Fiche de modélisations n°6

Variables et classes latentes

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Table des matières

1 Objectif

L'objectif de cette sixième série de modèles est de . . .

2 Analyses

TODO

3 Code et résultats

```r
#chargement des packages
library(knitr)
library(dplyr) #manipuler les bases de données
library(psych) #EFA
library(lavaan) #CFA et SEM
library(semPlot) #path draw CFA SEM
library(poLCA) #pour les Latent Categorical Variables
```

```r
library(ade4) #pour la fonction s5 de plot des classes de CAH
library(RColorBrewer) #palettes de couleur
library(ggplot2) #graphiques corrplot
library(tidyr) #pour pivot_longer / wider
library(tibble) #pour rownames_to_column
```

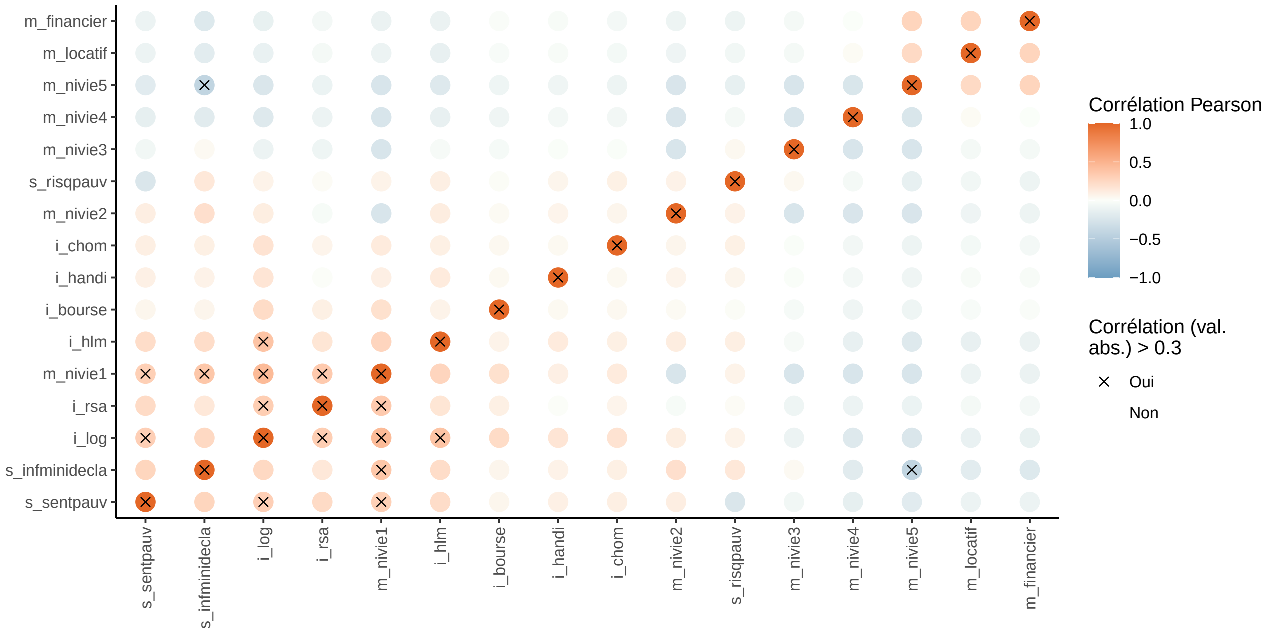
3.1 Correlation coefficients

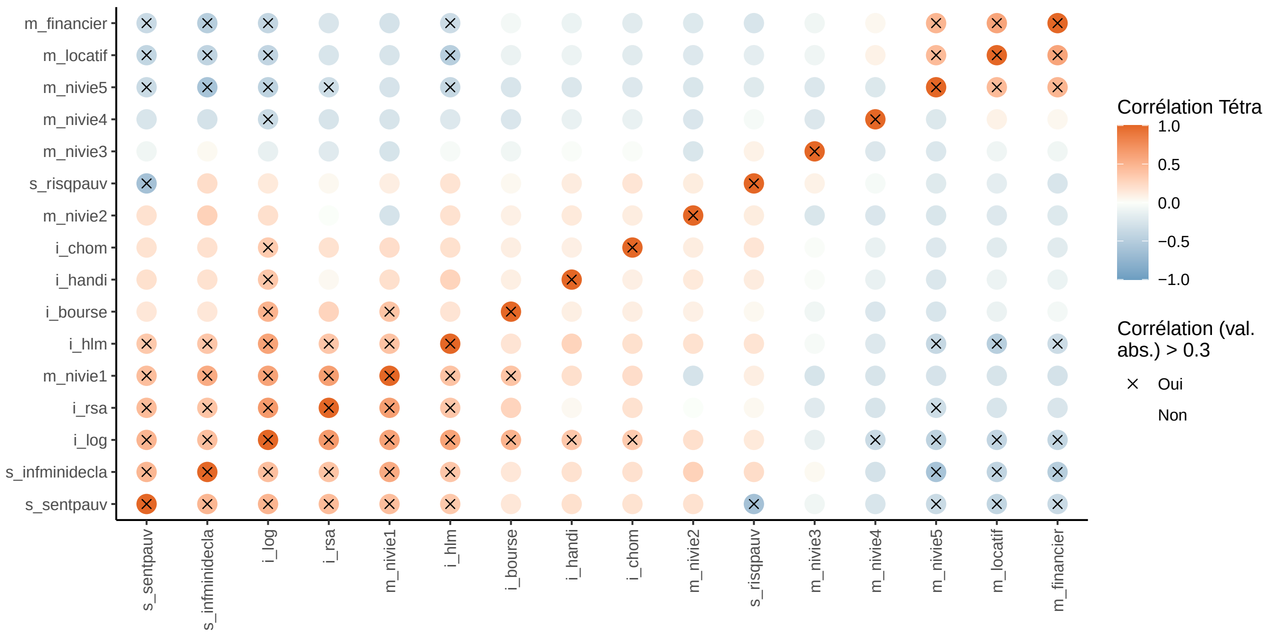
A correlation coefficient suited for dichotomous data and based on this underlying normal strategy is the tetrachoric correlation. It gives us a single number describing the degree of dependence in the table above with the extreme values of 1 if the off-diagonals are 0 and -1 if the diagonals are 0. In addition, we get estimates for the thresholds tau1 and tau2. polycholoric existe aussi pour deux items polytomous.

