study of poverty in Tunisia focused on monetary terms with a dominance of the work carried out by national and international institutions (African Development Bank, 2011; INS, African Development Bank and World Bank, 2012; World Bank, 2016).

Belhadj (2011) constructed a multidimensional poverty index using fuzzy set theory, applied to Tunisian data from the 1990 budget and consumption survey. The work retains 3 dimensions relating to: the region of residence (by differentiating between rural and urban coastal and interior environments as well as the urban region of the capital Tunis); the activity and level of education of the head of household. The results show that poverty is more severe for: residents in interior regions; households headed by a worker or illiterate.

Likewise, Nasri and Belhadj (2017) used household expenditure to analyze regional multidimensional poverty, by only retaining expenditure related to three headings: food, health and education. Other works such as Belhadj (2012); Hasnaoui and Belhadj (2015); Zedini and Belhadj (2015) have adopted the same logic. They exclude expenses relating to communication, leisure.

The approach to our work is completely different from this vision. Indeed, the contribution is to consider an understanding of multidimensional poverty that takes into account monetary and non-monetary aspects. This is at the heart of recent developments in the study of poverty.

The objective of this paper is to analyze poverty in Tunisia from a multidimensional perspective. For this purpose, we apply the method of Alkire and Foster (2009) to obtain the multidimensional poverty measures. These measurements are based on an identification method with two thresholds (Between and within dimensions). The

aggregation step is done through the fitted Foster-Greer and Thorbeck family of measures. The application is based on Tunisian data from the 2010 National Household Budget, Consumption and Standard of Living Survey.

Multidimensional measures

Fundament

The definition of poverty in terms of lack of capabilities and functioning aims to defend the right to a decent life for all individuals. Although income is essential to meeting needs, it is not the primary objective. Income is a means and not an objective in itself.

Functioning expresses all the possibilities of choice and actions, from the most basic to the most complex, accessible to an individual (being well fed, in good health, participating in social life). Capability is a combination of functioning that represents a certain way of life. Achievements consist of all the modes of functioning that a person actually exercises. It is necessary to differentiate between achievement on one side and freedom of achievement on the other. Sen's legal approach places a significant value on the freedom to achieve in the sense that it extends the choice possibilities of an individual.

For Sen, the "Capability" space is more appropriate for the study of poverty and inequality. First, the real freedoms admit an intrinsic importance for all individuals. The possibility to choose independently is a goal that everyone seeks to achieve. This provides to capabilities the basic role for a dignified and fulfilling human life. Second, economic and monetary conditions are not the only factor influencing the production of capabilities. Political freedoms, housing conditions, health status are important elements in people's perception. Finally, the relationship between monetary poverty and poverty in capabilities remains variable. This justifies the existence of situations where people suffering from various deprivations are not identified by a monetary approach. This relationship depends on several factors that influence the conversion of resources into functioning.

Construction

The measures of Alkire and Foster (2009) consisted of a two-step identification method (identification step) combined with a family of measures based on the Foster et al. (1984) index (aggregation step).

Identification: The population considered is composed of n individuals (denoted i ; $i = 1, \dots, n$). Individual achievements are counted in d dimensions (denoted j ; $j = 1, \dots, d$). The matrix of achievements is therefore noted:

$$X = [x_{ij}]_{n \times d}$$

The element x_{ij} denotes the achievement of the individual i in the dimension j . The line vector represents the individual achievements in the different dimensions. On the other hand, the column vector represents the distribution of one-dimensional achievements with respect to the entire population. The first identification step is based on setting a threshold for each dimension. For any dimension j , a deprivation threshold z_j is defined. The threshold vector is denoted $z = (z_1, \dots, z_d)$. To any matrix of achievement x_{ij} corresponds a deprivation matrix $g^0 = [g_{ij}^0]$ defined by:

$$g_{ij}^0 = \begin{cases} 1 & \text{if } x_{ij} < z_j \\ 0 & \text{if } x_{ij} \geq z_j \end{cases} \quad (1)$$

The value 1 indicates that the individual i is considered poor in dimension j . Counting the deprivation dimensions determines the account matrix $c = [c_i]$ where c_i the deprivation number.

