Nowcasting multidimensional poverty in the occupied Palestinian territory

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Expert Group Meeting on Multidimensional Poverty Index: Simulation and Optimization Methodologies

The Palestinian *MPI*

- The Palestinian *MPI* proposed by Khawaja, Al-Saleh, Reece, and Conconi (2020) has 22 "indicators" grouped into 7 "dimensions" (relative weight of dimensions in parentheses):
  - Education (2/15)
  - Health (2/15)
  - Employment (2/15)
  - Housing Conditions and Utilities (2/15)
  - Personal Safety and Use of Property (2/15)
  - Personal Freedom (2/15)
  - Monetary Resources (3/15)
- The higher weight allocated to the monetary resources dimension means that a household that is below the poverty line in the monetary dimension is automatically considered poor according to the multidimensional criterion.

A theoretical model of the *MPI*

- The calculation of the *MPI* is an exercise that is performed without difficulty when a survey is available. On the other hand, one must have a model for years without surveys.
- The *MPI* are functionals of the joint distribution of the 22 indicators at year t, $H_t(\mathbf{x})$:

$$H_t(\mathbf{x}) = H_t(x_1, x_2, \ldots, x_{22}) = Pr[X_1 \leq x_1, X_2 \leq x_2, \ldots, X_{22} \leq x_{22} | \text{year } = t].$$

- The Palestinian *MPI* is given by

$$MPI(H_t(\mathbf{x})) = \int_{\mathscr{D}} \left[\mathbb{1}\left(\sum_{k=1}^{22} d_k \mathbb{1}(x_k \leq z_k) \geq 0.20 \right) \times \left(\sum_{k=1}^{22} d_k \mathbb{1}(x_k \leq z_k) \right) \right] \mathrm{d}H_t(\mathbf{x}).$$

- This integral can be computed by Monte Carlo integration method if we have a model of $H_t(\mathbf{x})$. (It may be even easier than that)

A model of $H_t(\mathbf{x})$

- Suppose we have a model for each marginal distribution function $F_{X_k,t}(x_k)$. Using Sklar's theorem, we can rewrite

$$H_t(\mathbf{x}) = C_t(F_{X_1,t}(x_1), \ldots, F_{X_{22},t}(x_{22})),$$

  where $C(\cdot)$ is the copula that relates the ranks of the different marginal distributions.

- **A problem:** When one of the marginal distributions has a discrete variable, the copula still exists but it is not unique.

- I use the checkerboard copula estimator (*checkerboard copula*) from Genest, Nešlehová, and Rémillard (2017). I create a version that accounts for sample weights using a Hájek transformation of this estimator.

Decomposition of changes in $MPI(H_t(\mathbf{x}))$

- Let $H_{t_1:t_0}(\mathbf{x})$ be the multidimensional cumulative distribution function as a function of the year t_0 copula, $C_{t_0}(\cdot)$, and the year t_1 marginal distribution, $F_{X_k,t_1}(x_k)$, $k \in \{1,2,\ldots,22\}$.

- We can decompose a change in $MPI(H_t(\mathbf{x}))$ between 2016 (the base year) and any other year t:

$$MPI(H_{2016}(\mathbf{x})) - MPI(H_t(\mathbf{x})) = \underbrace{MPI(H_{2016:2016}(\mathbf{x})) - MPI(H_{t:2016}(\mathbf{x}))}_{\text{Change in } MPI \text{ under copula stability}}$$

$$+ \underbrace{MPI(H_{t:2016}(\mathbf{x})) - MPI(H_{t:t}(\mathbf{x}))}_{\text{Change in } MPI \text{ due to change in copula}}$$

