Exploring Subjective Poverty Dynamics:
Beyond the Minimum Income Question

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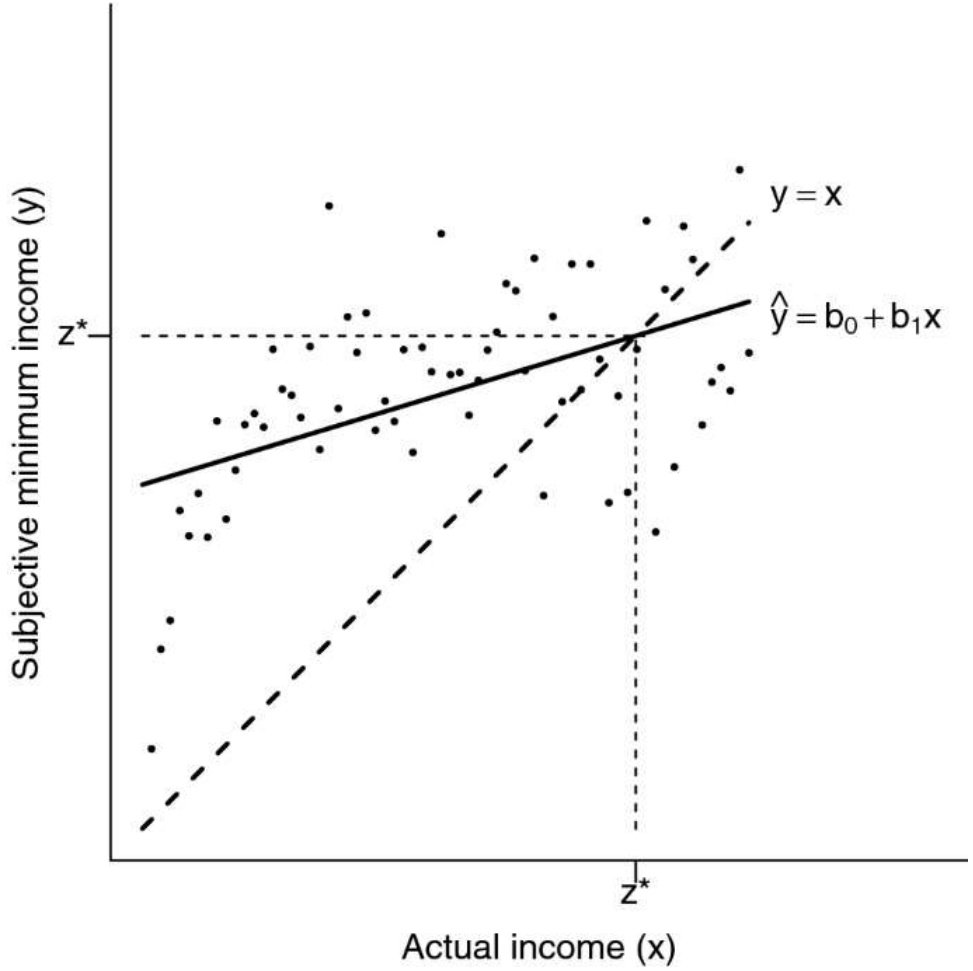
Subjective poverty measurement

Conventional approach

- Minimum Income Question (MIQ)
- Intersection approach
- Introduced in the 1970s
  (Goedhart et al., 1977)

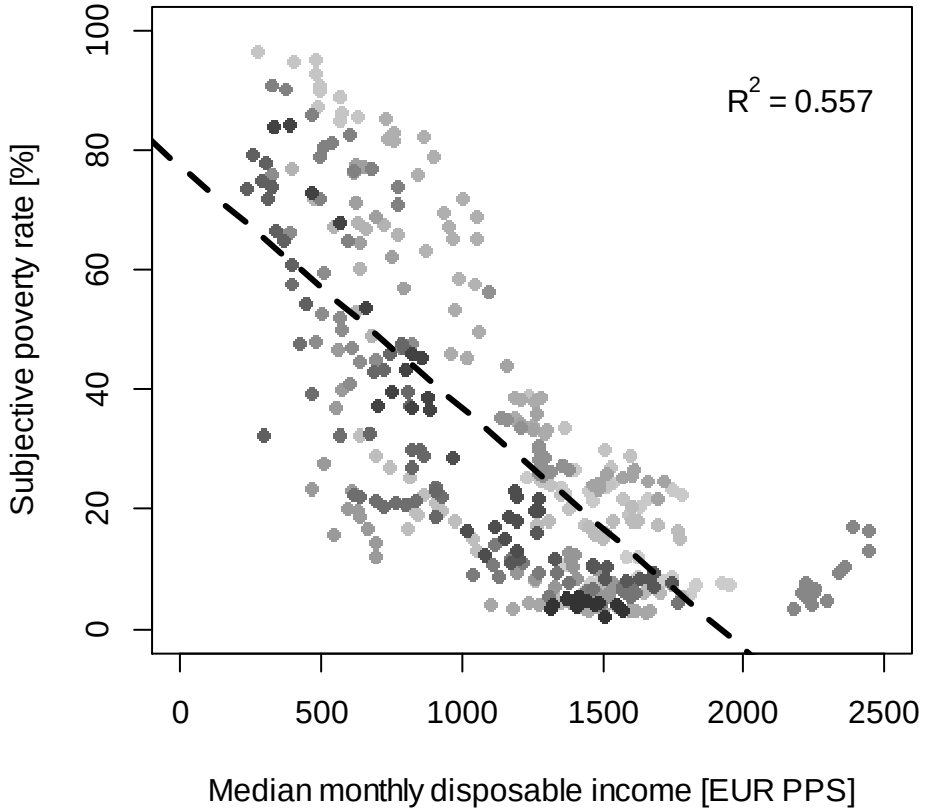


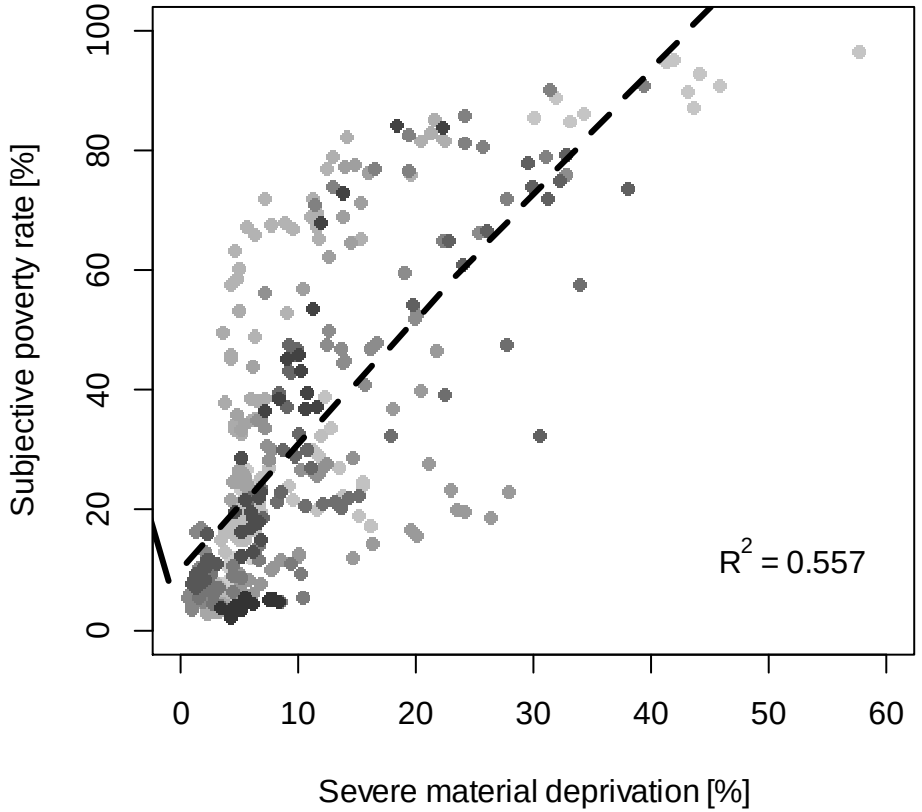
Želinský, Mysíková & Garner (2022)