We print out the last six eigenvalues and see that the last eigenvalue is negative. Thus, this matrix does not fulfill the properties of a correlation matrix. The trick is now to apply some smoothing on the correlations.

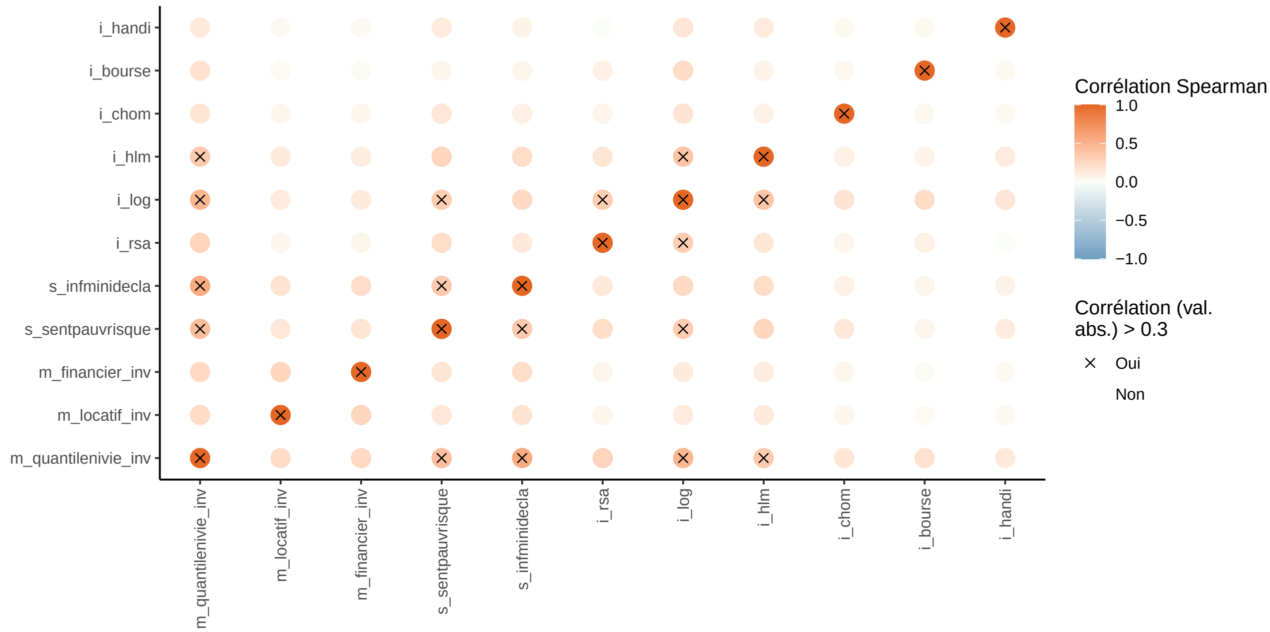
The final criterion is interpretability.

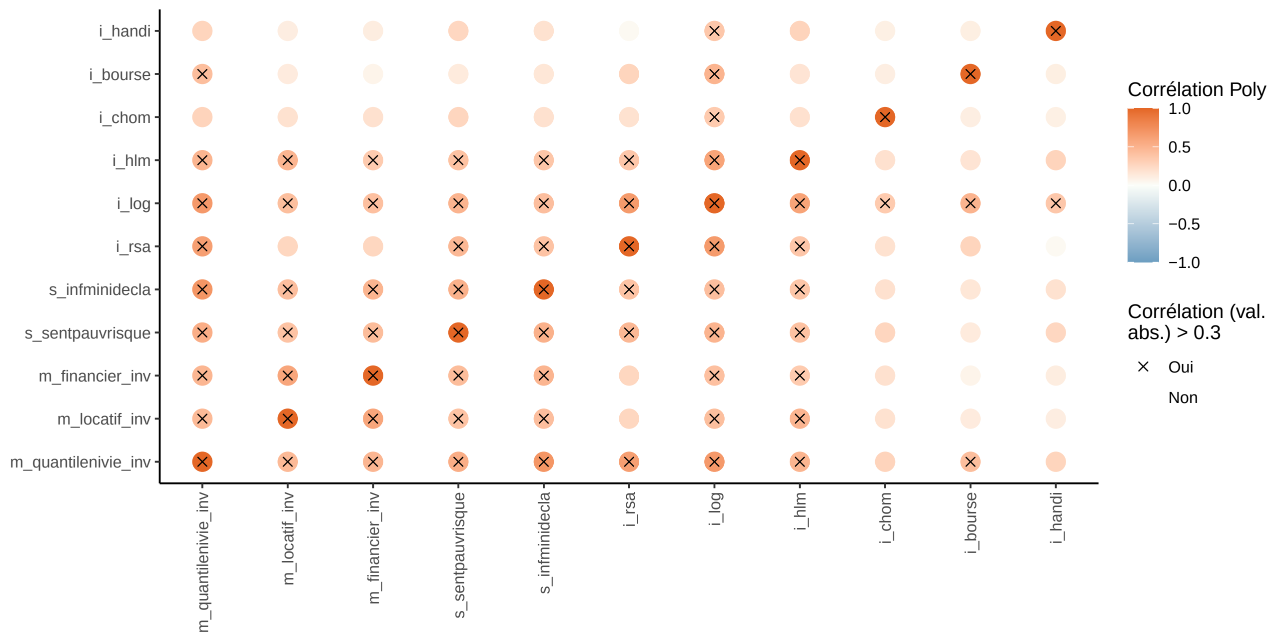
3.1.1 Indicatrices





3.1.2 Variables catégorielles (plus de 2 modalités possibles)





3.2 Exploratory Factor Analysis (EFA)

However, in order to get an even clearer picture, in EFA we typically apply a rotation on the loadings matrix. Such a rotation does not change the fit of the model; it is only done for interpretation purposes by transforming the loadings. We distinguish between two basic types of rotations: orthogonal (qui implique que les facteurs sont indépendants) and nonorthogonal rotation (comme oblimin).

In practice, EFA with oblique rotation is often used prior to a CFA in order to explore whether the underlying latent structure theory is reflected by the data.