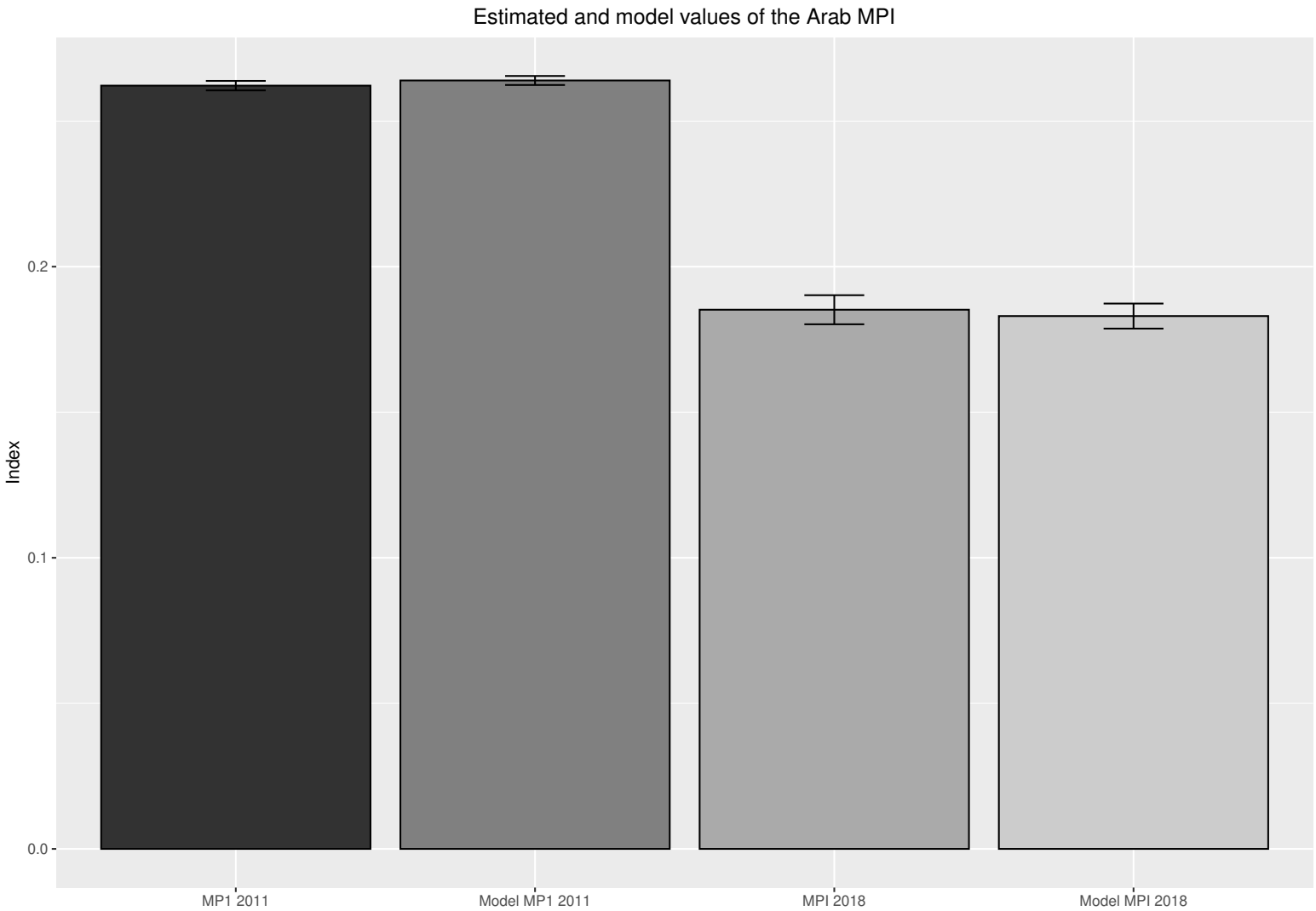
Decomposition of changes in $MPI(H_t(\mathbf{x}))$

- In order to model the changes in *MPI*, we make the assumption that the copula is stable, i.e. that

$$MPI\left(H_{t:2016}(\mathbf{x})\right) - MPI\left(H_{t:t}(\mathbf{x})\right) = 0.$$

- To have a value of $MPI\left(H_{t:2016}(\mathbf{x})\right)$, we need to estimate the 2016 copula and have a binary classification model (under vs. over z_k) for each margin at year t.