$$c_i = \sum_{j=1}^d g_{ij}^0 \quad (2)$$

In the case where a weighting system is $w = (w_1, \dots, w_d)$, the elements of the deprivation matrix consist of :

$$g_{ij}^0 = \begin{cases} w_j & \text{if } x_{ij} < z_j \\ 0 & \text{if } x_{ij} \geq z_j \end{cases} \quad (3)$$

And the account matrix will be interpreted as the weighted number of deprivations. In the case where the achievement is defined by cardinal variables, the matrix of normalized deprivation differences $g^1 = [g_{ij}^1]$ admits as typical element (whose value is between 0 and 1):

$$g_{ij}^1 = \begin{cases} \frac{z_j - x_{ij}}{z_j} & \text{if } x_{ij} < z_j \\ 0 & \text{if not} \end{cases} \quad (4)$$

The elements of this matrix are non-negative, between 0 and 1. A non-zero value indicates the deprivation intensity felt by the individual i in the dimension j . This matrix can be generalized for a rank α ($\alpha > 0$) : $g^\alpha = [(g_{ij}^1)^\alpha]$

The second stage of identification is based on the number of individual deprivations k . The function of multidimensional deprivation is therefore:

$$\rho_k(x_i; z) = \begin{cases} 1 & \text{if } c_i < k \\ 0 & \text{if not} \end{cases} \quad (5)$$

The union approach ($k = 1$) considers as poor any individual in a state of deprivation in at least one dimension. On the other hand, in the intersection approach ($k = d$), the individual is poor when he is deprived in all dimensions. Eliminating data on non-poor individuals allows the construction of the matrix $g^0(k) =$

$[g_{ij}^0(k)]$; with:

$$g_{ij}^0(k) = \begin{cases} g_{ij}^0 & \text{if } c_i \geq k \\ 0 & \text{if not} \end{cases} \quad (6)$$

Aggregation

The incidence of poverty H , percentage of the poor population, is the most used measure.

$$H(X, z) = \frac{q}{n} \quad (7)$$

where

$$q = q(X, Z) = \sum_{i=1}^n \rho_k(x_i, z) \quad (8)$$

represents the number of individuals identified as poor by the multidimensional method.

In defining the matrix:

$$g^\alpha(k) = [g_{ij}^\alpha(k)] , \quad (9)$$

$$g_{ij}^\alpha(k) = \begin{cases} g_{ij}^\alpha & \text{if } c_i \geq k \\ 0 & \text{if not} \end{cases} \quad (10)$$

it is possible to propose a family of measures M_α such as (for a vector v , $\mu(v)$ represents the average of all elements):

$$M_\alpha(X, k) = \mu[g^\alpha(k)] \quad (11)$$

The α parameter is an indicator of poverty aversion. It is also interpreted as an elasticity of individual poverty relative to the poverty deficit. A 1% increase in the deficit results in a α % increase in the poverty measure.

For a value $\alpha = 0$, the measure obtained is:

$$M_0(X, k) = \mu[g^0(k)] = |c(k)|/nd \quad (12)$$

Where $|v|$ denotes the sum of all elements for the vector v .

DATA AND DEPRIVATION DIMENSIONS

Data

The empirical work done is based on data from the 2010 National Survey on Household Budget, Consumption and Living Standards. Conducted by the National Institute of Statistics (INS), the five-year survey took place between June 2010 and main 2011 on a sample of 13,400 households. The purpose of the survey is to provide information on three aspects: household consumption expenditure, food consumption and household access to health and education services made with a sample halved.

The merging of the data provided by the three components made it possible to obtain a sample composed of 5,690 households representing 25,055 individuals of which 64.66 % live in a urban

Table 1. Distribution of households (in%) by marital status.

Status	Male	Female	Total
Single	1.59	4.12	1.99
Married	95.89	21.29	84.13
Widowed	2.13	66.44	12.27
Divorced	0.40	8.14	1.62
Total	100.00	100.00	100.00

area. Male-headed households account for 84.24% of the sample. In 95% of these cases, the head of household is married. When a woman is in the position of household head (15.76% of the total households), the dominant marital status is "widowed" representing 64.44% of households headed by females. Households headed by females are, on average, smaller in size. Half of the households in the sample, the head is between 40 and 60 years old (Table 1).