Différences entre EFA et ACP - Les ACP reposent sur des estimations bien plus simples que les EFA (ML, LS). - L'EFA se concentrent sur l'explication des termes en dehors de la diagonales des éléments de grand sigma (explique les covariances) alors que l'ACP se concentre sur la diagonale (explique principalement la variance, même si pas totalement aveugle aux covariances). - Les scores des facteurs sont calculés post hoc alors que ceux de l'ACP est une conséquence directe du SVD. - En EFA, on fixe p avant de faire tourner le modèle, dans l'ACP on choisit le nombre d'axes a posteriori. - En EFA, les rotations peuvent aider à mieux interpréter sans changer la solution, contrairement à la PCA pour laquelle la solution est changée.

PCA et EFA sont deux techniques de réduction de dimensions mais elles ont des différences.

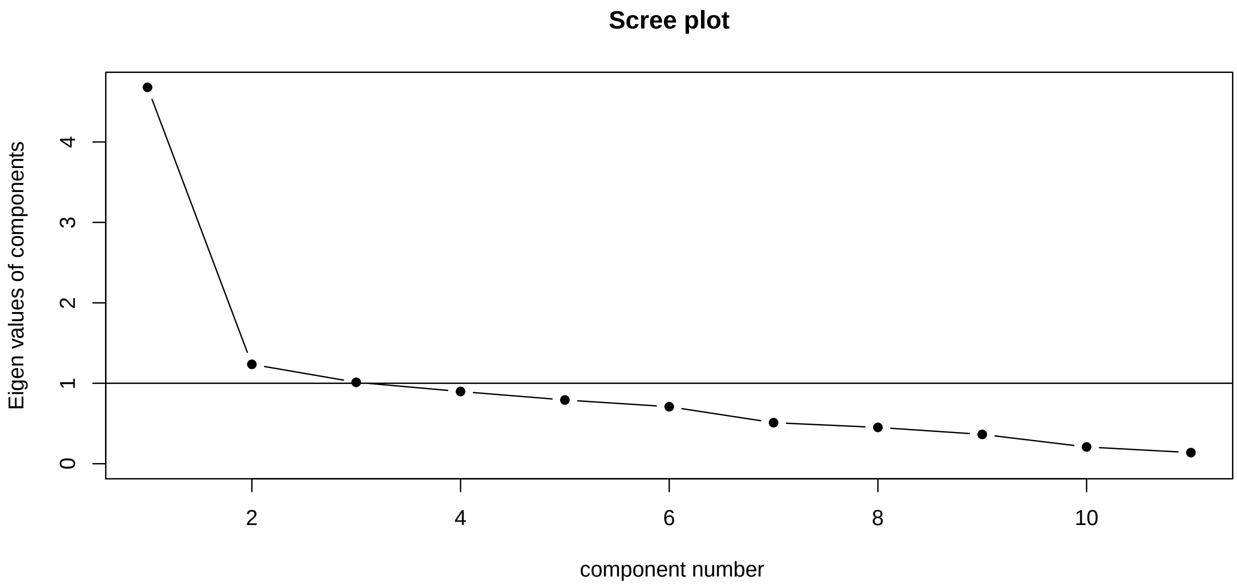
On utilise la PCA quand les variables sont très corrélées cela permet de réduire le nombre de variables observées en un plus petit nombre de composantes principales qui résument un maximum de variances des variables observées On utilise l'EFA pour identifier le nombre de variables latentes (non mesurée directement) et la structure des facteurs qui découlent d'un ensemble de variables. Elle permet d'estimer les facteurs qui influencent les réponses des variables observées.

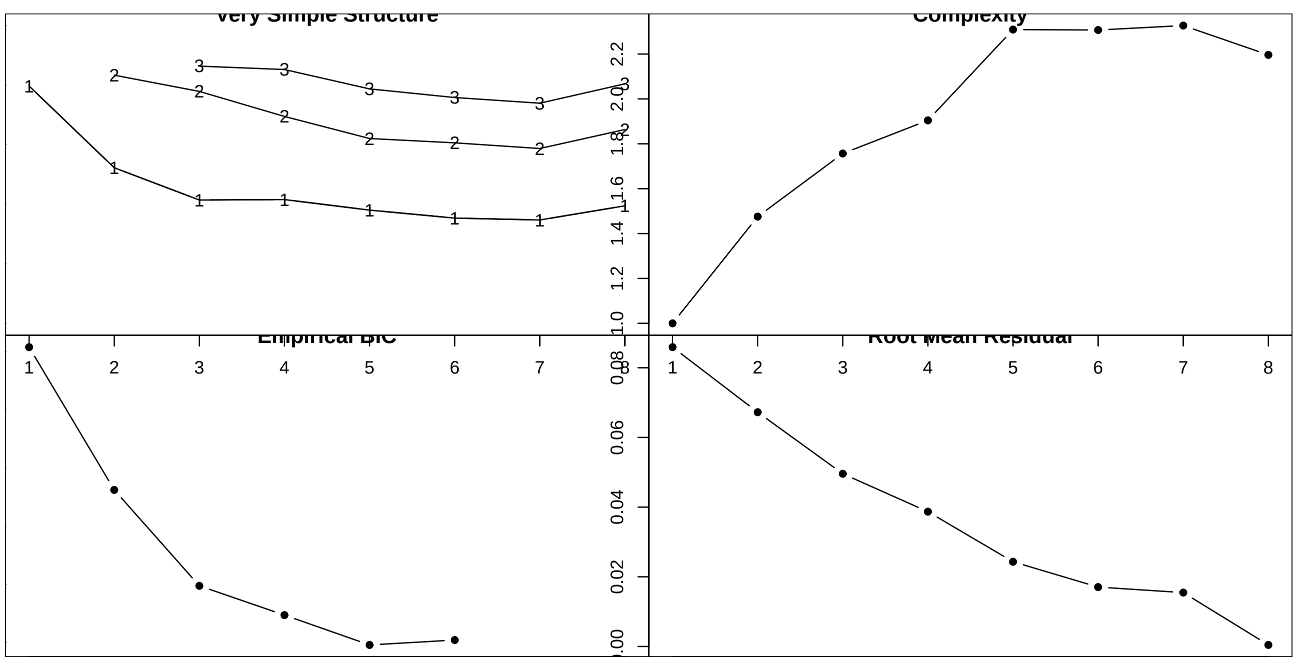
Unlike factor analysis, principal components analysis or PCA makes the assumption that there is no unique variance, the total variance is equal to common variance. Recall that variance can be partitioned into common and unique variance. If there is no unique variance then common variance takes up total variance (see figure below). Additionally, if the total variance is 1, then the common variance is equal to the communality.

