

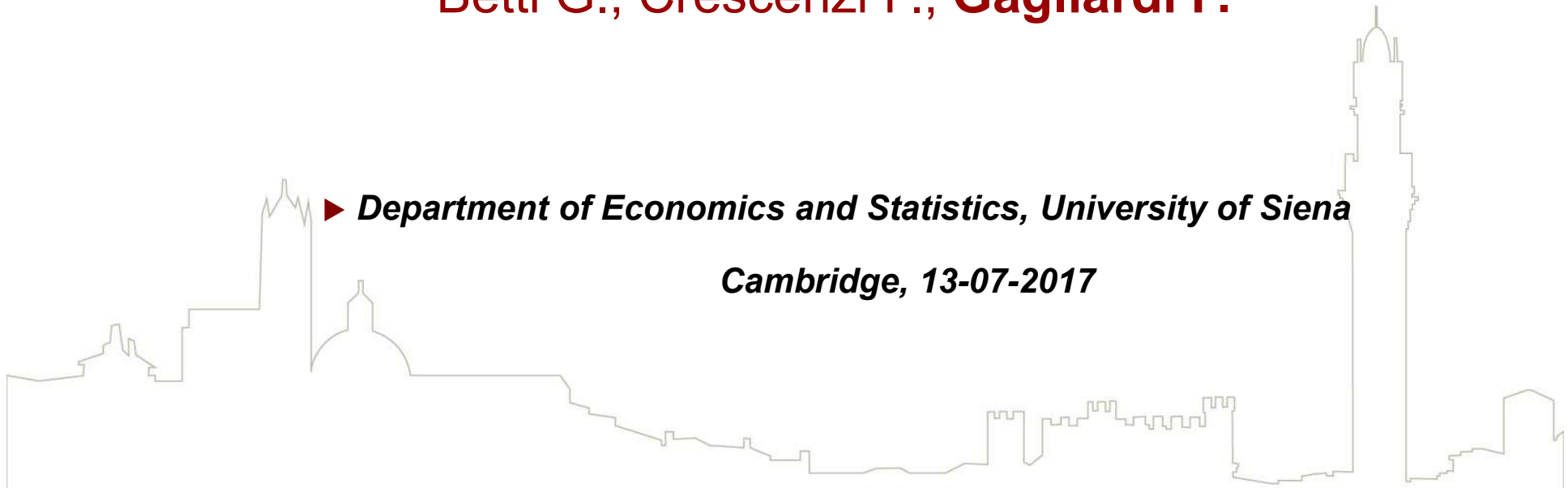


# What was the Effect of the Economic Crisis on Fuzzy Measures of Poverty at the Regional Level?

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# Summary

- Poverty and fuzzy measures definition
- Variance estimation of fuzzy measures
- Small Area methodology
- Effect of crisis on Spain regions
- Conclusions

# Poverty is a Fuzzy State

It is not a discrete attribute characterised in terms of presence or absence.

It is rather a vague predicate that manifests itself with different shades and degrees.



Nevertheless, traditional methods of analysis treat poverty as dichotomous variable, a simplification that wipes out all the nuances that exist between the two extremes.

# Fuzzy monetary and non-monetary poverty

- Poverty is a multidimensional concept
- Poverty cannot be related only on monetary aspects
- Non-monetary poverty = deprivation based on several non-monetary indicators of living conditions
- FM = Fuzzy Monetary poverty
- FS = Fuzzy Supplementary (non-monetary) deprivation

# Membership functions of monetary or non-monetary deprivation

For any individual of rank  $j$  in the ascending income distribution :

*Betti, Cheli, Lemmi and Verma (2006)*

$$\mu_{j,K} = \left( \frac{\sum_{\gamma=j+1}^n w_{\gamma} | X_{\gamma} > X_j}{\sum_{\gamma=2}^n w_{\gamma} | X_{\gamma} > X_1} \right)^{\alpha_K - 1} \left( \frac{\sum_{\gamma=j+1}^n w_{\gamma} X_{\gamma} | X_{\gamma} > X_j}{\sum_{\gamma=2}^n w_{\gamma} X_{\gamma} | X_{\gamma} > X_1} \right) \quad j: 1, \dots, n-1; \quad \mu_{n,K} = 0$$

- $X$  is the equivalised income in the monetary deprivation, or the overall score  $s$  in the non-monetary deprivation.
- $w_{\gamma}$  is the sample weight of individual of rank  $\gamma$
- $\alpha_K$  ( $K = 1, 2$ ) are two parameters corresponding, respectively, to monetary and non-monetary dimensions of deprivation

*Parameter  $\alpha$  is chosen so that the mean of the m.f. is equal to the At-Risk-of-Poverty-Rate (ARPR), known also as Headcount Ratio (HCR).*

# Membership function based on supplementary variables (FS)

1. Identification of items of deprivation to be included in the analysis;
2. Transformation of the items into the  $[0, 1]$  interval;
3. Exploratory and confirmatory factor analysis to identify dimensions of deprivation;
4. Calculation of weights of individual items of deprivation within each dimension (each group of items) defined taking into account dispersion and correlation among items;
5. Calculation of scores for each dimension;
6. Calculation of an overall score and the parameter  $\alpha$ ;
7. Construction of the fuzzy deprivation measures separately in each dimension, taking their simple average as a measure of overall non-monetary ('supplementary') deprivation.