Dimensions and indicators

The choice of dimensions and associated indicators follows two possible approaches (Guio, 2009; Guio et al., 2009):

- i. the normative approach: consists of proceeding in a logical way, by attributing indicators to specific dimensions previously chosen (Multidimensional Poverty Index IPM built by the UNDP, poverty in living conditions in France);
- ii. the descriptive approach: uses the CFA (Confirmatory factor analysis) analysis techniques to identify groups of indicators according to the degree of correlation (Nolan and Whelan, 1996).

Monetary dimension

In this dimension, households that have an amount of consumption expenditure below a monetary poverty line, are considered in a state of deprivation. The threshold calculated by the INS is the sum of food and non-food components. It is calculated for three areas: metropolitan, communal (urban) and non-communal (rural). The respective values are estimated at 1277, 1158 and 820 dinars (Tunisian currency) per person / year.

Housing dimension

Housing is an essential dimension in the well-being of households. Deprivation in this dimension is assessed according to the comfort and availability of essential services. Four indicators were selected:

- i. the number of persons per room: the threshold chosen is 3. Thus, a household will be judged in deprivation if the value of the indicator is greater than 3;
- ii. the availability of electricity;
- iii. the availability of potable water: provided by SONEDE (National Company of Exploitation and Distribution of Waters). Households who obtain drinking water by means of: public fountain, sellers, public or private wells as well as waterways are considered deprived;
- iv. the Connection to the sewerage network.

Education dimension

Deprivation in the education dimension is assessed in relation to

the education level of the household head. The household is deprived if the head has never studied.

Health and social security dimension

Two indicators are used to represent deprivation in this dimension. For the first indicator, a household will be considered poor if one of these members is suffering from a long-term illness without having care coverage (through: CNAM National Health Insurance Fund, a mutual or a group insurance, free of charge, with a family member). The second indicator concerns the affiliation of the household to a social security organization (Caisse Nationale de Sécurité Sociale, CNSS or Caisse Nationale de Retraite et de Sociale, CNRPS). Deprivation in this indicator is confirmed when the head of household is not affiliated.

RESULTS AND DISCUSSION

Deprivation by dimension

When the dimension is represented by more than one indicator, the household is considered deprived if it accumulates deprivations in at least 50% of the indicators. Tables 2 to 4 summarize the information on the indicators by dimension (reporting the threshold and frequency of deprivation).

The data show that income poverty affects 14.24% of households. The proportion of the poor in this dimension is even higher:

- i. in the rural area (19.74%) compared to the urban area (11.23%);
- ii. in the inner regions of the country, the poverty rate is 28.77 % in the Midwest, while it is 5.34 % in the Center East;
- iii. for larger households;
- iv. when the head of the household belongs to the category of unemployed or farm workers. As for the monetary poverty, the deprivation of education is more widespread in the rural area (48.41 % against 22.68 % in the urban area), as well as in the interior regions (in particular in the center west and North West). At the national level, 31.76% of household heads have never studied. In fact, the geographical distribution of schools is uneven between regions. This compromises development and increases the hardships of the inhabitants of some regions of the country. In rural areas, schools are devoid

Table 2. Deprivation Rate (in %) by dimension.

Dimension	Deprivation rate
Monetary	14.24
Housing	20.83
Education	31.76
Health	36.68

Table 3. Housing dimension.

Indicator	Threshold	Deprivation (%)
Number of person/ room	Greater than 3	10.93
Electricity	No electricity	0.77
Potable water	No connection SONEDE	17.29
Sanitation	No connection	45.13

Table 4. Dimension of health and social security.

Indicator	Threshold	Deprivation (%)
Long-term illness	Patient without care coverage	11.49
Affiliation to social security	Not affiliated	36.41

of equipment and lack of maintenance and teaching staff.

The regional differential of deprivation seems even more important in the housing dimension. While the proportion of households in deprivation is 2.08 % in Tunis agglomeration, it reaches 48.19 % in the center west. At the national level, the rate of housing deprivation is 20.83%. Official data on housing in Tunisia indicate a sustained evolution of the housing stock. However, as Zaafrane (2014) points out, the living conditions and the households' comfort vary according to their socio-economic characteristics. Thus, the poorest households live in very difficult conditions. Housing policy must take into account social and regional parameter.

For the health and social security dimension, the deprivation rates in each indicator are shown in Table 4. The proportion of households in deprivation in the dimension is estimated at 36.68%. Despite the large offer of care, it remains characterized by strong disparities. Belhadj et al. (2016) note that community care structures in several regions can only provide one medical consultation per week. In addition, there are financial difficulties in accessing healthcare, particularly because of the non-affiliation of a large part of the population to the CNAM.