Subjective poverty measurement

Evidence from Europe

- Subjective poverty & objective indicators





Subjective poverty measurement

Evidence from Europe

- Main source of data: EU-SILC
- MIQ [HS130]: *"In your opinion, what is the very lowest net monthly income that your household would have to have in order to make ends meet, that is to pay its usual necessary expenses? Please answer in relation to the present circumstances of your household, and what you consider to be usual necessary expenses (to make ends meet)."*
- Collected until 2020

- *What next?*

Subjective poverty measurement
Alternative approaches (EU-SILC data)

- [HS120]: *"A household may have different sources of income and more than one household member may contribute to it. Thinking of your household's total income, is your household able to make ends meet, namely, to pay for its usual necessary expenses?"*
  (With great difficulty – With difficulty – With some difficulty – Fairly easily – Easily – Very easily)
- Some of the options:
  - Quasi-Leyden Poverty Line (Piasecki & Bieńkuńska, 2018).
  - Proportional Odds Logistic Regression (Pittau & Zelli, 2023).
  - Binary classification (Želinský, Ng & Mysíková, 2020).

This presentation

- Focus on two approaches:
  1. SPL based on binary classification.
  2. Identifying the subjectively poor using Machine Learning methods.

Estimating SPL using Binary Classification Methods

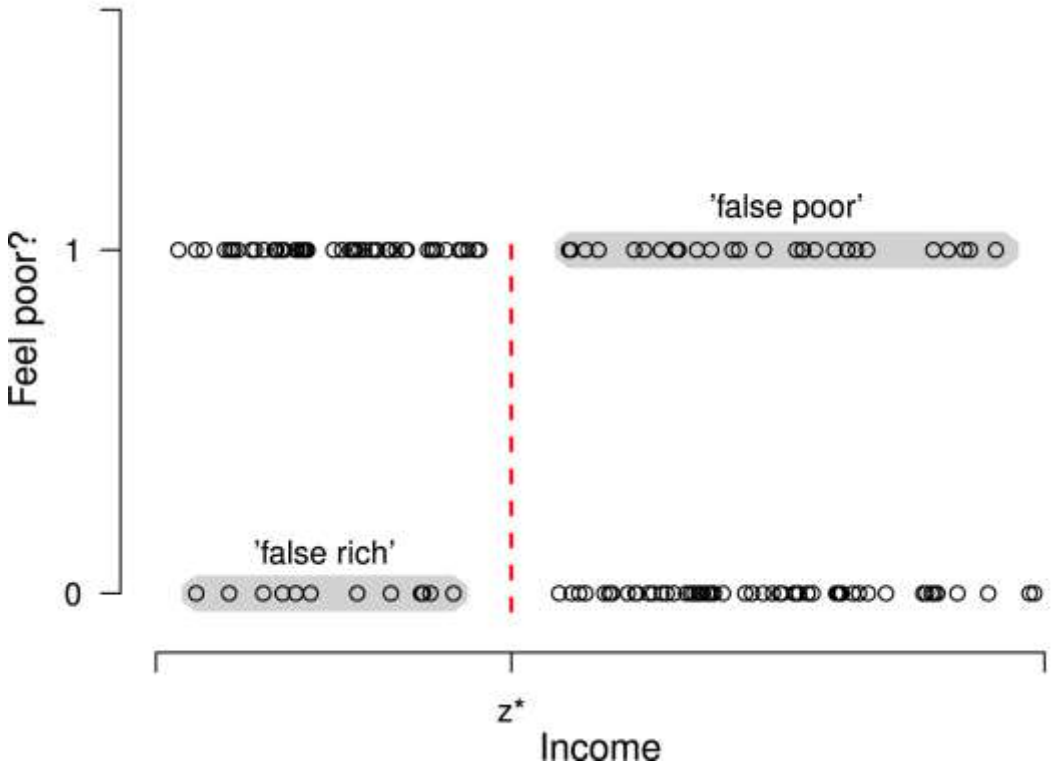
Part 1

SPL based on binary classification methods

The starting point

- Previous research:
  - *Youden J index*
  - (confusion matrix)

- Other potential classification measures:
  - *Accuracy*
  - ***The product of sensitivity and specificity***
  - ***The F1 score metric***
  - ***Cohen's Kappa***
  - ***Distance to the point [0,1] on ROC space (Euclidean's index)***
  - *The absolute difference of sensitivity and specificity*
  - *The absolute difference between positive predictive value (PPV) and negative predictive value (NPV)*



Želinský, Ng & Mysíková (2020)

SPL based on binary classification methods

The adopted classification measures :: Confusion matrix

		Predicted condition	
		Positive	*Negative*
Actual condition	*Positive*	True positive (*TP*)	False negative (*FN*)
	Negative	False positive (*FP*)	True negative (*TN*)

- Sensitivity (*Se*): $\frac{TP}{TP + FN}$

- Specificity (*Sp*): $\frac{TN}{TN + FP}$

SPL based on binary classification methods

The adopted classification measures

- Youden *J* index:

  $Se + Sp - 1$

- The product of sensitivity and specificity

  $Se \cdot Sp$

- The *F*1 score metric

  $$\frac{2 \cdot TP}{2 \cdot TP + FP + FN}$$

- Cohen's *Kappa*

  $$\frac{2\,(TP \cdot TN - FN \cdot FP)}{(TP + FP) \cdot (FP + TN) + (TP + FN) \cdot (FN + TN)}$$

- Distance to the point [0,1] on ROC space (Euclidean's index)