$MPI\left(H_{2011:2018}(\mathbf{x})\right)$ in Iraq



Modeling changes in $F_{X_k,t}(x_k)$

- To capture the change in the marginal distributions of our 22 indicators, we calibrate the deprivation of these indicators from 2011 to 2016 (the two years for which we have surveys) on the following logistic functions:

$$F^M_{X_k}(z_k) = \frac{1}{1 + e^{-\alpha_k + \beta_k \iota_t}},$$

  where ι_t is the real GDP per capita at t, a demolition index at t, an occupation severity index at t, or simply the year t.

- Ten of the twenty-two indicators appear only in the 2016 Palestinian Consumption and Expenditure survey (PECS). In order to capture the dynamics of these indicators, we will assume that the semi-elasticity (β_k) of the $F^M_{X_k,t}(z_k)/(1 - F^M_{X_k,t}(z_k))$ is equal to the same semi-elasticity for another indicator belonging to the same "dimension".

- We impose additional shocks of the COVID-19 (other than those related to its impact on GDP) on schooling and some chronic diseases.

Evolution of Real GDP Per Capita Indicators

- The evolution of the following indicators is calibrated using changes in real GDP per capita:
  - X_1: All children 6-17 are in school
  - X_2: All 7-18 year olds are in school and have never repeated a grade
  - X_7: Health insurance coverage
  - X_9: At least one person in the household is employed
  - X_{10}: Workers in the household have employer-paid benefits
  - X_{11}: Workers in the household have regular jobs
  - X_{12}: All youth in the household are either employed or in school
  - X_{22}: Equivalent household consumption
- It is assumed that X_4 (no education quality problem) has the same semi-elasticity of the odds ratio as X_2.

Evolution of elapsed time indicators

- The evolution of the following indicators is calibrated using the year (i.e. elapsed time):
  - X_3: Maximum schooling in the household
  - X_{13}: Connected to public water supply
- The evolution of the following indicators is calibrated using the year (i.e. elapsed time) in the sub-model for the Gaza Strip:
  - X_8: Household lives within 5 km of the nearest medical clinic or hospital
  - X_{15}: No problems with ventilation, smoke, pollutants
  - X_{16}: No overcrowded housing