# Data

- These concepts have been applied to EU-SILC cross-sectional data for Spain.
- Years: 2007 (ante-crisis) – 2011 (in-crisis)
- NUTS 2 Spain regions (19)
- In the framework of Europe 2020 strategy of the European Commission, estimates of poverty and social exclusion at sub-national regional level have become of central interest

# Non-monetary dimensions identified -1

- 1 Basic life-style – these concern the lack of ability to afford most basic requirements:
  - Keeping the home (household's principal accommodation) adequately warm.
  - Paying for a week's annual holiday away from home.
  - Eating meat chicken or fish every second day, if the household wanted to.
  - Ability to make ends meet
- 2 Financial situation – these concern the lack of ability to pay in time due to financial difficulties:
  - Inability to cope with unexpected expenses.
  - Arrears on mortgage or rent payments.
  - Arrears on utility bills.
  - Arrears on hire purchase instalments.
- 3 Housing amenities – these concern the absence of basic housing facilities (so basic that one can presume all households would wish to have them):
  - A bath or shower.
  - An indoor flushing toilet.
  - Leaking roof and lamp
  - Rooms too dark



## Non-monetary dimensions identified -2

- 4 Environmental problems – these concern problems with the neighbourhood and the environment:
  - Pollution.
  - Crime, violence, vandalism.
  - Noise.
- 5 Consumer durables - these concern enforced lack of widely desired possessions ("enforced" means that the lack of possession is because of lack of resources)
  - A car or van.
  - A colour TV.
  - A pc
  - A washing machine.
  - A telephone.
- 6 Health related – these concern problems with personal health:
  - General health.
  - Chronic illness.
  - Mobility restriction.
  - Unmet need for medical exam
  - Unmet need for dental exam.

# Non-monetary dimensions identified -3

## 7 Work & Education

- Early school leavers
- Low education
- Worklessness
- Duration of unemployment

Betti G., Gagliardi F., Lemmi A., Verma V. (2012) Subnational indicators of poverty and deprivation in Europe: methodology and applications, *Cambridge Journal of Regions, Economy and Society*, 2012, **5**, 129-147.

# Variance of the estimates

## Jackknife Repeated Replication (JRR)

- $z$  be a full-sample estimate of any complexity.
- $i$  sample primary sampling unit (PSU)
- $h$  stratum;
- $a \geq 2$  is the number of PSUs in stratum  $h$ .
- $z_{(hi)}$  estimate produced using the same procedure after eliminating primary unit  $i$  in stratum  $h$  and increasing the weight of the remaining  $(a_h-1)$  units in the stratum by an appropriate factor  $g_h$ .
- $z_{(h)}$  be the simple average of the  $z_{(hi)}$  over the  $a_h$  sample units in  $h$ .

$$\text{var}(z) = \sum_h \left[ (1 - f_h) \cdot \sum_i g_{(hi)} \left( z_{(hi)} - z_{(h)} \right)^2 \right]$$

$$g_{(hi)} = w_h / (w_h - w_{hi}) \quad w_h = \sum_i w_{hi}$$

$$w_{hi} = \sum_j w_{hij} \quad \text{ultimate units } j \text{ in primary selection units } i$$

# Problems in computing variances

- Sample structure availability (*Strata, PSU, detailed description of sampling*)
  - Available to us for 2011 (thank to co-operation with OECD), but not for 2007
  - ⇒ *Alternative procedure*
- Sample size
  - Too small at regional level. Estimates with large variability
  - ⇒ *Small Area procedures.*
- Poverty line defined at national level and fixed for each replication.
  - Betti G., Gagliardi F., Verma V. (2017) Simplified Jackknife Variance Estimates for Fuzzy Measures of Multidimensional Poverty, *International Statistical Review*.

