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A Multidimensional Vulnerability Index for Adults 65+: Methodological Framework and Analytical Protocol

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Abstract: In the framework of the project “In depth Analysis of the factors affecting aging in Albania” supported by NASRI (National Agency for Research and Innovation), a primary survey of persons 65+ across several selected municipalities will take place. This paper aims to detail in advance of fieldwork, the analytical protocol by which a multi dimensional vulnerability index for persons 65+ will be constructed from the survey instrument and ranked across municipalities. Additionally, it will use polychoric principal component analysis. This is suitable because the survey items are ordinal. A continuous vulnerability score will also be generated by these to methods combined. Four domains derived from the questionnaire will be the basis for the indicators, with twelve underlying items mapped to those domains. A protocol for the second stage analysis is planned. The protocol will link link municipal vulnerability rankings with four Census 2023 structural variables. The paper presents the methodology with a fully worked illustrative simulated micro-data. At this stage no empirical findings on real respondents are reported. The aim of this preregistering of analytical plan is three folded: reduces post-hoc decision; the methodology is reviewed before the results are available; prepares the next stage to focus on findings rather than methodology debate.

Keywords: Alkire–Foster method; Polychoric PCA; Multi-dimensional deprivation

JEL Classification: I32, J14, C43, C38.

1. Introduction

The PKKZH (Project Proposals for Research and Development) 2025 project on aging in Albania, jointly led by the Faculty of Economics of the University of Tirana with the support of NASRI (National Agency for Scientific Research and Innovation) in Albania, addresses the demographic aging and its implications and consequences from the socioeconomic perspective at municipality level. This paper is a pre-registered methodological protocol, that specifies, in advance of fieldwork, the analytical protocol by which a multi-dimensional vulnerability index will be constructed from the survey instrument and ranked across municipalities. Additionally, municipal rankings will be linked to Census 2023 structural variables in a second stage analysis. It reports no empirical findings on real survey respondents. Pre-registering the analytical plan in this form serves three purposes. First to address before findings publishing any objections to the index construction and ensure methodological scrutiny in advance of

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empirical results. It disciplines analytical decisions made after data are observed, reducing the risk of specification searching. And finally, it positions a Phase 2 paper to report empirical findings focusing on substantive interpretation without any doubt of the methodology.

The paper is organized as follows. The section two covers the methodological literature on the deprivation measurements and multidimensional literature. It presented the motivation to adopt two harmonised approaches. The primary and secondary data sources, are presented in section 3, as well as the indicator selection from the questionnaire and their assignment to four domains. Additionally, it presents the Alkire Foster and polychoric principal component approaches, including all pre-registered analytical decisions. Section 4 presents the second stage protocol linking municipal rankings to structural variables of 2023 Census. Section 5 presents the limitations and finally the paper is completed in section 6 with conclusions.

2. Methodological Literature and Conceptual Framework

This paper uses, for the same indicator set, the counting and latent variable approaches in parallel. The Alkire Foster method is the key specification due to the transparency it presents and its clarity handling of the deprivation thresholds that policy actors must in any case decide. While the polychoric PCA, used as a continuous score for the second stage regression and a thorough check on the rank ordering of municipalities, is used as the second specification. The convergence of the two approaches strengthens the confidence in municipal ranking, while the divergence shows that which conclusions are sensitive toward methodological choices.

Vulnerability and deprivation are mistakenly considered identical; indeed, they are closely related but not the same. Deprivation refers to a lack of well being in one or more dimensions at a specific point in time. While vulnerability, has a forward looking component: the probability of falling into deprivation; it considers the future and refers to the risk of experiencing deprivation, or becoming more deprived, due to unexpected events or shocks.

For this study, deprivation is the directly measurable construct, while vulnerability is a more demanding inference that requires either longitudinal data or strong assumptions about exposure to risk. Therefore, this paper measures multidimensional deprivation and uses it as a practical indicator of vulnerability. The methodology of multi-dimensional measurement literature is dominated by three methods. The first is the counting approach formalised by Alkire and Foster (Alkire & Foster, 2011). This method has been adopted by a growing number of national statistical offices and by UNDP for the Multidimensional Poverty Index (UN, 2025). The headline indicator M0, the adjusted headcount ratio, is the product of the headcount of the multi-dimensionally poor (H) and the average breadth of their deprivation (A).

The second one is the composite indicator approach. This method creates a single score by combining several indicators into one measure. This approach is more compact, but the results can change depending on the weights and methods used. The process usually includes selecting indicators, assigning weights, normalising data and combining the results. The OECD–JRC Handbook on Composite Indicators (2008) sets out the standards. The third one is the latent variable approach. This approach estimates an underlying concept that cannot be directly observed by using several measured indicators. Methods such as factor analysis and principal component analysis (PCA) are commonly used. For ordinal data, like questionnaire responses, polychoric PCA is more suitable than standard PCA because it captures better the relationships between ordered categories (Kolenikov & Angeles, 2009).