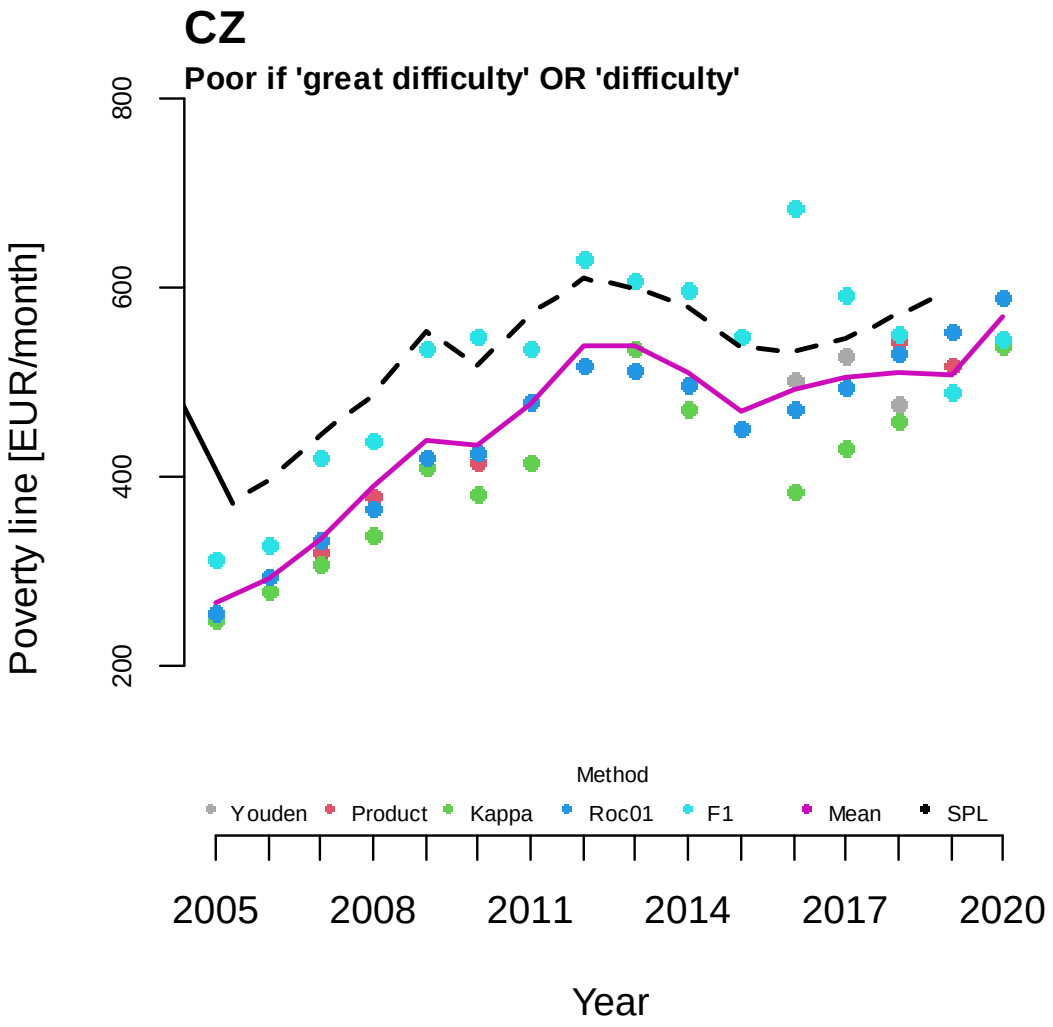
  $$\sqrt{(1 - Se)^2 + (1 - Sp)^2}$$

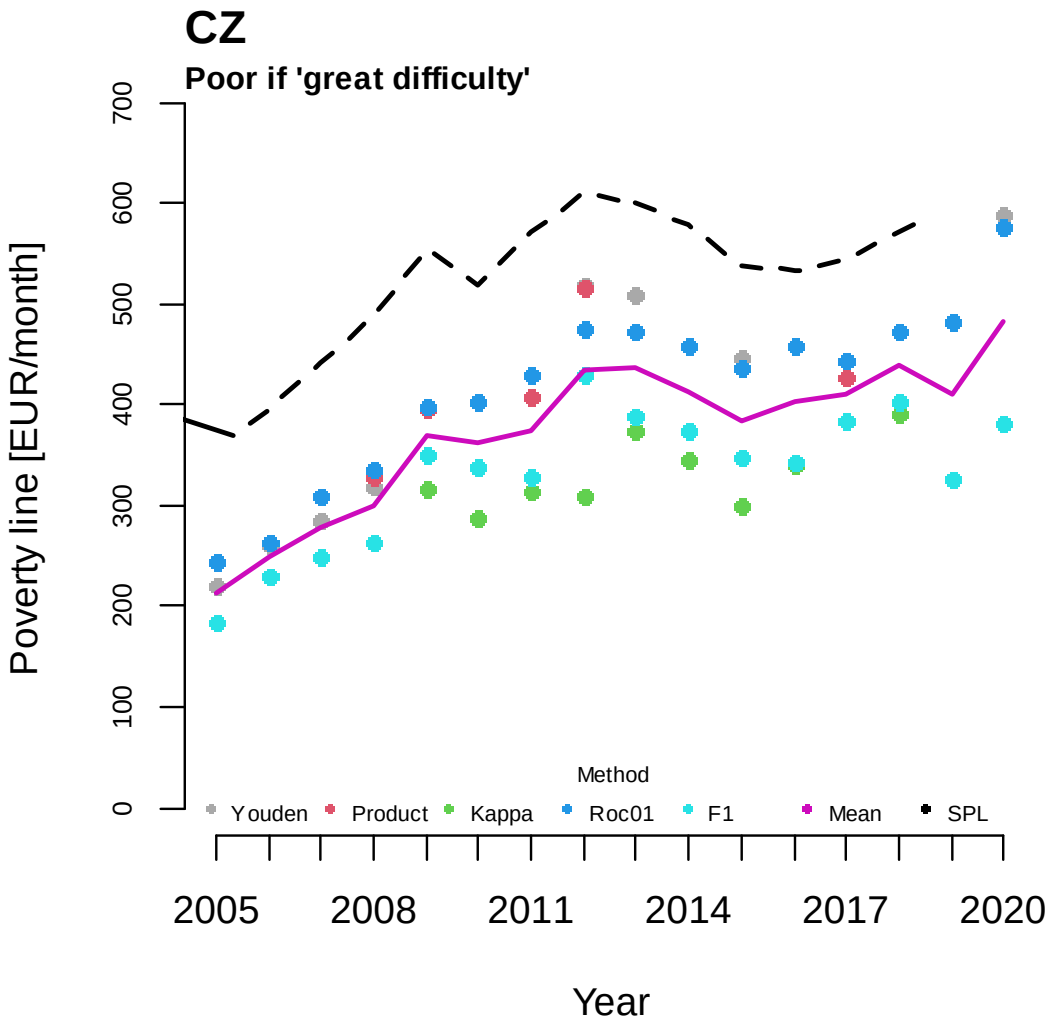
SPL based on binary classification methods
Empirical exercise

- 2004 – 2020 EU-SILC data *[EU-SILC Cross UDB – version of 2023-09]*
- Subsample: One person household
- Key variable: HS120 – Ability to make ends meet
  - The choice whom to consider subjectively poor is arbitrary:
    1. Ability to make ends meet '*with great difficulty*' or '*with difficulty*' [HS120 ≤ 2]
    2. Ability to make ends meet '*with great difficulty*' [HS120 = 1]