— PCA suppose l'absence d'outliers. L'EFA suppose une distribution normale multivariée quand la méthode de ML est utilisée
— Les axes de la PCA tiennent compte de la variance maximale des variables observées alors que les facteurs de l'EFA tiennent compte de la variance commune
— La PCA utilise une matrice de corrélation alors que l'EFA utilise une matrice de corrélation ajustée
— Dans une PCA il y a des 1 sur la diagonale de la matrice de corrélation alors que dans l'EFA la diagonale est ajustée avec les facteurs uniques.
— La PCA minimise la somme des carrés perpendiculaire à la distance aux axes des composantes. L'EFA estime des facteurs qui influencent la réponse à des variables observées.
— Les scores des composantes de la PCA est une combinaison linéaire des variables observées pondérées par les vecteurs propres. Les variables observées de l'EFA sont une combinaison linéaire des facteurs uniques

n alternative to factor analysis, which is unfortunately frequently confused withfactoranalysis, isprincipal components analysis. Although the goals ofPCAandFAare similar,PCA is a descriptive model of the data, while FA is a structural model. Psychologiststypically use PCA in a manner similar to factor analysis and thus theprincipalfunctionproduces output that is perhaps more understandable than that produced byprincompin thestatspackage. Table 4 shows a PCA of the Thurstone 9 variable problem rotatedusing thePromaxfunction. Note how the loadings from the factor model are similar butsmaller than the principal component loadings. This is because the PCA model attemptsto account for the entire variance of the correlation matrix, while FA accounts for just thecommon variance. This distinction becomes most important for small correlation matrices.Also note how the goodness of fit statistics, based upon the residual off diagonal elements,is much worse than thefasolution.

```
[1] 42.54 11.24  9.20  8.16  7.20  6.44  4.64  4.10  3.31  1.90  1.26
```