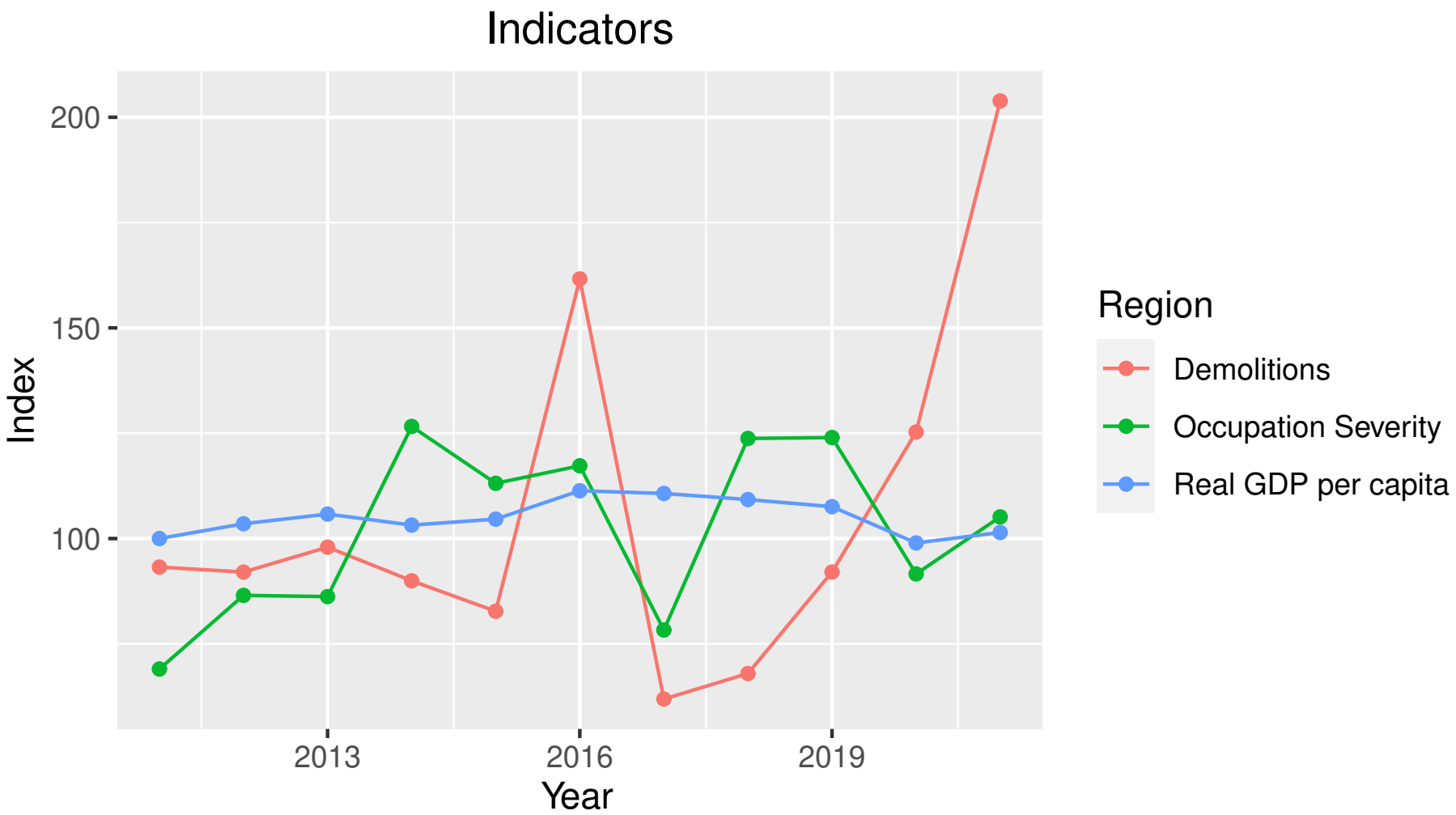
Changes in Expropriation Indicators

- The evolution of the following indicators is calibrated using an index of expropriation and demolition in the West Bank:
  - X_8: Household lives within 5 km of the nearest medical clinic or hospital
  - X_{15}: No problems with ventilation, smoke, pollutants
  - X_{16}: No overcrowded housing
- We assume that "X_5 : No disability in the household" has the same semi-elasticity of the odds ratio as X_8 and as "X_{14}: No disruption of running water or electricity" has the same semi-elasticity of the odds-ratio as X_{16}.

Evolution of occupation Intensity Indicators

- An index of occupation intensity is constructed from data on the number of injuries due to military violence by the occupying force, expropriations and demolitions (for the West Bank) and imports of basic necessities (for the Gaza Strip).
- The evolution of indicator X_{18}: Free access to land and non-confiscation is linked to this index
- The following indicators have the same semi-elasticity of the odds ratio as X_{18}:
  - X_{17} : No theft or damage to property
  - X_{19}: No interpersonal or state violence
  - X_{20}: Full freedom of movement
  - X_{21}: Women have full autonomy