SPL based on binary classification methods

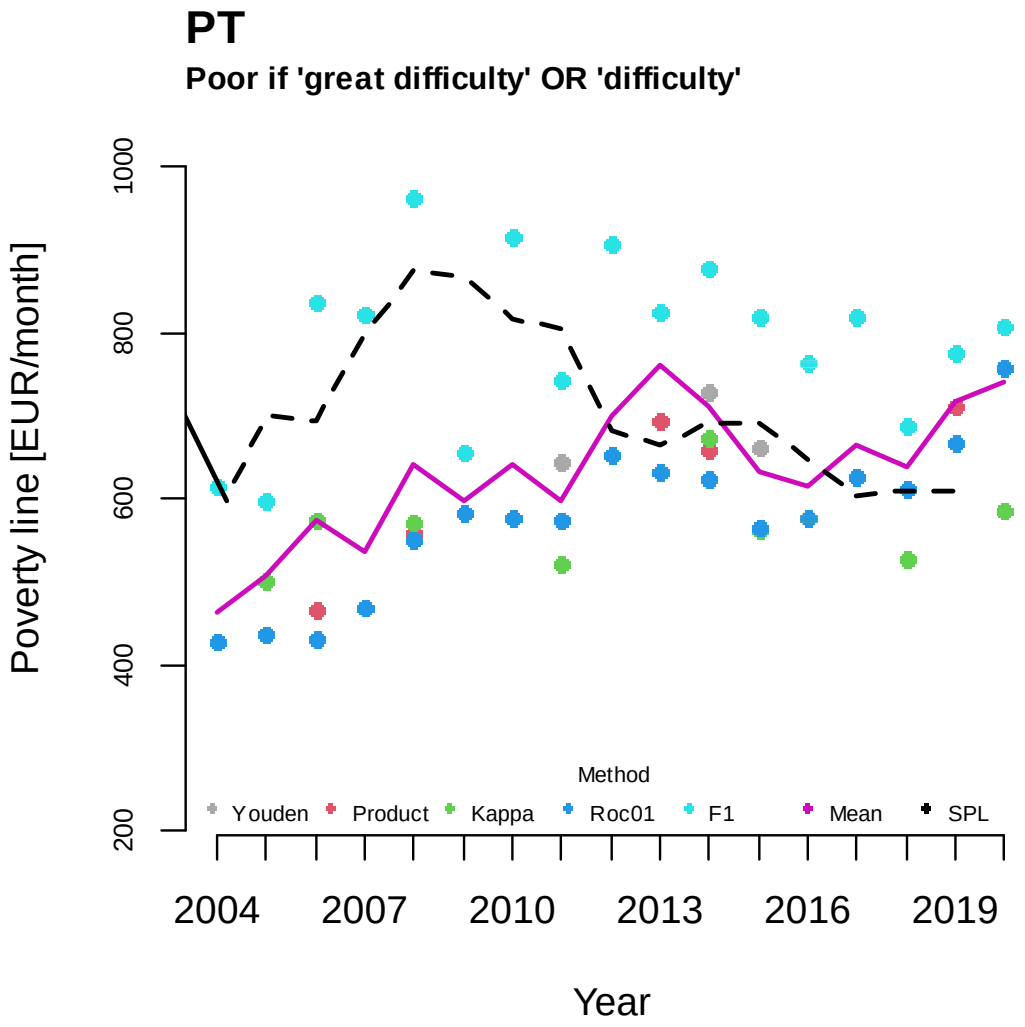
Empirical exercise :: Results #1

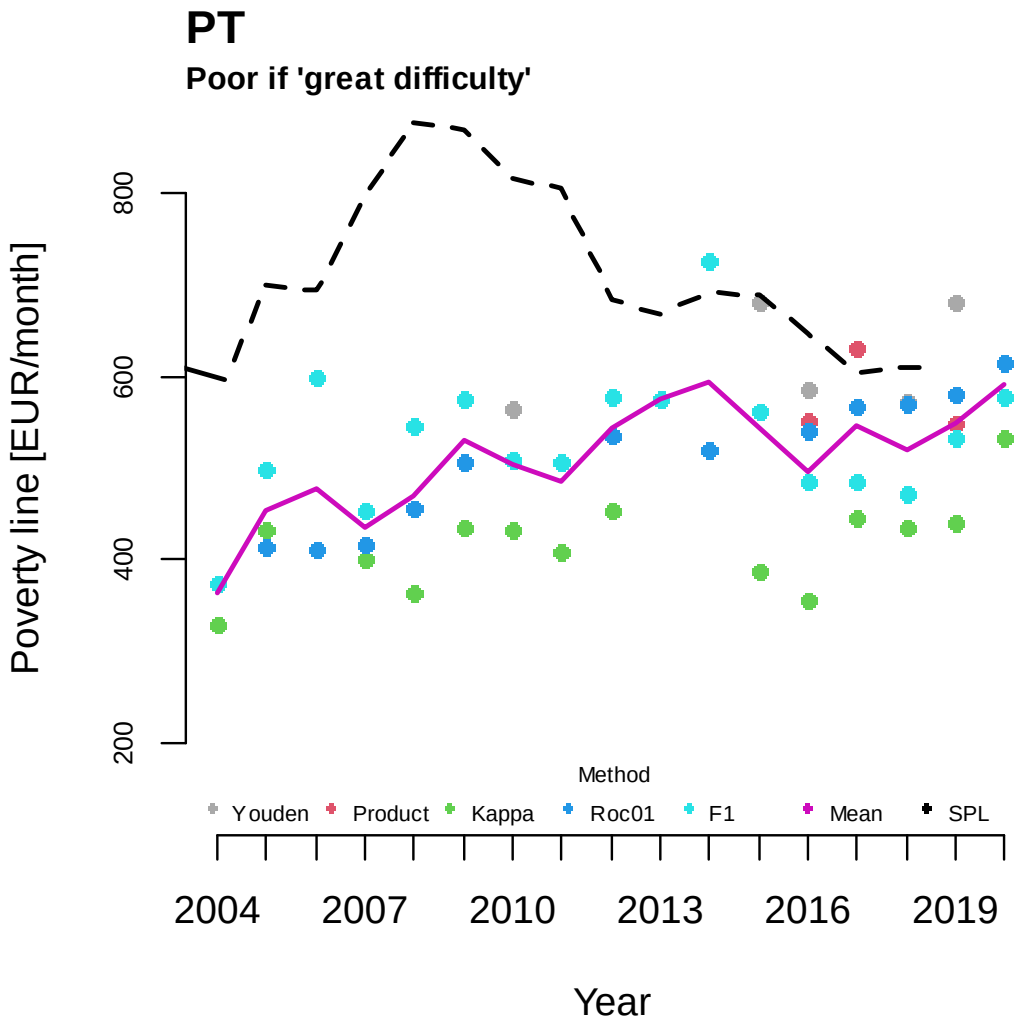




SPL based on binary classification methods

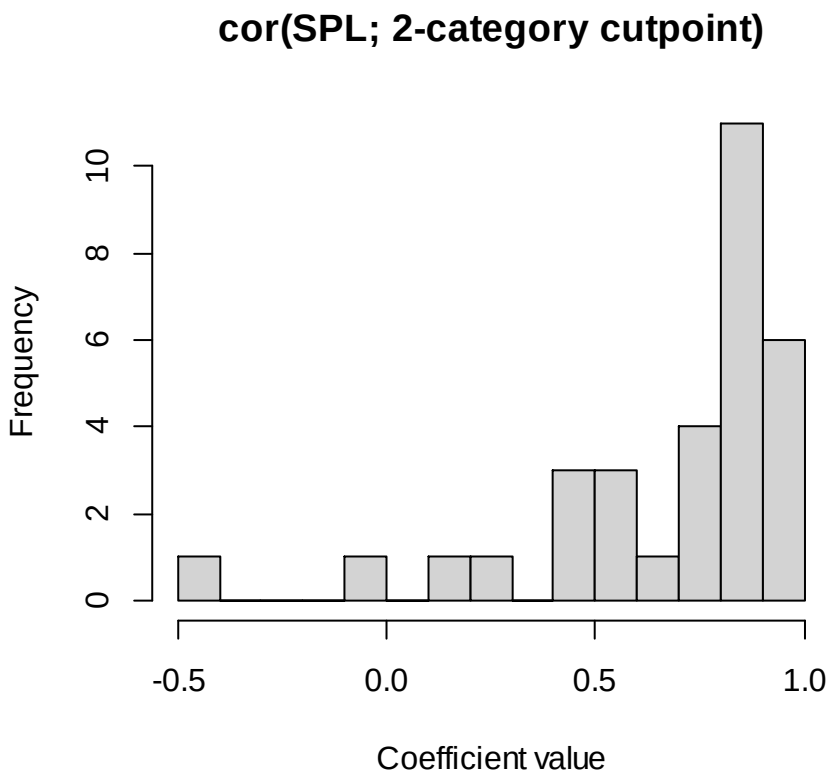
Empirical exercise :: Results #2

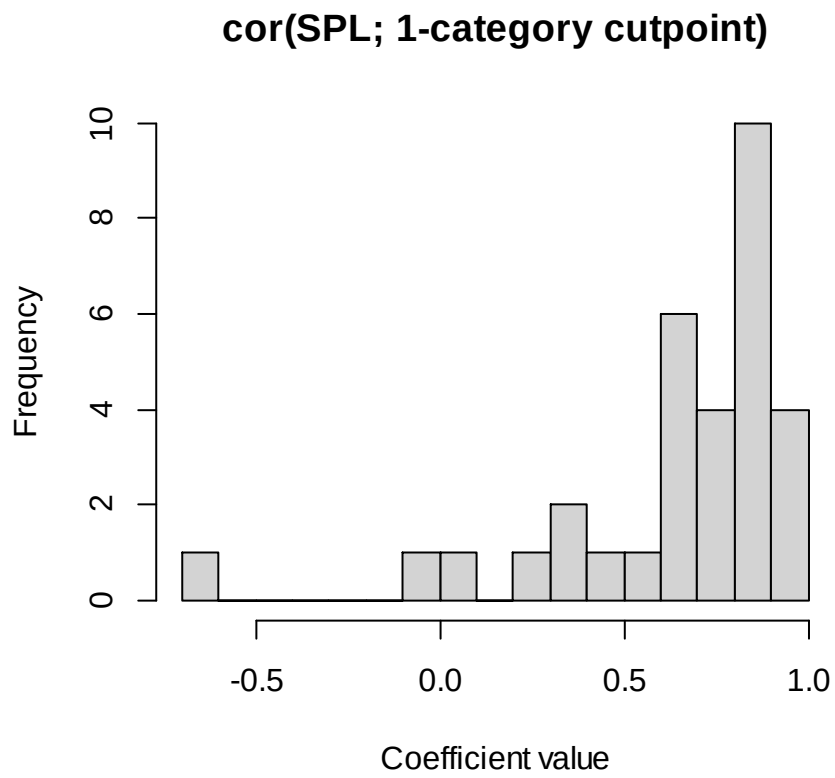




SPL based on binary classification methods
Empirical exercise :: Results #3