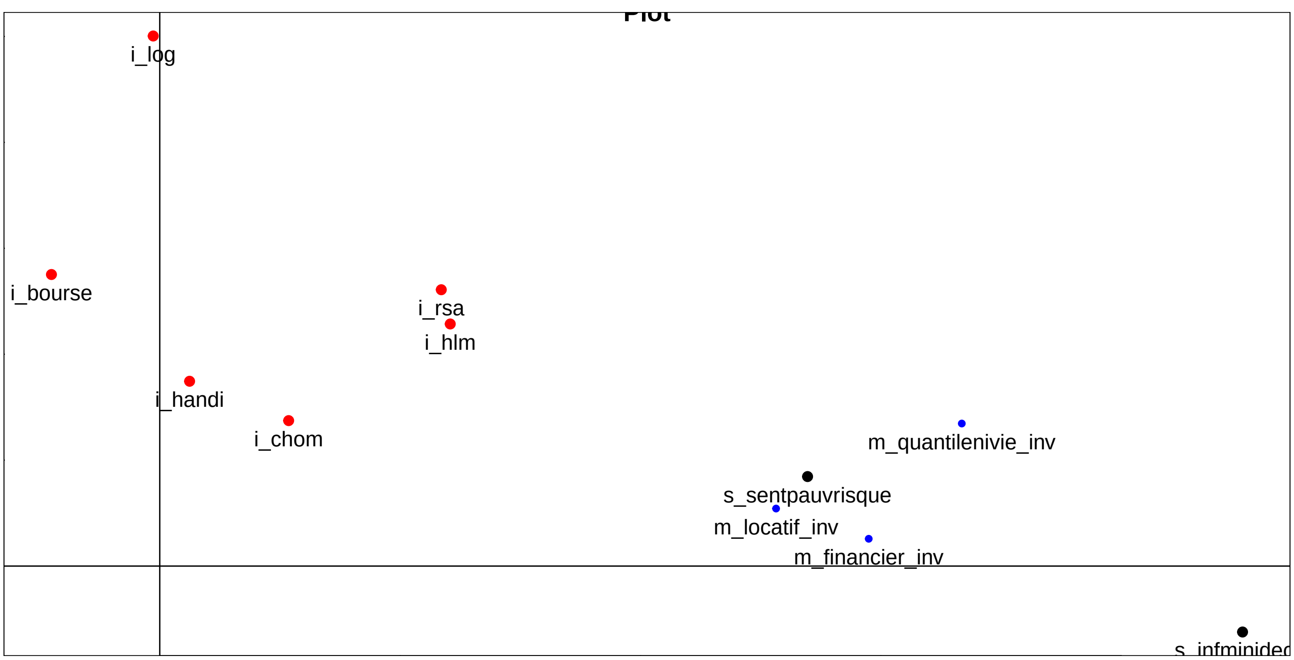




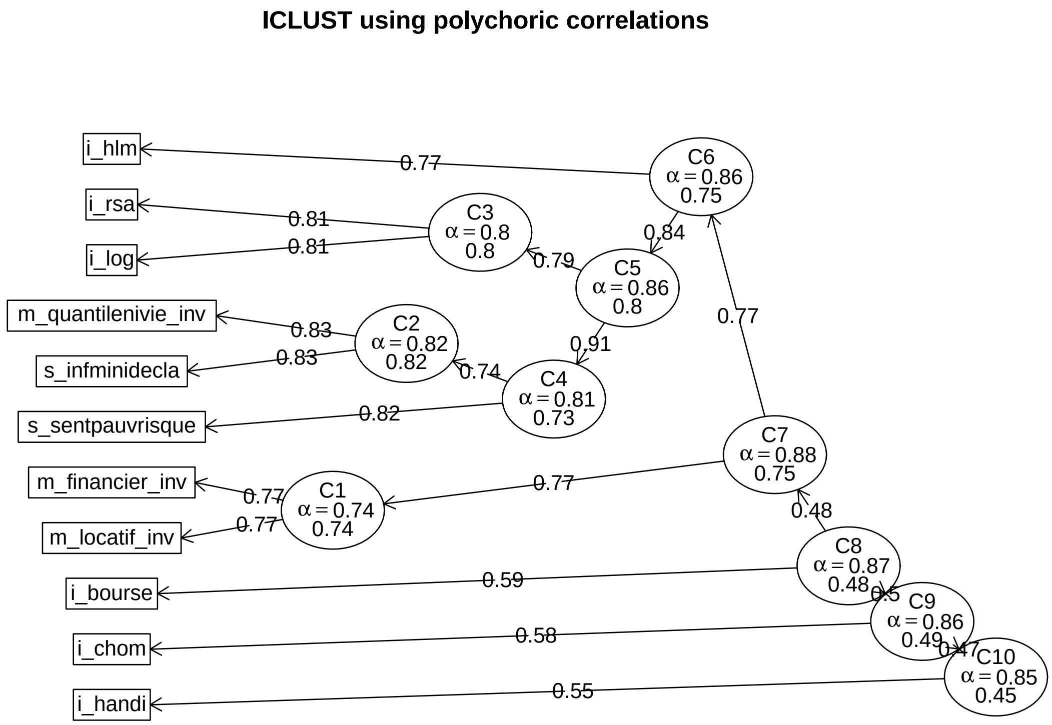

```
Factor analysis with Call: fa(r = bdd_poLCA_poly$rho, nfactors = 2, rotate = "oblimin",
    scores = "regression", missing = TRUE, impute = "median",
    fm = "ml", cor = "poly")

Test of the hypothesis that 2 factors are sufficient.
The degrees of freedom for the model is 34  and the objective function was  0.81

The root mean square of the residuals (RMSA) is  0.07
The df corrected root mean square of the residuals is  0.09

 With factor correlations of
     ML2  ML1
```

```
ML2 1.00 0.61
ML1 0.61 1.00

Loadings:
                    ML2    ML1
s_sentpauvrisque     0.539
s_infminidecla       0.901
m_quantilenivie_inv  0.668
m_locatif_inv        0.513
m_financier_inv      0.590
i_log                       1.001
i_rsa                       0.522
i_chom
i_handi                     0.349
i_bourse                    0.550
i_hlm                       0.457

                 ML2   ML1
SS loadings    2.294 2.114
Proportion Var 0.209 0.192
Cumulative Var 0.209 0.401
```

```
   s_sentpauvrisque      s_infminidecla m_quantilenivie_inv       m_locatif_inv
               0.43                0.69                0.74                0.34
    m_financier_inv               i_log               i_rsa              i_chom
               0.39                1.00                0.48                0.12
            i_handi            i_bourse               i_hlm
               0.13                0.25                0.40
```



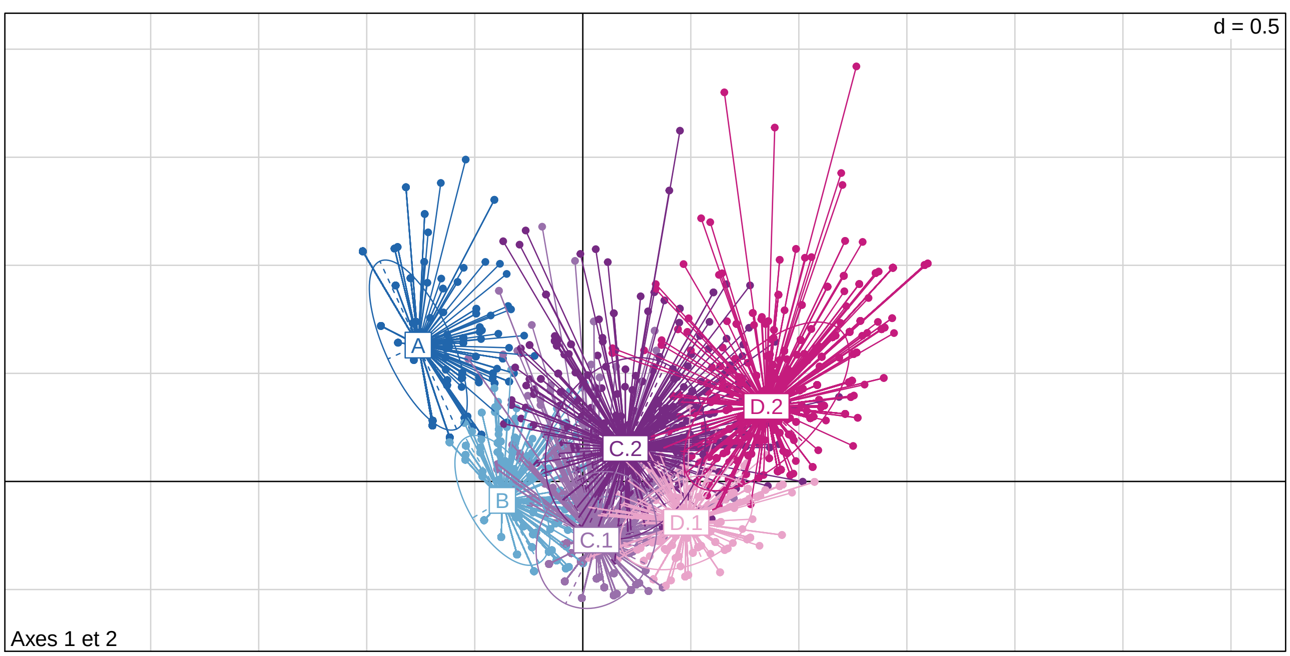
Premier type de clustering (de variables et non d'individus) avec iclust