Indicators underlying the modeling



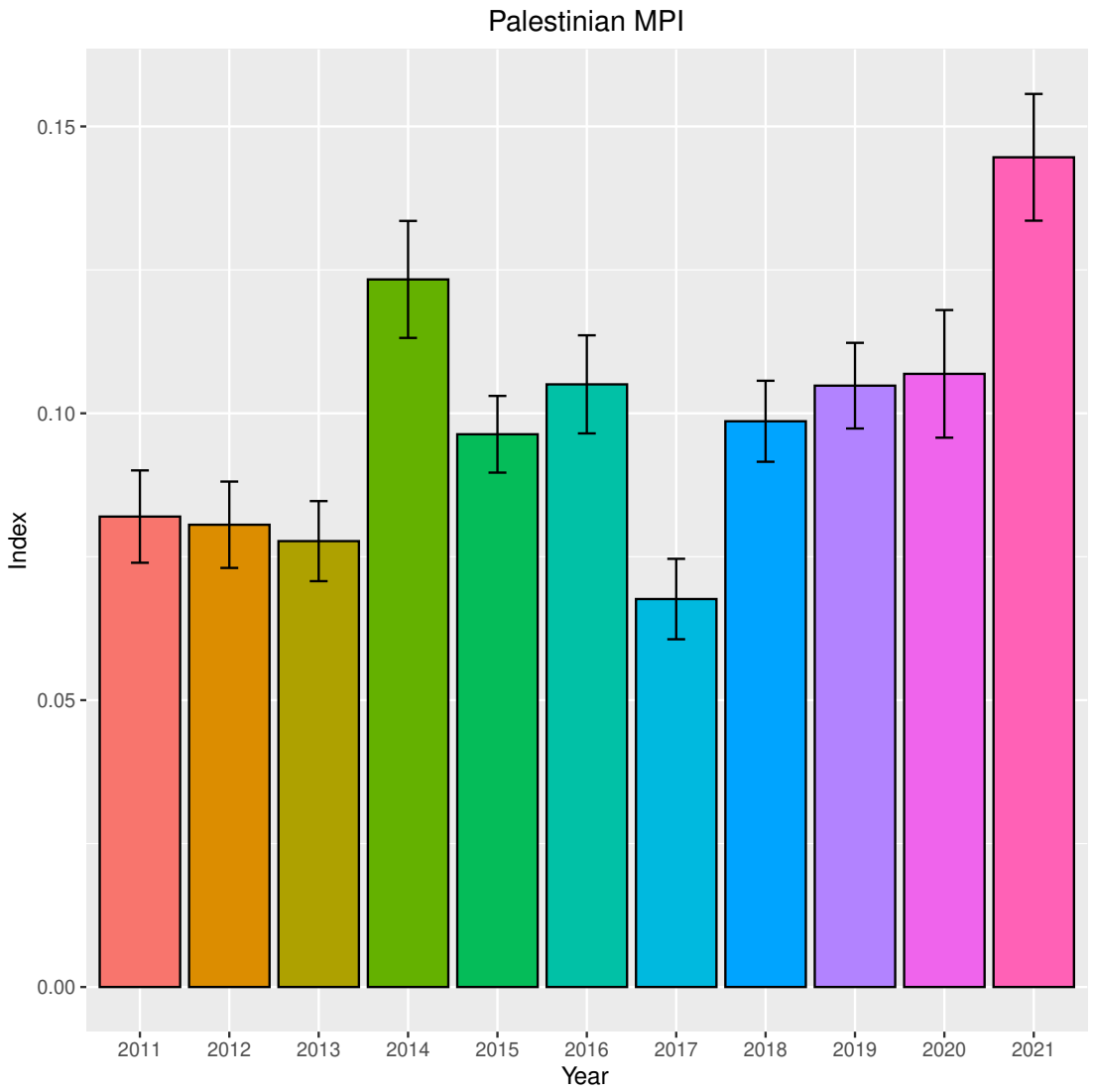
Modelling the impact of the Covid-19 pandemic

- Through its impact on the international economy, the Covid-19 pandemic has repercussions that are channeled through the induced change in global production.
- The baseline model is already capturing these impacts as in its October 2020 economic update on the West Bank and Gaza, the World Bank estimated that in 2020 there will be an 8 percent contraction in GDP and a recovery of only 2.5 percent is projected for 2021.
- These assumptions are included in our model, and the baseline simulation results capture these Covid-19 impacts.