# An alternative procedure for variance estimation for year 2007 - 1

- *Design effect:*  $d = s.e./s.e._{SRS}$  or  $d^2 = V/V_{SRS}$ , ratio of the variance (V) under the given sample design, to the variance ( $V_{SRS}$ ) under a simple random sample of the same size.
- So  $V = d^2 * V_{SRS}$

## Component of the design effect:

$$d^2 = d_w^2 * d_h^2 * d_d^2 * d_x^2$$

- $d_w^2$  *effect of the weights* (Kish factor)  $\approx 1 + CV^2(w)$
- $d_h^2$  *clustering of persons within households*  $\approx$  squared of the mean household size
- $d_d^2$  *clustering of persons and households within dwellings* (=1 for direct households sampling like in Spain)
- $d_x^2$  *multi-stage sampling, stratification and other design complexities*

## An alternative procedure for variance estimation for year 2007 - 2

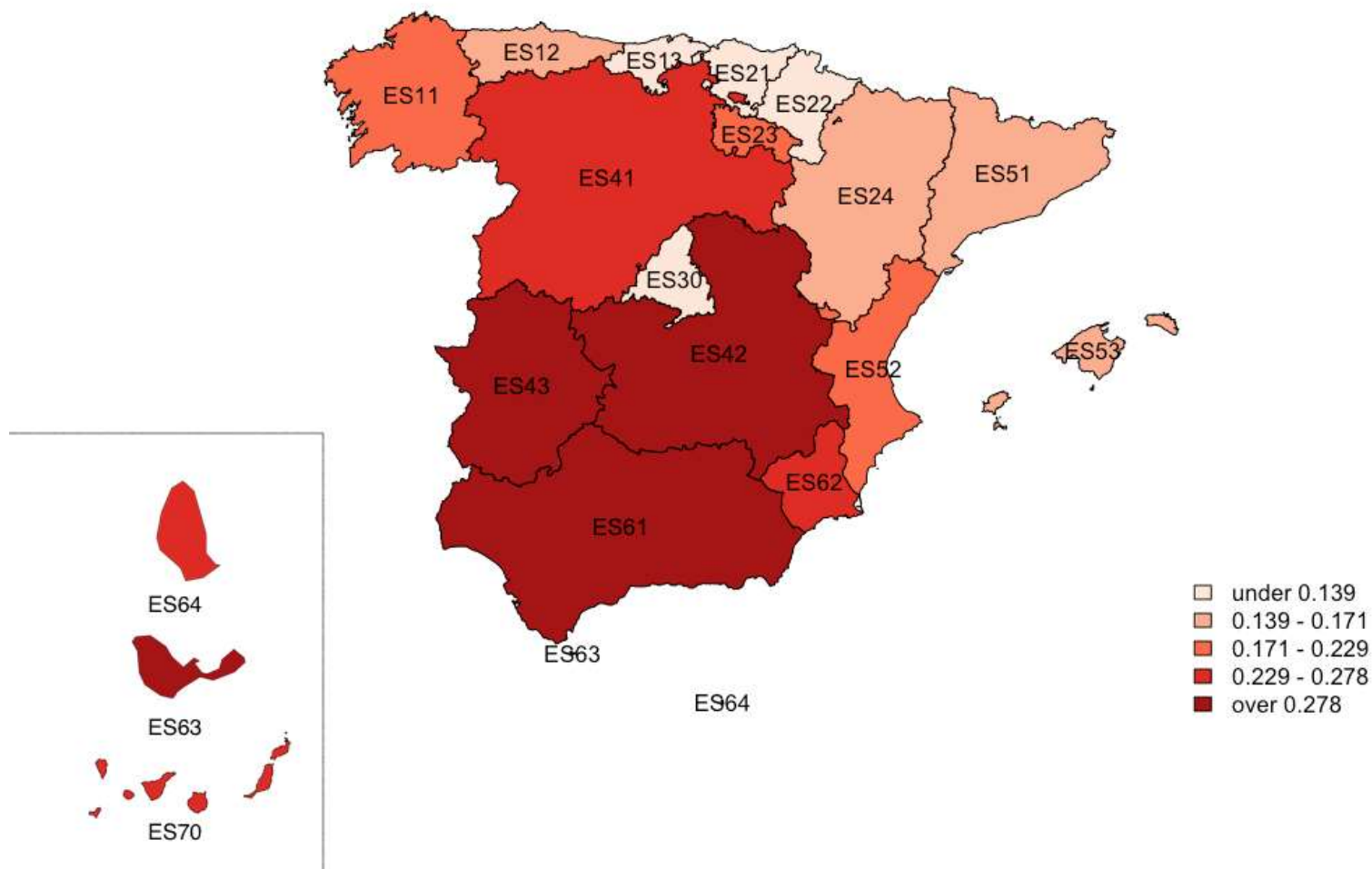
- All the component of  $d$ , but  $d_x$ , do not require the knowledge of the sample structure, so they can be directly computed from 2007 data.
- $d_x$  can be compute for 2011 and imputed to 2007, given that the sampling prcedure remain unchanged.
- From  $CV^2(Y) = n \cdot V_{SRS}(Y)/Y^2$ ,  $V_{SRS}$  can be derived
- So we have V.