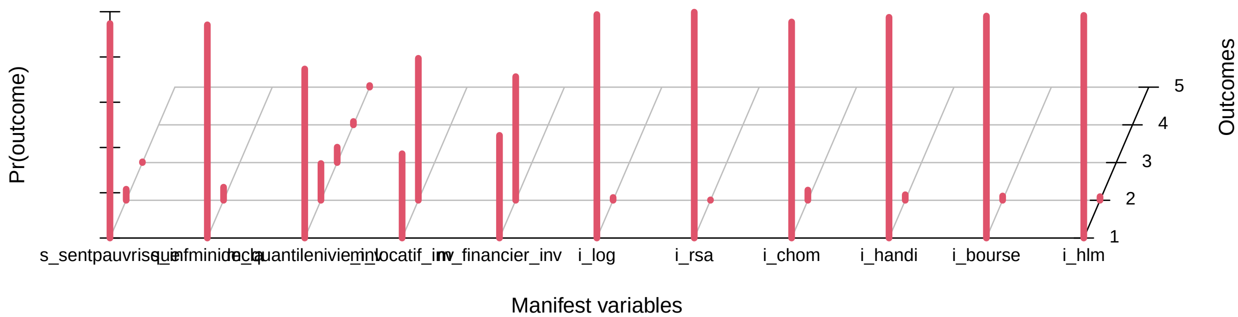
3.3 Latent Categorical Variables

Source : https://m-clark.github.io/sem/mixture-models.html

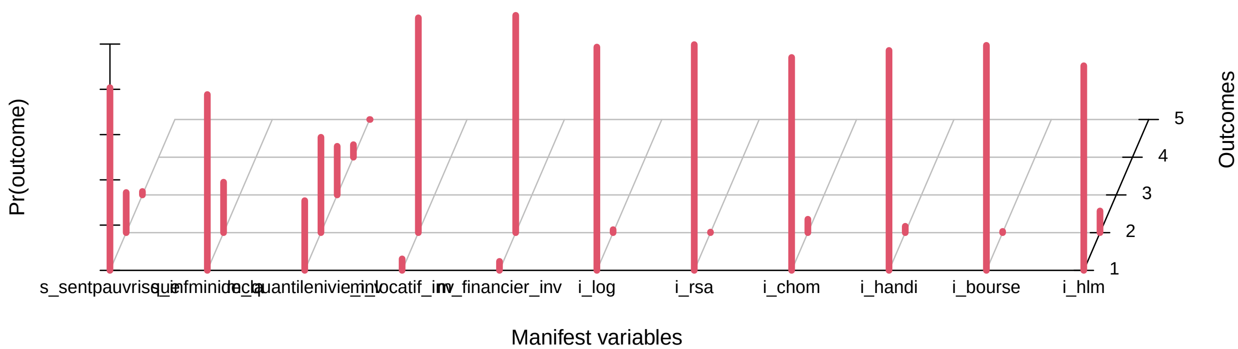
Documentation https://raw.githubusercontent.com/dlinzer/poLCA/master/inst/doc/poLCA-manual-1-4.pdf



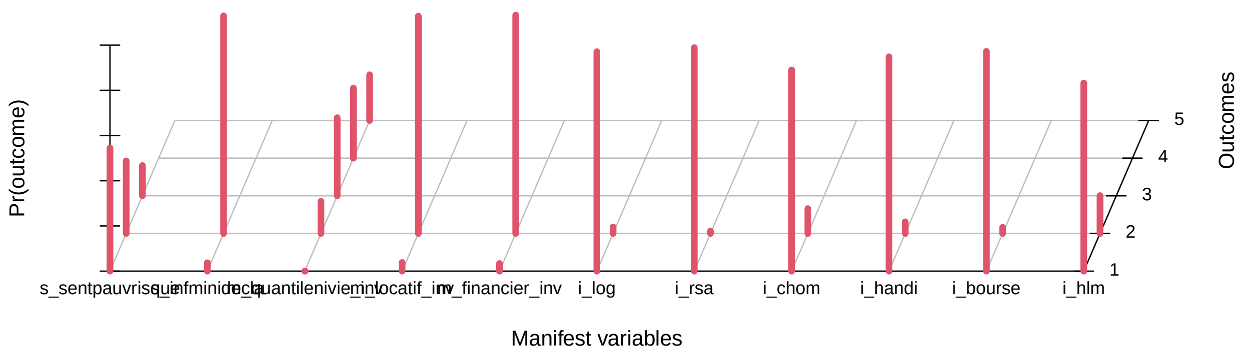
Classe A : part de la population = 12.8 %



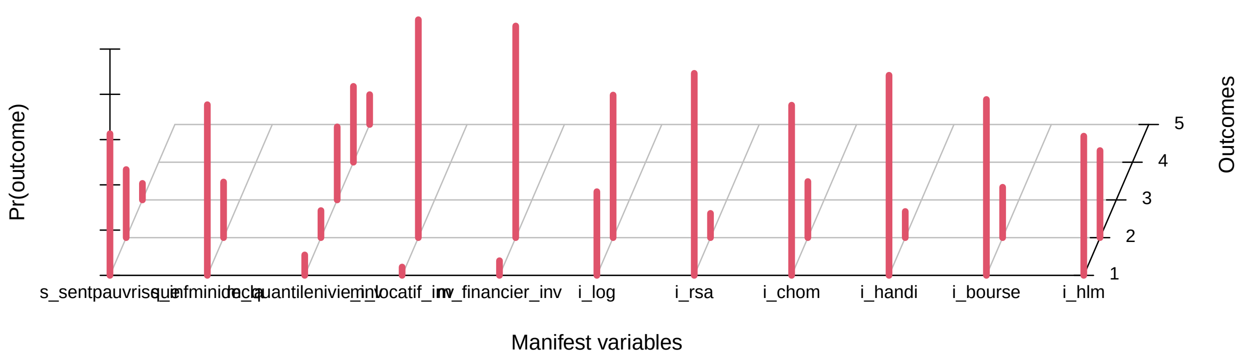
Classe B : part de la population = 30.5 %



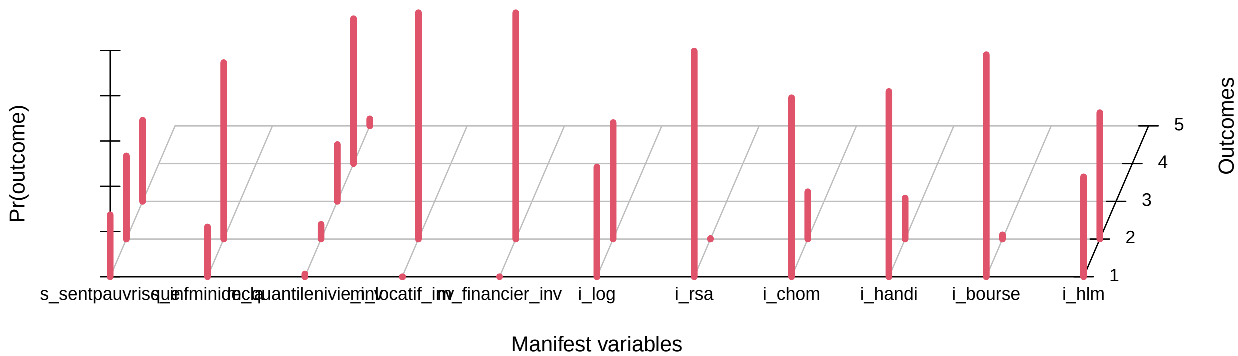
Classe C.1 : part de la population = 23.3 %