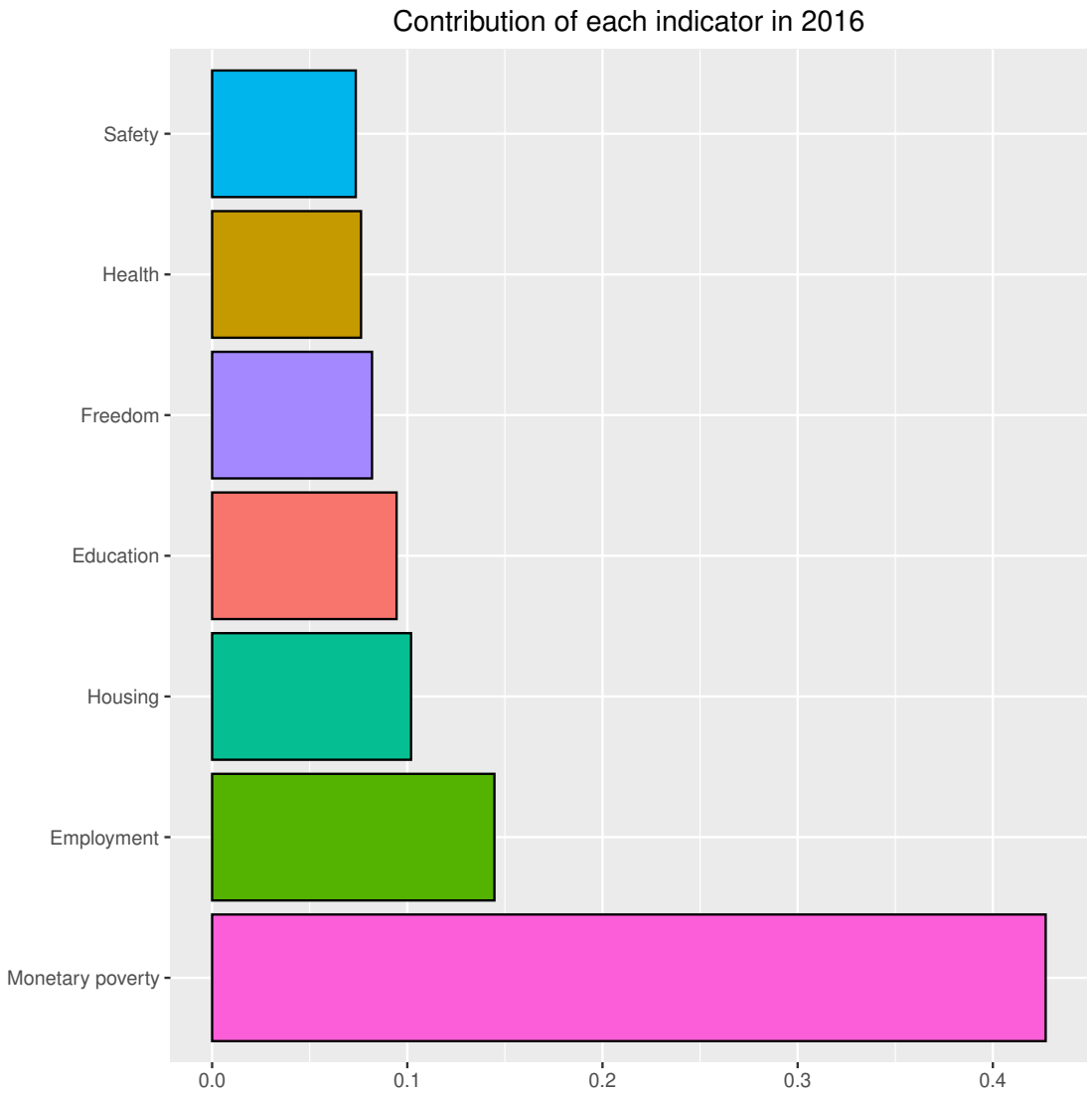
Modelling the impact of the Covid-19 pandemic

- In addition to these impacts that are channeled through economic variables, we can expect additional impacts. We make the following assumptions:
  - Some minor or transient illnesses (including Covid-19 infections) may become chronic illnesses due to a lack of appropriate treatment. This lack of treatment may be a consequence of unavailability of hospitals due to pressure on the health care system or lack of money and/or lack of health insurance. For this reason, we assume that the Covid-19 pandemic has a low 2% impact on chronic diseases.
  - An additional 8 percent impact on schooling.
  - An additional 6 percent impact on grade repetition.
  - An additional 20 percent impact on the quality of education.
  - A small impact of 2 percent on the educational attainment of the general population.