# SAE methodology

- SEBLUP (Spatial EBLUP)
- Linear model that uses external covariates at area level (NUTS 2) to get more efficient regional estimates.
- The Spatial version takes into consideration the ‘vicinity’ of regions as source of similarities.

# SEBLUP results: HCR 2007-2011

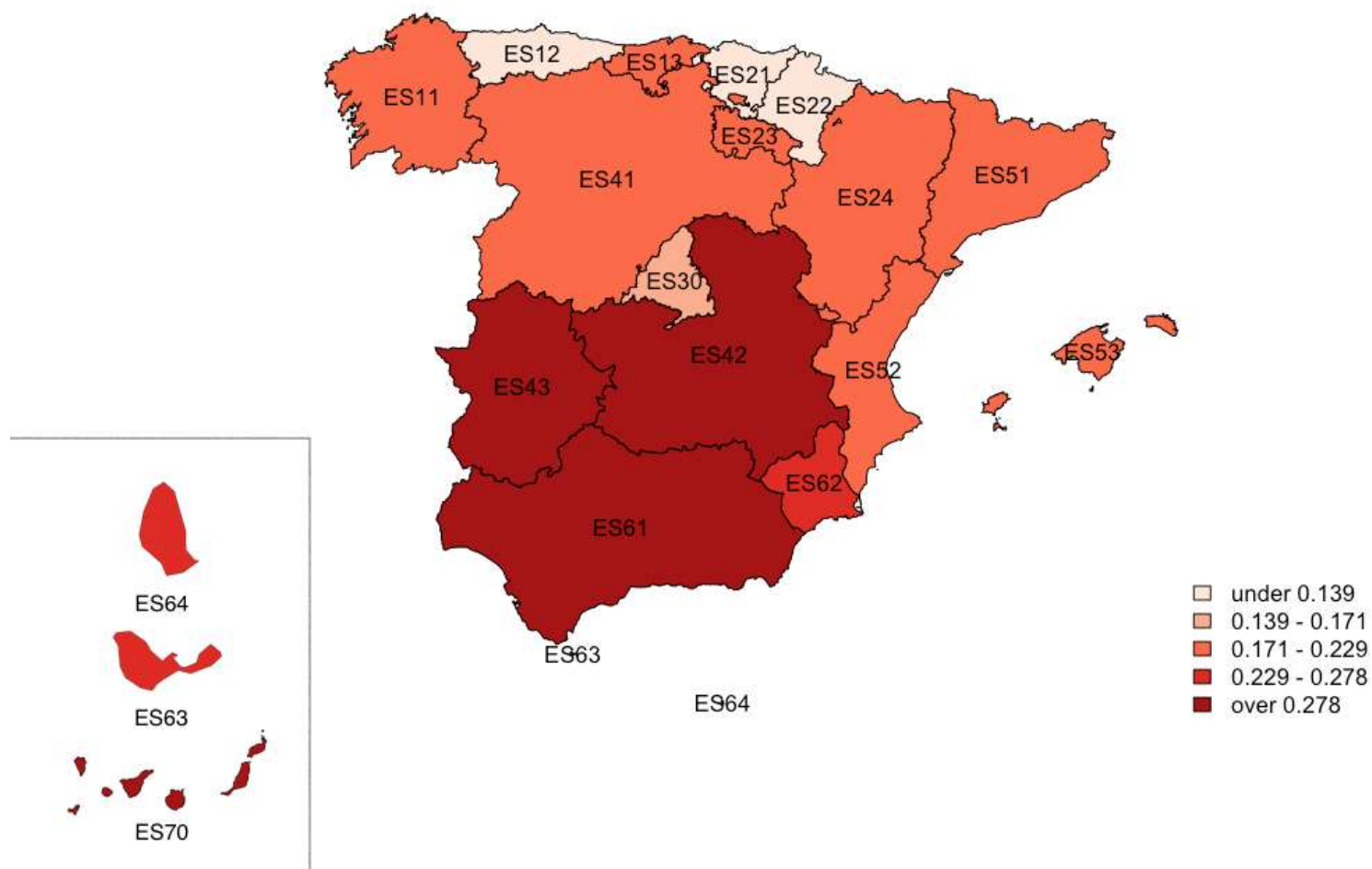
HCR2007





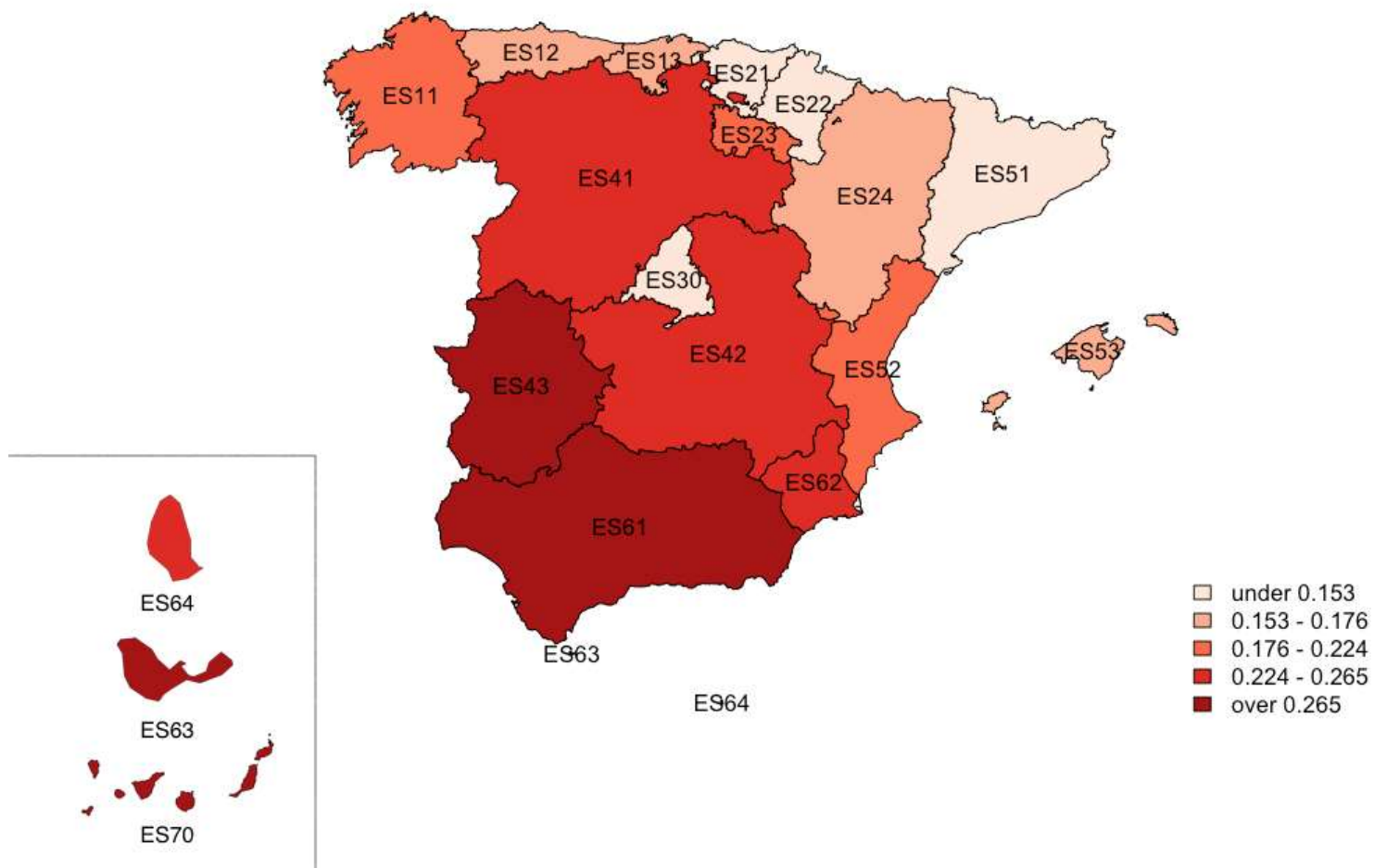
# SEBLUP results: HCR 2007-2011

HCR 2011



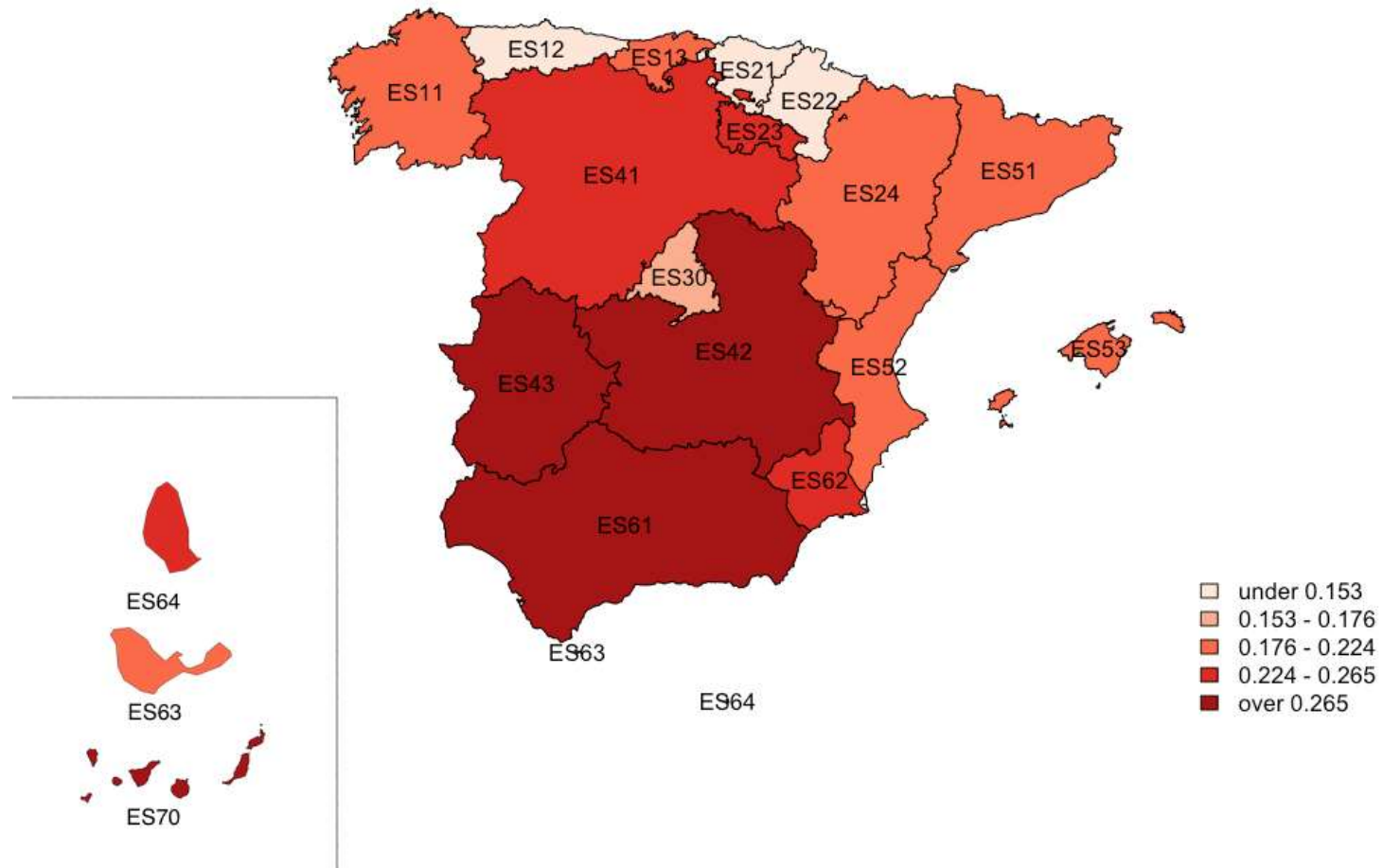
# SEBLUP results: FM 2007 - 2011

FM 2007



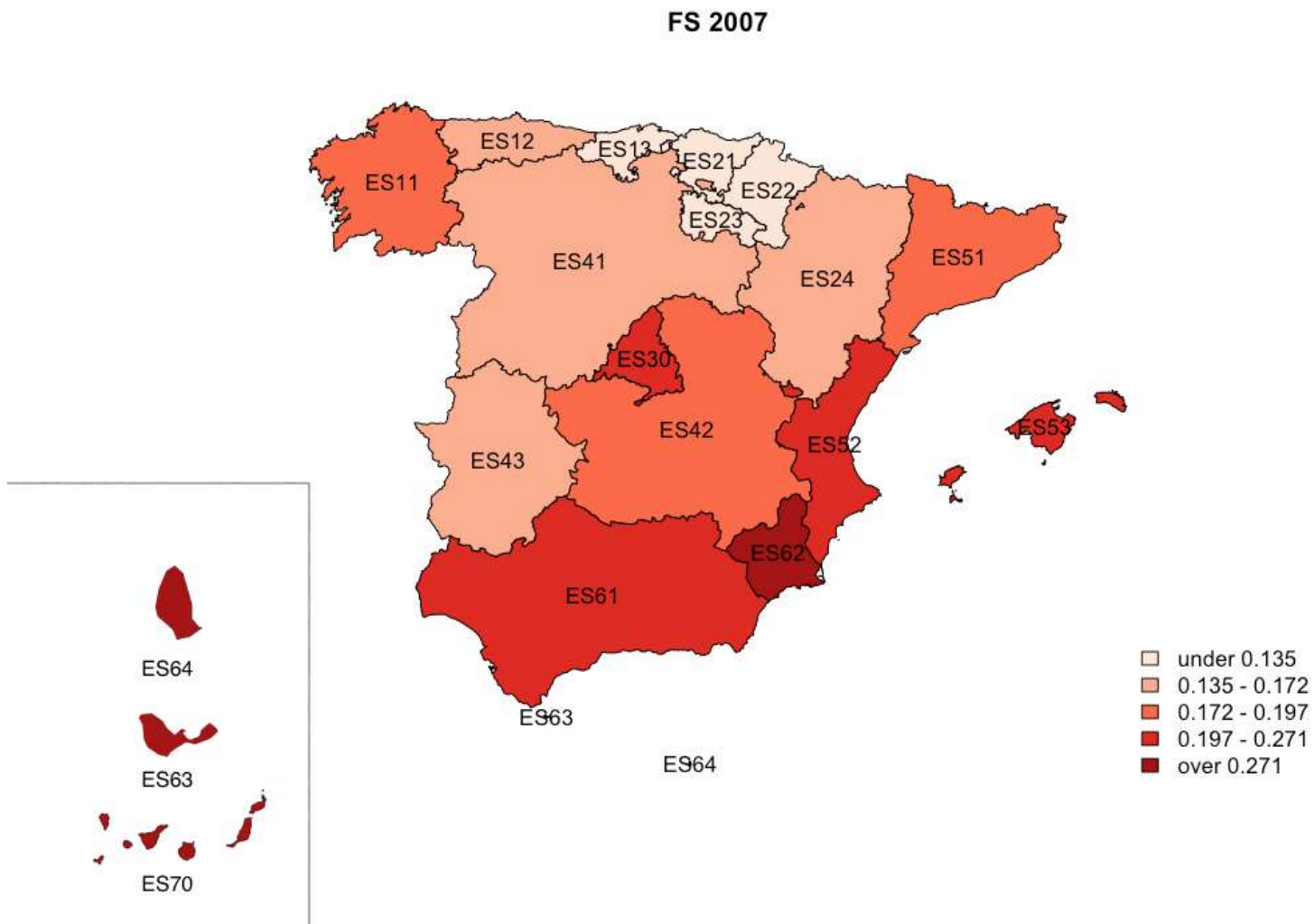
# SEBLUP results: FM 2007 - 2011

FM 2011



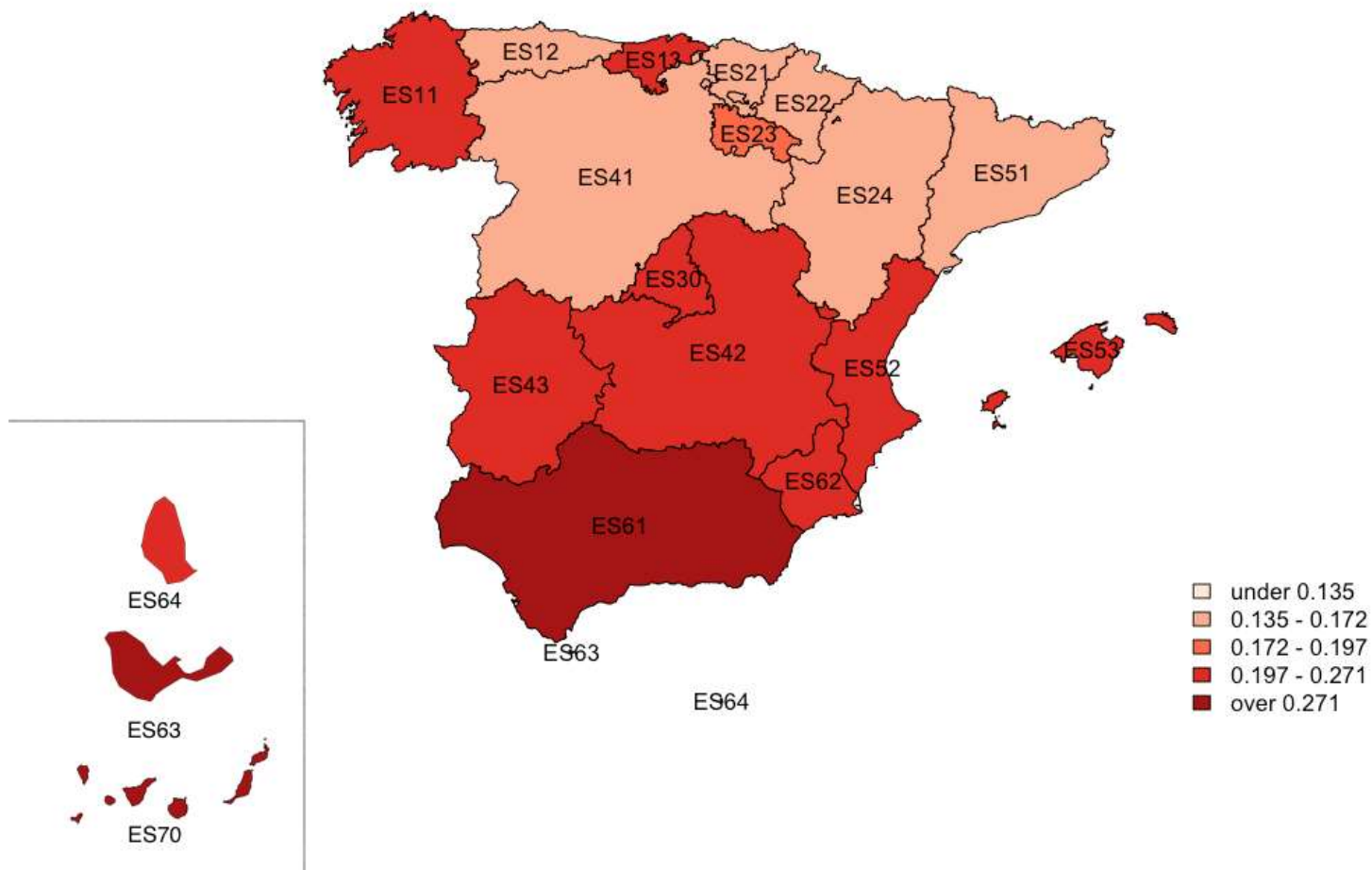
# SEBLUP results: FS 2007 - 2011

FS 2007