3. Data Sources

The analysis is based on two data sources composed of the survey data with persons 65+ conducted across 15 Albanian municipalities under the PKKZH 2025 project. The questionnaire managed through Computer Assisted Technique was composed of four parts: economic income, health, social life, and care from others. A cover sheet captures household identification, sex, date of birth, marital status, and education attainment. The sample size per municipality, and the final list of selected municipalities will be part in the project documentation. The second source of data is based on the Population and Housing Census 2023 results. Aiming to link the vulnerability index to structural context for the second stage analysis, four variables are identified at municipality level Census data: the old-age dependency ratio; the share of the population (65+) whose highest completed education is primary or less; the share of the resident population in rural settlements; and the share of 65+ living in single person households. Data linkage between the primary and secondary sources is at the municipality level only. While for the purpose of the study it is not planned or sought individual level linkage between survey respondents and Census data. The survey is anonymous at the individual level. To four domains are assigned twelve indicators, selected from the questionnaire. The selection is based on the following criteria: (1) each indicator is included only if its policy interpretation as a deprivation is unambiguous; (2) where possible, each domain should have a similar number of indicators to avoid giving more weight to domains with more indicators; (3) where two or more questionnaire items address the same underlying construct (for example, hearing related social interference and overall mental/physical limitation of social participation), the more general item is preferred. The four domains and their twelve indicators are as follows in Table 1.

Table 2. The Four Domains, Twelve Indicators General Table Based on the Questionnaire

Domain	Indicator	Cut-off (deprived if...)	Weight (%)	Source
1. Economic	Financial-satisfaction deprivation	Categories 4–6 of Q1.3	8.33	Q1.3
1. Economic	Informal-income reliance	Only/principal income from informal sources, no pension	8.33	Q 1.1
1. Economic	Basic-needs prioritisation	Income only on food, utilities, healthcare	8.33	Q 1.2
2. Health	Any functional difficulty	Reports ≥ 1 of vision/walking/hearing/communication/mental	8.33	Q 2.1
2. Health	Poor self-rated health	Response “Poor” on 4-pt scale	8.33	Q 2.2
2. Health	Frequent activity-limitation by health	Response “Often” or “All of the time”	8.33	Q 2.5
3. Social	Low contact frequency	Less than monthly, never, or no friends/family	8.33	Q 3.1
3. Social	Small confidant network	0 or 1 close friends to discuss problems	8.33	Q 3.6
3. Social	Adverse-event burden	≥ 2 adverse life events in past 2 years	8.33	Q 3.4

Domain	Indicator	Cut-off (deprived if...)	Weight (%)	Source
4.Instrumental support	Lack of help when ill (chores)	“Never” or “Rarely”	8.33	Q 4.1.1
4.Instrumental support	Lack of help when bedridden	“Never” or “Rarely”	8.33	Q 4.1.2
4.Instrumental support	Lack of help with meal preparation	“Never” or “Rarely”	8.33	Q 4.1.3

The first specification used as mentioned above is Alkire–Foster method, which is applied in five steps. First, the unit of analysis is defined in this study, which is persons aged 65 +. The second step is the indicators and deprivation cut-offs selection, which are selected above (Table 1). The third step is assigning weights. Each of the four domains receives the same weight, 25%. Within each domain, the three indicators are also weighted equally, which means that each indicator receives 8.33% of the total weight. And the four step is the calculation of the deprivation for each person. If the person is deprived it is assigned a value of 1 and 0 if not. These deprivations are then multiplied by the indicator weights and added together to create a total deprivation score. If the deprivation score is at least 33.3%, then the person is classified as multidimensionally vulnerable. Sensitivity tests be carried out also using lower and higher cut offs as 25% and 50%. And finally, the fifth step, there are calculated three measures. The share of people 65+ who are vulnerable is presented as the headcount ratio; the intensity shows the average level of deprivation among vulnerable people; and the adjusted headcount ratio combines both measures and is the main municipal indicator. Two breakdowns have been calculated. The first shows which are the indicators that contribute most to vulnerability. The second shows which are the domains that contribute to most. These help explain the differences between municipalities.