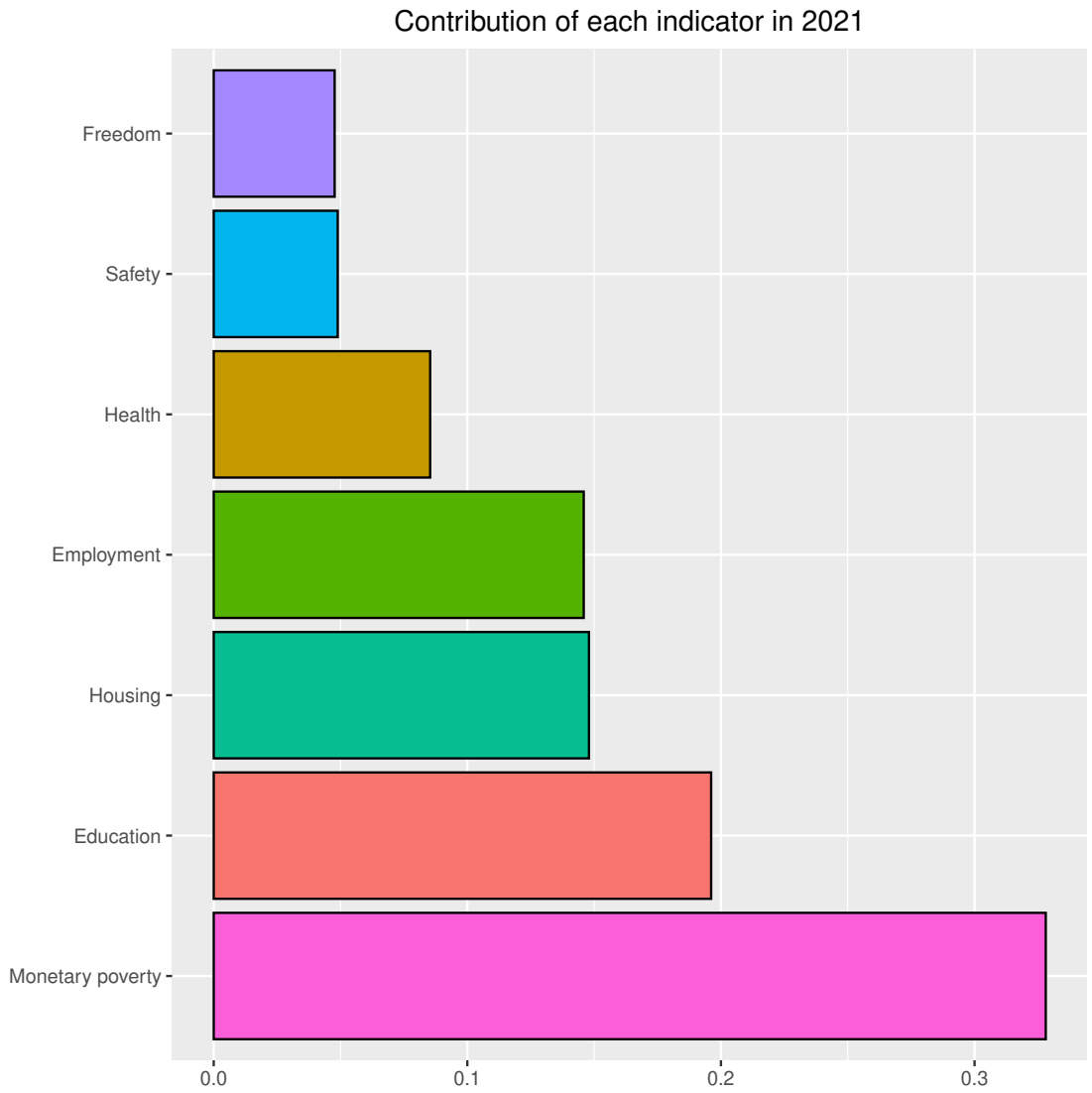
Palestinian *MPI*



Contribution of each dimension in 2016



Contribution of each dimension in 2021



Conclusion

- We have presented a simple model of the multidimensional poverty index.
- The model predicts the index value almost perfectly if the classification (under/over the threshold) of each margin is accurate.
- The model used for the margins shows that we can condition the margins on different types of variables (political, economic, temporal). This is only a calibrated illustration.
- **Current work** (with Mohamad Khaled and Myra Yazbeck)**:** We are working on two aspects of this modelling approach:
  - We are trying to reduce the difficulty of computations of the simulated values (and the cpu time). We think (we are still working on the proof) that if we assume a checkerboard copula, we can propose an alternative approach that will be similar to computing the *MPI* with real data.
  - We want to implement a machine learning binary classification model to improve the modelling of marginal distributions.