# SEBLUP results: FS 2007 - 2011

FS 2011





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# Ratio 2007/2011

Region	HCR	FM	FS
ES11	1.121	1.064	0.774
ES12	1.369	1.080	0.889
ES13	0.735	0.770	0.515
ES21	1.168	1.026	0.706
ES22	0.676	0.799	0.659
ES23	0.893	0.858	0.704
ES24	0.893	0.924	1.026
ES30	0.924	0.902	0.904
ES41	1.028	1.002	0.905
ES42	0.911	0.933	0.848
ES43	1.129	1.107	0.741
ES51	0.824	0.821	1.222
ES52	0.876	0.891	1.153
ES53	0.937	0.827	0.737
ES61	0.943	0.945	0.891
ES62	1.027	0.951	1.241
ES63	1.586	1.594	1.464
ES64	0.977	0.924	1.473
ES70	0.889	0.951	0.958
Mean	0.995	0.967	0.937

# Comments on results - 1

- Generally all measures show that the crisis has an impact on poverty.
- HCR more stable than fuzzy measures.
- FS represents better the effects of the crisis.
- FM moves in the same direction of HCR but shows more extreme results.
- In some cases HCR and FS move in opposite directions.
- The most extreme results are in regions with very small sample sizes.
- Regions close to each other usually show a similar impact of crisis.

## Comments on results - 2

- Concerning standard errors:
  - ✓ Direct estimates have large s.e. (region sample size too small)
  - ✓ SEBLUP reduces s.e. (SAE procedures are necessary)
  - ✓ s.e. of fuzzy measures are much more stable than ones of traditional measures (Betti *et al.* 2017)