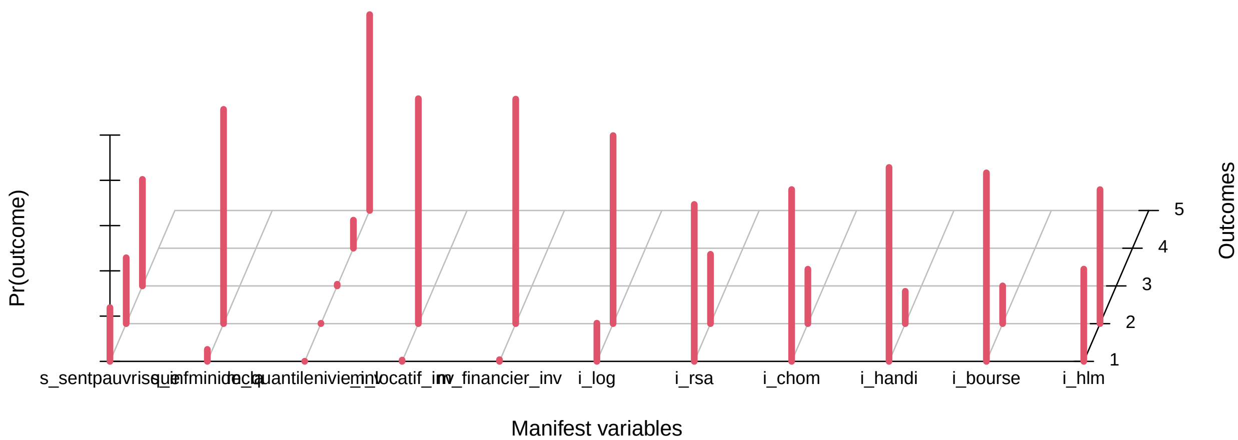
Classe C.2 : part de la population = 7.2 %



Classe D.1 : part de la population = 9.9 %



Classe D.2 : part de la population = 16.3 %

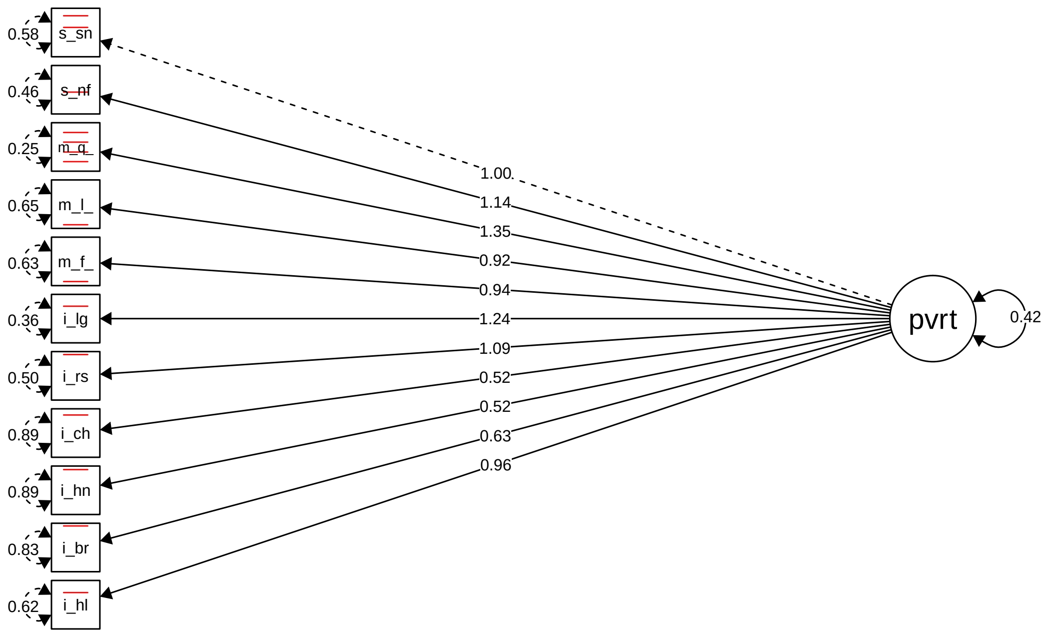


A1(bleu foncé) : Très riches A2(bleu moyen) : Riches B1 (violet foncé) : Q1 Q3 / **pas infminidecla** / pauvetrisque / **insti** B2(violet clair): Q1 Q3 / **infminidecla enorm** / pauvetrisque / **pas insti** C2(rose clair): Q1/ infminidecla / **sent pauv et risque** / **peu insti** C1(rose foncé) : Q2 / infminidecla / **sent pauv** / **inst**

3.4 Confirmatory factor analysis (CFA) des dimensions de la pauvreté

EFA and CFA are mathematically very similar, since we have the same fundamental equation in both cases. In EFA we assumed uncorrelated factors by setting