It is therefore necessary to carry out reforms that guarantee access to care and overcome the financial difficulties encountered by users. Also, it is necessary to reduce the imbalances between the regions by revising the health map and by giving priority to the regions of the

west and south of the country. On this point, Achour (2011) underlines the significance of regional inequalities which is manifested by indicators such as the concentration of beds, equipment and health personnel in the coastal regions (the eastern regions of the country).

The results (Table 6) also show that households headed by women are more exposed to the risks of deprivation, particularly in the education and health dimensions. According to the socio-professional category, it appears that deprivation affects more severely the farmers and farm workers in the housing, education and health dimensions. The inactive and households without support also experience high rates in the education and health dimensions.

Poverty measures

The identification of multidimensional poor households as well as the measures depends on the threshold k , which indicates the number of deprivation dimensions needed to consider them as poor (Table 5). Equal weighting was adopted in construction measurements. The debate is very open for this choice and the literature is rich in contributions: Decancq and Lugo (2008) and Anand and Sen (1997) as examples.

Table 6 shows the different measures according to the values of k . When $k = 1$ (union approach), it suffices that a household suffers from deprivation in at least one

Table 5. Multidimensional poverty measures by the threshold k .

Threshold	Rate (%)	$M0(k)$
$k = 1$	56.59	25.87
$k = 2$	31.28	19.55
$k = 3$	12.58	10.2
$k = 4$	3.04	3.04

Table 6. Deprivation and poverty measures according to the households' characteristics.

Characteristics	Deprivation rate (in %)				Multidimensional measures (in %)			
	Monetary	Housing	Education	Health	k=1	k=2	k=3	k=4
Gender								
Male	14.31	20.85	25.45	31.92	51.72	27.08	11.00	2.73
Female	13.82	20.73	65.44	62.11	82.61	53.73	21.07	4.68
Marital status								
Single	12.39	25.66	25.66	57.52	69.91	34.51	14.16	2.65
Married	14.98	21.52	25.78	33.19	52.41	28.12	11.82	3.11
Widowed	10.32	16.9	73.21	54.01	81.23	52.29	18.05	2.87
Divorced	7.61	8.7	35.87	60.87	70.65	32.61	8.70	1.09
Household size								
1 to 2	4.58	19.35	53.69	47.14	68.89	41.21	13.01	1.66
3 to 4	8.88	17.23	24.50	33.29	49.06	24.50	8.97	1.37
5 to 6	18.03	20.73	25.39	33.16	52.69	28.34	12.59	3.68
7 to 8	30.77	29.78	40.04	41.03	70.81	43.39	20.51	6.90
more than 8	42.53	47.70	45.40	46.55	82.18	56.32	31.03	12.64
Regions								
Tunis Agglomeration	7.81	2.08	20.36	18.97	35.57	11.96	1.58	0.10
North east	8.03	18.68	32.63	35.92	57.37	28.03	7.63	2.24
North west	20.41	40.22	42.92	51.76	73.27	49.94	25.52	6.56
Center east	5.34	9.2	23.11	27.35	42.54	17.40	4.05	1.01
Midwest	28.77	48.19	45.85	59.30	80.23	59.53	33.68	8.65
South east	16.89	18.69	28.69	34.10	56.56	30.98	9.18	1.64
South west	17.46	11.95	33.46	33.82	60.29	27.21	8.09	1.10
Area of residence								
Rural	19.95	54.02	48.79	57.39	83.92	58.59	29.60	8.04
Urban	11.16	2.97	22.59	25.54	41.89	16.59	3.43	0.35
Socio-professional categories								
Higher managerial and professional occupations	0.00	1.81	1.81	3.26	4.71	1.81	0.36	0.00
Intermediate occupations	2.67	4.58	3.44	8.40	14.89	3.44	0.76	0.00
Other employees	7.64	6.74	8.99	16.85	27.42	10.11	2.47	0.22
Small employers	7.78	10.07	14.65	25.86	39.13	14.65	4.12	0.46
Own account workers	10.63	6.25	9.38	26.25	36.25	13.75	2.50	0.00
Workers	22.02	24.97	22.96	42.24	63.52	33.67	12.18	2.81
Farmers	18.13	50.09	48.29	57.81	80.79	56.55	28.55	8.44
Agricultural workers	37.50	49.04	43.27	63.46	81.73	63.46	36.54	11.54
Non employed	37.84	38.74	32.43	73.87	89.19	55.86	29.73	8.11
Retired	5.94	9.94	36.23	8.91	44.80	13.26	2.63	0.34
Other inactive	13.39	20.37	71.65	60.11	84.90	54.99	21.37	4.27
Support outside the household	22.85	40.45	60.30	84.27	92.13	70.04	35.58	10.11

Table 7. Correlation between deprivations.