# Conclusions

- Even if the analysed data have a lag of just 4 years, the effect of crisis is clearly reflected on them.
- Fuzzy measures show the impact of crisis on poverty.
- Fuzzy measures reflect the crisis better than traditional ones.
- In our paper we will present results also for each dimension of the FS to investigate the impact of crisis on them.
- More in depth analysis of the standard errors and of the SAE methodologies will be presented.

# References

- Betti G., Gagliardi F., Lemmi A., Verma V. (2012) Subnational indicators of poverty and deprivation in Europe: methodology and applications, *Cambridge Journal of Regions, Economy and Society*, 2012, **5**, 129-147.
- Betti G., Gagliardi F., Verma V. (2017) Simplified Jackknife Variance Estimates for Fuzzy Measures of Multidimensional Poverty, *International Statistical Review*.
- Betti G., Cheli B., Lemmi A., Verma V. (2006) Multidimensional and longitudinal poverty: an integrated fuzzy approach. In Lemmi A. and Betti G. (eds.) *Fuzzy Set Approach to multidimensional Poverty Measurement*, pp. 111-137, Springer.
- Verma V., Lemmi A., Betti G., Gagliardi F., Piacentini M. (2017), How precise are poverty measures estimated at the regional level?, *Regional Science and Urban Economics*.



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*Thank you for  
your attention!*