Formally:

$$c_i = \sum_j w_j \cdot g^0[i,j] \quad \text{Equation 1. Deprivation Score}$$

A person is vulnerable if:

$$c_i \geq k \quad \text{Equation 2. Vulnerability Threshold}$$

The main indicators are:

$$H = q / n \quad \text{Equation 3. Headcount Ratio}$$

A = average deprivation among vulnerable persons

$$A = (1/q) \sum c_i \text{ for all } c_i \geq k \quad \text{Equation 4. Average Deprivation Among Vulnerable Persons}$$

$$M0 = H \times A \quad \text{Equation 5. Adjusted Multidimensional Vulnerability Index}$$

As mentioned in the beginning, the second specification is the polychoric principal-component analysis.

Three implementation decisions that are pre-registered. First, it is estimated the polychoric correlations using maximum likelihood. Cells with fewer than five expected observations are flagged, not dropped.

It is also pre-registered a smoothed correlation estimator, as a sensitivity check. Second, Eigenvalue above 1, using Kaiser criteria helps us to decide how many components to retain, which is cross checked against a parallel-analysis benchmark (Horn, 1965). Only the first principal component becomes the vulnerability score, and only if its eigenvalue clears both thresholds. And the third, the score is normalised to the 0–100 range across all the selected municipalities, where 0 marks the lowest observed vulnerability and 100 the highest.

The municipal vulnerability index is calculated as the average polychoric-PCA score for each municipality. Using bootstrap methods, the confidence intervals are estimated at 95%. Using Spearman rank correlation, the main robustness check compares the municipality ranking from Alkire–Foster M0 with the ranking from polychoric-PCA. If the correlation is 0.8 or higher, then the two methods are considered to give similar results. However, if it is below 0.8, the municipalities with different rankings are checked indicator by indicator and reported for transparency

3. Linkage to Population and Housing Census 2023 of the Structural Variables

Since the sample size is based in 15 municipalities, this sample size limits what the second-stage analysis can claim. It is not considered as a strong inference since currently there are 61 municipalities in Albania (INSTAT, 2024). For this reason, the analysis is considered as descriptive, not a casual one.

With this approach for 15 municipalities the question is narrow: does the vulnerability index line up with the structural factors that theory says should drive the vulnerability of persons 65+? We do not test whether those factors cause vulnerability.

The second stage analysis links the municipal vulnerability indicators to four pre-registered structural variables drawn from the Census, once each of the municipalities is assigned an M0 value and a polychoric-PCA score. The variables are: the old-age dependency ratio; the share of the 65+ population whose highest completed education is primary or less; the rural share of the resident population; and the share of persons 65+ in single person households. Two analytical models are pre-registered. The first one uses the Spearman rank correlation model, which compares each Census variable with each vulnerability indicator. In total it gives eight correlations. The second one, uses OLS regression model. This model tests how the four structural variables relate to the polychoric PCA score. The OLS results use HC1 robust standard errors and the unit of the analysis is the municipality. As mentioned above, since there is $n=15$ municipalities, this analysis is exploratory.

4. Limitations

The first limitation relies on the level of distribution, it is planned in only 15 municipalities and not a national portrait. The second one is related to the index, which is cross-sectional and shows the deprivation status of persons 65+ at the time of the survey, it does not show how their situation changes over time. Additionally, it also does not predict future deprivation after possible shocks. For this reason, the vulnerability index is used as an operational term. Future surveys can present more dynamic measurement of vulnerability. Another limitation is based on the index that treats all the indicators as binary, which means that a person is either deprived or not deprived. This is due to the usage of the Alkire Foster method. For this purpose, the analysis uses polychoric PCA to reduce this problem, which uses the full ordinal response structure when estimating correlations. However, the binary indicators are still used when comparing PCA results with the Alkire–Foster ranking. The last one is the linkage to the

Census 2023 data. The Census values may have slightly changed and the census data are not adjusted, from the time of Census to the survey.

5. Conclusion

This paper presents the analytical protocol in advance of real data analysis. It is a methodology approach on how the collected data will be analysed to explain how the vulnerability index will be constructed. Two complementary methodological approaches (i) the Alkire–Foster counting method and (ii) a polychoric principal component analysis, are pre-registered. The second stage models, cut offs, indicators and weights are defined as a methodology in advance. The paper methodological scope is to discuss the methodology selected, it does not pretend otherwise, it is modest and explicit. The Alkire Foster method is internationally established; polychoric PCA is a standard adaptation for ordinal data. The contribution lies not in methodological novelty but in the disciplined application of these methods to persons 65+ vulnerability at the municipal level. This is more significant since the evidence of persons 65+ at municipality level has not previously been systematically constructed. Once the primary data collection is completed, the empirical findings will be reported in the Phase 2 paper. By publishing the methodology before the data are analysed, the paper increases transparency and ensures that the findings are based on a pre-registered plan.

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