Dimension	Monetary	Housing	Education	Health
Monetary	1			
Housing	0.2469*	1		
Education	0.1272*	0.2331*	1	
Health	0.2493*	0.2967*	0.3112*	1

*Significant at 5%

Table 8. Proportions of poor households (in %) detected by the one-dimensional measures.

Dimension	Multidimensional Measures (%)			
	$k=1$	$k=2$	$k=3$	$k=4$
Monetary	25.2	38.3	59.2	100
Housing	36.8	55.6	83.5	100
Education	56.1	71.3	86.5	100
Health	64.8	84.7	95.0	100

dimension to be considered "poor". On the other hand, for a value of $k = 4$ (intersection approach), a household is considered poor only when it experiences difficulties in the four dimensions selected.

In view of the results, it should be noted that more than half (56.59%) of the population suffers from deprivation in at least one dimension. This proportion adds up to one quarter of the total deprivation ($M_0(1) = 25.87\%$) of possible deprivations equal to $n \times d = 5690 \times 4$.

For a threshold value $k = 3$, only households with deprivations in three or four dimensions are considered poor. For this threshold, 12.58% of households are classified as poor. These households total deprivations equivalent to $M_0(3) = 10.2\%$ possible deprivations.

An analysis of deprivations by household characteristics shows that households living in the Midwest and the North West are the most vulnerable to multidimensional poverty, regardless of the value of the threshold k . The deprivations are more felt in the dimensions of housing, health and education. Globally, the multidimensional measures are higher when the head of household is a farm worker, unemployed or a farmer.

Table 6 also shows that multidimensional poverty is more prevalent in the urban area. Research studies explained the deterioration in the living conditions of rural households by the deterioration of the terms of trade for agricultural products on the one hand and the decrease in investments in the agricultural sector on the other hand (Elloumi and Dhehibi, 2009). The rural environment seems unable to follow an economic model with high productivity. This imbalance between rural and urban areas is the result of a historical cleavage between town and country as well as the result of policies and development model for decades.

The low degree of correlation between deprivations by

dimension attests to the usefulness of the multidimensional approach (Table 7). Indeed, each dimension provides additional information regarding the poor population. Thus, 68.95% of poor households in terms of housing are not detected by income poverty. Indeed, despite suffering from deprivation in the housing dimension, they have an income above the poverty line. This proportion climbs to 74.21% for the health dimension and 79.25% for the education dimension.

Moreover, the monetary dimension can only identify 60% of the poor population in multidimensional terms ($k = 3$). This proportion drops to 38.3 % when $k = 2$ (poor households are those experiencing difficulties in at least two dimensions). For a value of the threshold $k = 3$, the intersection between the multidimensional approach and the housing, education and health dimensions are respectively 83.5, 86.2 and 94.5% (Table 8).

Conclusion

The objective of this work was to identify multidimensional poverty in Tunisia and to build adapted measures. The approach adopted considered poverty in terms of capabilities according to a set of deprivations relating to different dimensions. Based on data from the 2010 National Survey on Household Budget, Consumption and Living Standards, indicators in four-dimensional were selected. In addition to the monetary dimension, they concern the dimensions of housing, education and health.

The measures, built on the basis of the two-threshold counting method, proposed by Alkire and Foster (2009), was applied. The results demonstrate the importance of non-monetary deprivations. They also show that more

than half of the population suffers from deprivation in at least one dimension. These deprivations are widespread especially in the rural area as well as in the interior regions of the country. The risk of deprivation increases significantly when the head of the household is female or unemployed, working as a farmer, agricultural worker.

This work clarifies the nature of deprivation in Tunisia by introducing additional dimensions. We demonstrated the usefulness of this multidimensional approach. Indeed, the low correlation between deprivations by dimension attests to the contribution of each dimension to the understanding of poverty in Tunisia.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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