- Correlation between SPL and estimated cutpoints.
  - Poor if: '*great difficulty*' or '*difficulty*' (left) // '*great difficulty*' (right)





SPL based on binary classification methods

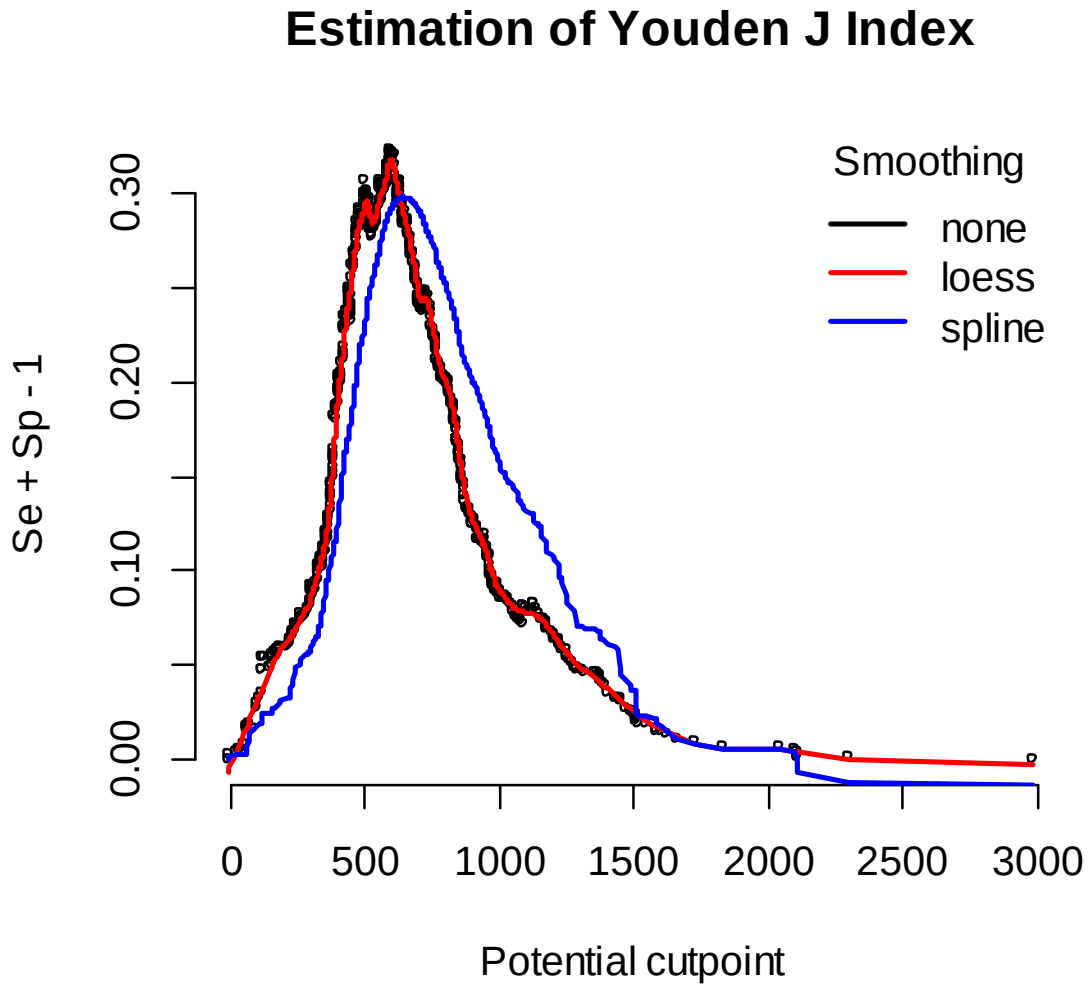
Empirical exercise :: Results #4.1

- However, a curve based on a confusion matrix is not necessarily smooth.
- As a result: multiple combinations:

  N classification metrics

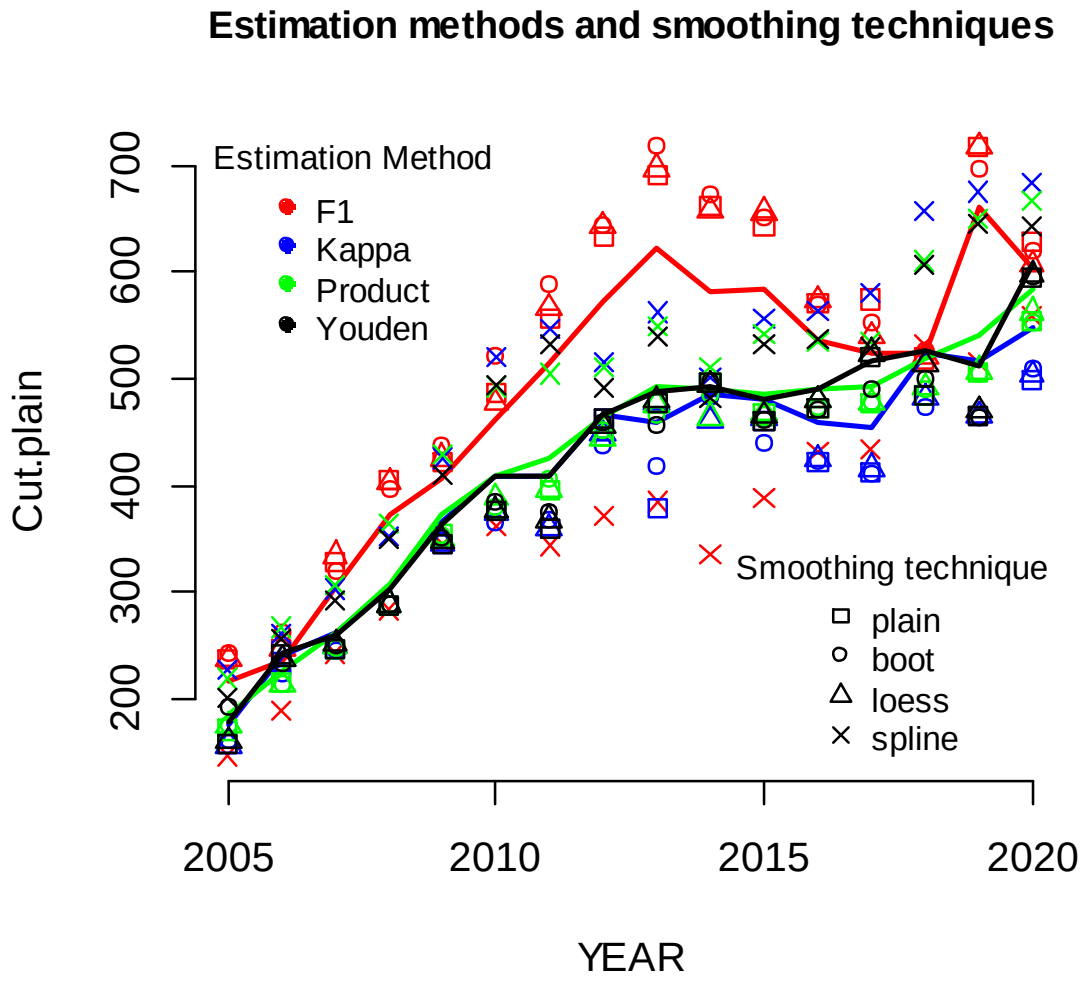
  ×

  K smoothing techniques



SPL based on binary classification methods
Empirical exercise :: Results #4.2

- A comparison of different estimation methods and smoothing techniques.



SPL based on binary classification methods
Preliminary conclusions

- Exploration of diverse estimation methods to identify optimal cutoff points.
- Application of various smoothing techniques.
- Result: Multiple ‘subjective poverty lines’ for consideration.
- Priority lies in recognizing trends rather than fixating on specific SPL values.
- Essential: additional testing and simulations for comprehensive insights.

Identifying the subjectively poor using Machine Learning methods

Part 2

Identifying the subjectively poor (ML approach)
Motivation & intuition

- Can we predict subjective poverty status using survey characteristics?
- The intuition:
  - MIQ will be included in EU-SILC every six years.
  - This enables proper identification of subjectively poor in year T_0 using MIQ/intersection approach.
  - Using T_0 data, our goal is to train an ML model for classifying households.
  - Apply the the model to predict subjective poverty status in years T_1 *to* T_5.

Identifying the subjectively poor (ML approach)
The adopted classification methods

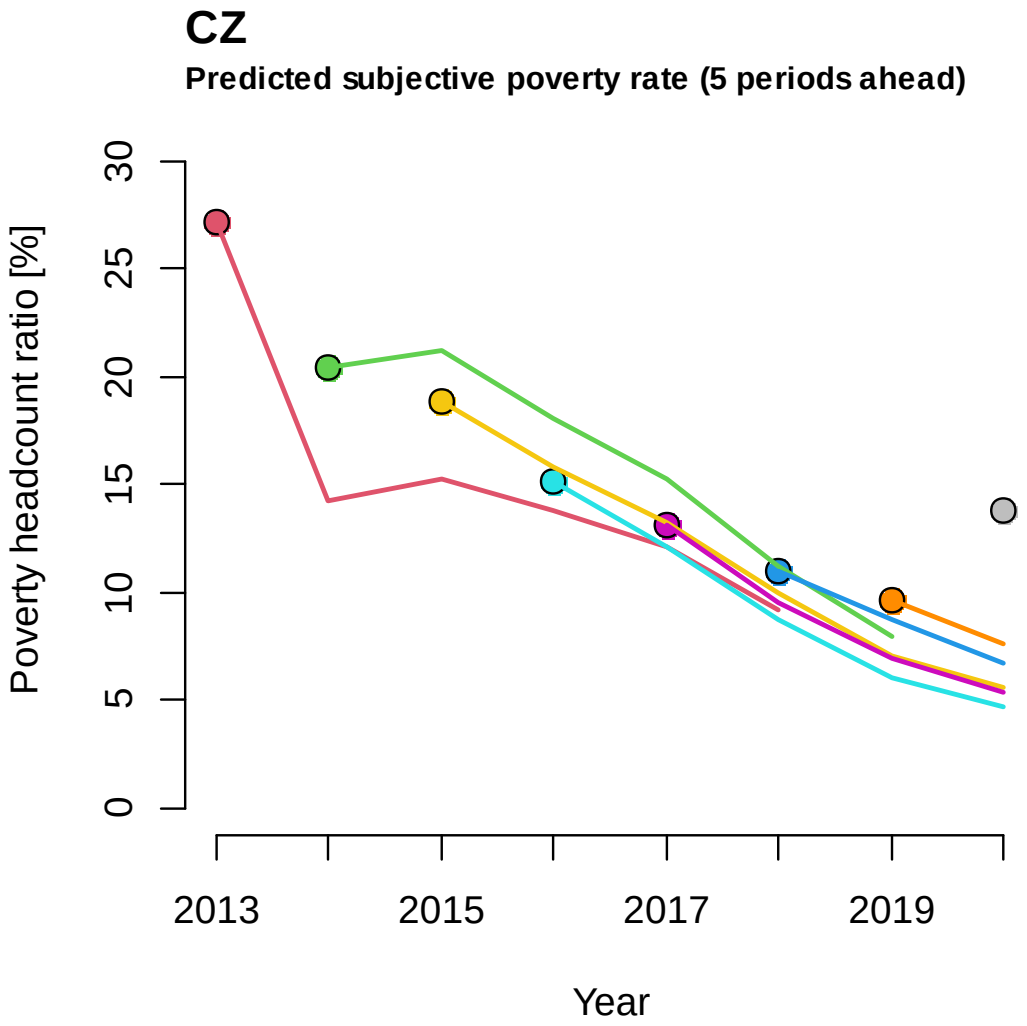
- **Neural networks**
  - Deep learning models for intricate patterns, with interconnected layers of neurons.
- **Random forest**
  - Ensemble of decision trees for classification, improving accuracy and generalization.
- **K-nearest neighbours**
  - Instance-based classification by majority vote of nearby data points.
- **Decision Tree Classifier**
  - Tree-like model making decisions through recursive partitioning of feature space.
- **Logistic regression**
  - Linear model for binary classification using logistic function.

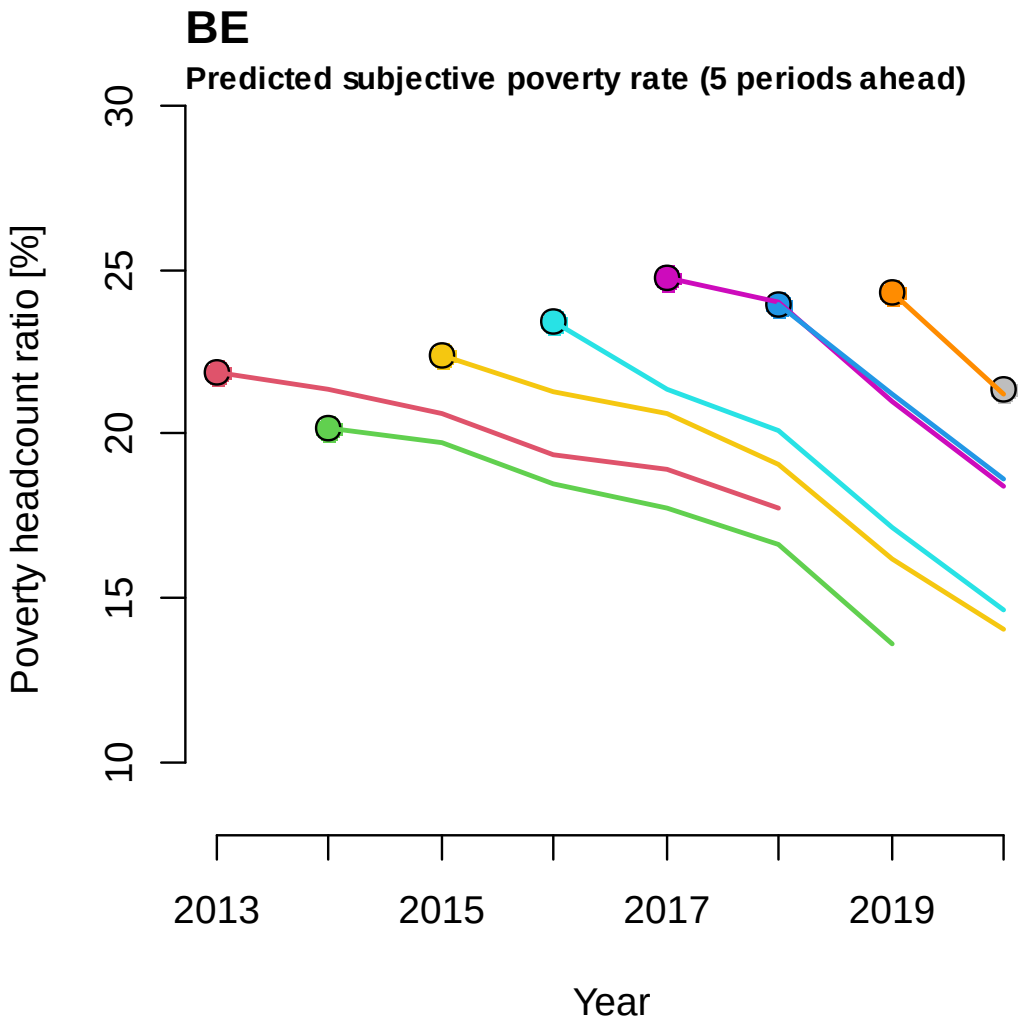
Identifying the subjectively poor (ML approach)
Empirical exercise

- 2013 – 2020 EU-SILC data *[EU-SILC Cross UDB – version of 2023-09]*
- Outcome variable:
  - *Y* = 1 if classified as subjectively poor using MIQ/intersection approach; 0 otherwise.
- Classification of households based on numerous characteristics
  - Income; Household structure; Material deprivation indicators; etc.
- Main results: **Neural networks**
  - Hyperparameters were systematically explored using grid search
    - Number of neurons in hidden layers: [32, 64, 128, 256]
    - Number of hidden layers: [1, 2, 3, 4, 5, 6, 7, 8]
    - Learning rate: [0.001, 0.005, 0.01]

Identifying the subjectively poor (ML approach)

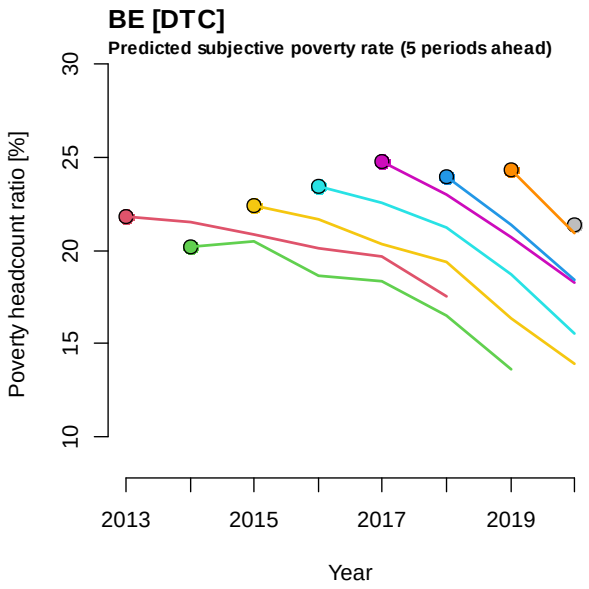
Empirical exercise :: Results #1 (Neural networks)

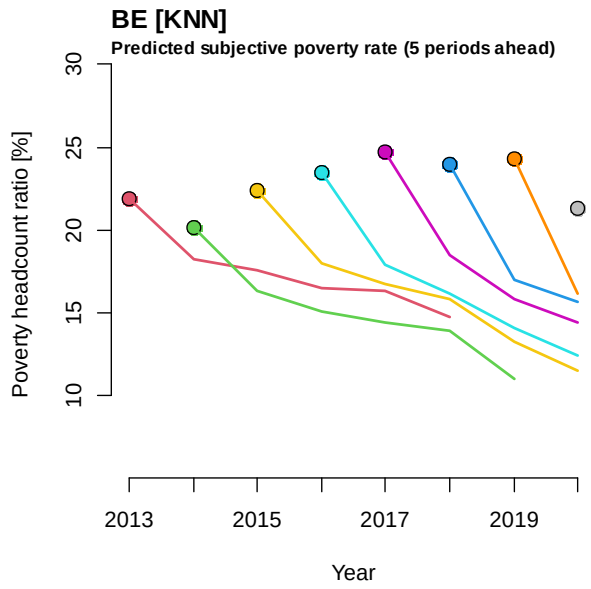


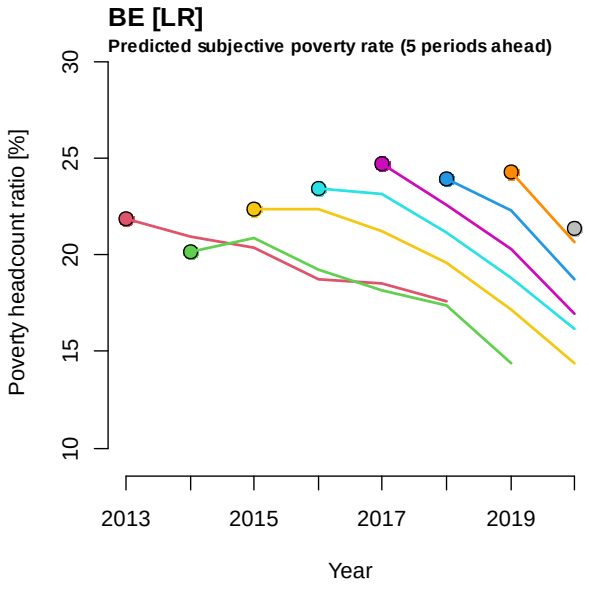


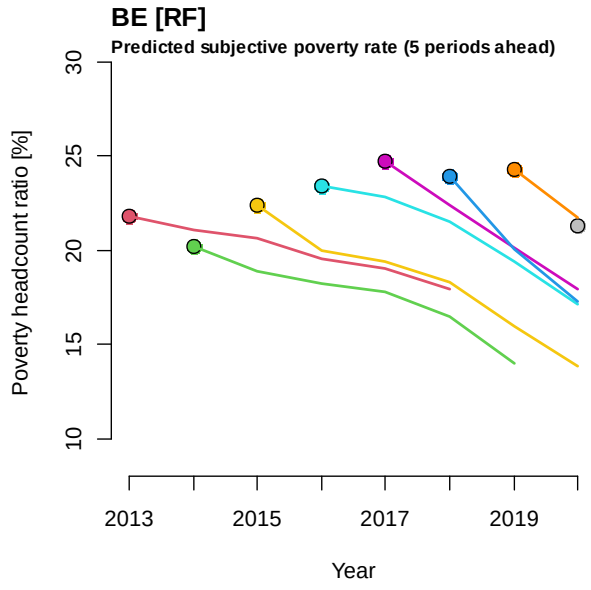
Identifying the subjectively poor (ML approach)

Empirical exercise :: Results #2 (Other methods)



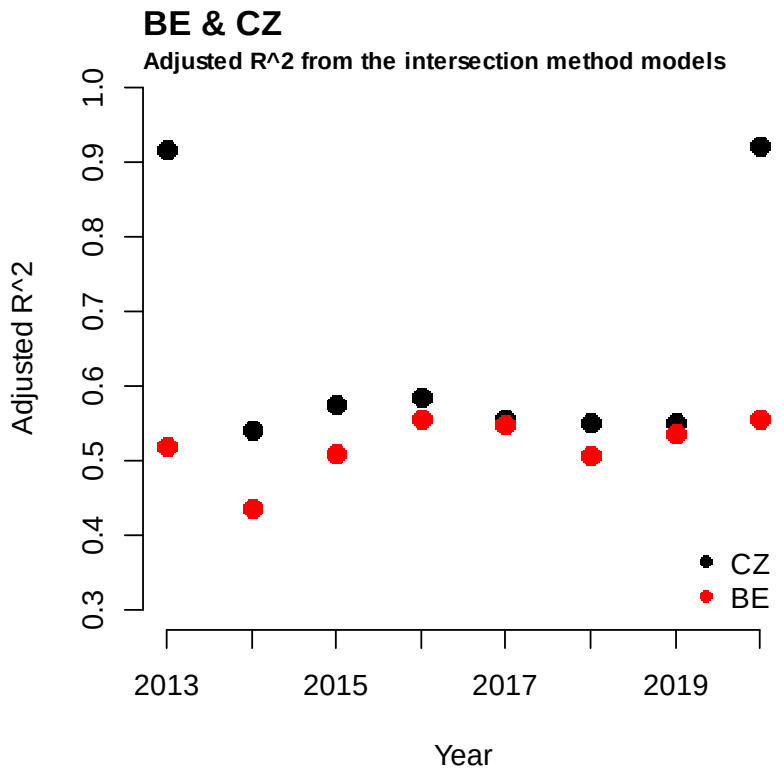


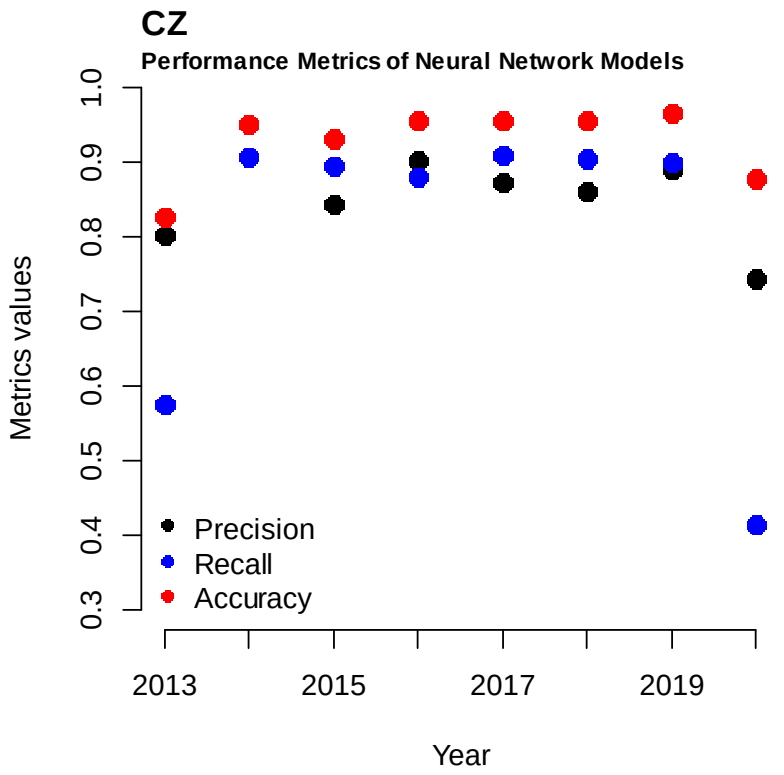


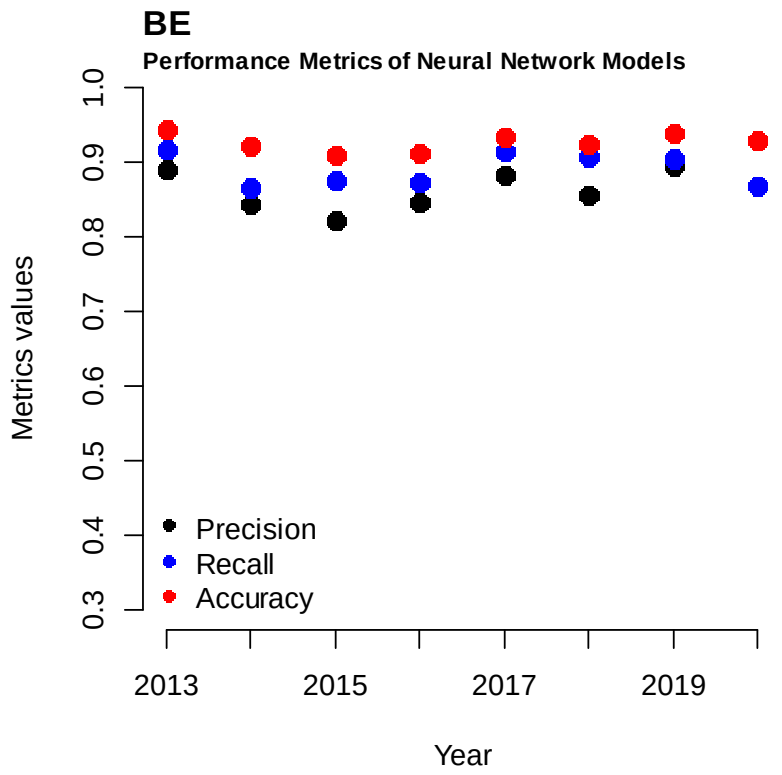


Identifying the subjectively poor (ML approach)
Empirical exercise :: Results #3 (Neural networks)

- Can variations in model quality account for differences observed in the results?
  - *Unlikely.*







Identifying the subjectively poor (ML approach)
Preliminary conclusions

- Various machine learning methods employed.
- Significant variability in predictive performance across different countries.
- Further research is crucial for deeper understanding and refinement.

Concluding remarks

- **Incorporate the MIQ in surveys.**
  - Refer to the Report for detailed recommendations.
- Utilize the intersection method.

Thank you for your attention

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