3.4.1 Modèle sans dimensions de la pauvreté



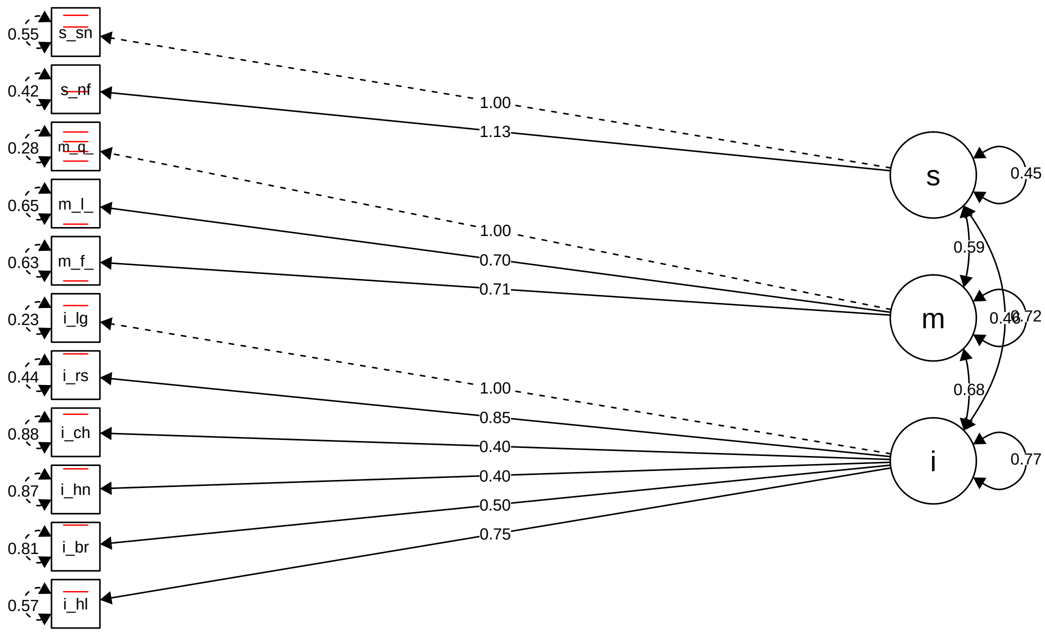

```
lavaan 0.6-8 ended normally after 19 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          26

  Number of observations                           13359

Model Test User Model:
                                              Standard      Robust
  Test Statistic                              1142.455    1398.800
  Degrees of freedom                                44          44
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.819
  Shift parameter                                            3.550
       simple second-order correction

Model Test Baseline Model:

  Test statistic                             53597.773   43159.977
  Degrees of freedom                                55          55
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.242

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.979       0.969
  Tucker-Lewis Index (TLI)                       0.974       0.961
```

```
  Robust Comparative Fit Index (CFI)                                 NA
  Robust Tucker-Lewis Index (TLI)                                    NA

Root Mean Square Error of Approximation:

  RMSEA                                          0.043       0.048
  90 Percent confidence interval - lower         0.041       0.046
  90 Percent confidence interval - upper         0.045       0.050
  P-value RMSEA <= 0.05                          1.000       0.933

  Robust RMSEA                                                 NA
  90 Percent confidence interval - lower                       NA
  90 Percent confidence interval - upper                       NA

Standardized Root Mean Square Residual:

  SRMR                                           0.079       0.079

Parameter Estimates:

  Standard errors                           Robust.sem
  Information                                 Expected
  Information saturated (h1) model        Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  pauvrete =~
    s_sentpauvrisq    1.000                               0.645    0.645
    s_infminidecla    1.142    0.018   64.093    0.000    0.736    0.736
    m_quantilnv_nv    1.346    0.018   73.191    0.000    0.868    0.868
    m_locatif_inv     0.921    0.025   36.913    0.000    0.594    0.594
    m_financier_nv    0.942    0.024   39.561    0.000    0.607    0.607
    i_log             1.241    0.018   68.625    0.000    0.800    0.800
    i_rsa             1.092    0.021   51.013    0.000    0.704    0.704
    i_chom            0.518    0.022   23.300    0.000    0.334    0.334
    i_handi           0.519    0.026   20.002    0.000    0.335    0.335
    i_bourse          0.632    0.027   23.774    0.000    0.408    0.408
    i_hlm             0.956    0.018   51.721    0.000    0.616    0.616

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .s_sentpauvrisq    0.000                               0.000    0.000
   .s_infminidecla    0.000                               0.000    0.000
   .m_quantilnv_nv    0.000                               0.000    0.000
   .m_locatif_inv     0.000                               0.000    0.000
   .m_financier_nv    0.000                               0.000    0.000
   .i_log             0.000                               0.000    0.000
   .i_rsa             0.000                               0.000    0.000
   .i_chom            0.000                               0.000    0.000
```

```
   .i_handi          0.000                               0.000    0.000
   .i_bourse         0.000                               0.000    0.000
   .i_hlm            0.000                               0.000    0.000
    pauvrete         0.000                               0.000    0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    s_sentpvrsq|t1    0.267    0.011   24.326    0.000    0.267    0.267
    s_sentpvrsq|t2    1.020    0.013   77.484    0.000    1.020    1.020
    s_infmindcl|t1   -0.123    0.011  -11.357    0.000   -0.123   -0.123
    m_qntlnv_nv|t1   -0.852    0.012  -68.664    0.000   -0.852   -0.852
    m_qntlnv_nv|t2   -0.266    0.011  -24.223    0.000   -0.266   -0.266
    m_qntlnv_nv|t3    0.252    0.011   22.964    0.000    0.252    0.252
    m_qntlnv_nv|t4    0.836    0.012   67.760    0.000    0.836    0.836
    m_locatf_nv|t1   -1.435    0.016  -89.369    0.000   -1.435   -1.435
    m_finncr_nv|t1   -1.380    0.016  -88.614    0.000   -1.380   -1.380
    i_log|t1          0.693    0.012   58.531    0.000    0.693    0.693
    i_rsa|t1          1.543    0.017   90.111    0.000    1.543    1.543
    i_chom|t1         1.139    0.014   82.368    0.000    1.139    1.139
    i_handi|t1        1.451    0.016   89.539    0.000    1.451    1.451
    i_bourse|t1       1.593    0.018   90.139    0.000    1.593    1.593
    i_hlm|t1          0.675    0.012   57.238    0.000    0.675    0.675

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .s_sentpauvrisq    0.584                               0.584    0.584
   .s_infminidecla    0.458                               0.458    0.458
   .m_quantilnv_nv    0.246                               0.246    0.246
   .m_locatif_inv     0.647                               0.647    0.647
   .m_financier_nv    0.631                               0.631    0.631
   .i_log             0.359                               0.359    0.359
   .i_rsa             0.504                               0.504    0.504
   .i_chom            0.888                               0.888    0.888
   .i_handi           0.888                               0.888    0.888
   .i_bourse          0.834                               0.834    0.834
   .i_hlm             0.620                               0.620    0.620
    pauvrete          0.416    0.010   40.495    0.000    1.000    1.000

Scales y*:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    s_sentpauvrisq    1.000                               1.000    1.000
    s_infminidecla    1.000                               1.000    1.000
    m_quantilnv_nv    1.000                               1.000    1.000
    m_locatif_inv     1.000                               1.000    1.000
    m_financier_nv    1.000                               1.000    1.000
    i_log             1.000                               1.000    1.000
    i_rsa             1.000                               1.000    1.000
    i_chom            1.000                               1.000    1.000
    i_handi           1.000                               1.000    1.000
```

```
    i_bourse          1.000                                    1.000    1.000
    i_hlm             1.000                                    1.000    1.000
```

3.4.2 Modèle avec 3 dimensions de la pauvreté (i,m,s)




```
lavaan 0.6-8 ended normally after 22 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          29

  Number of observations                           13359

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               792.116     979.597
  Degrees of freedom                                41          41
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.811
  Shift parameter                                            2.975
       simple second-order correction

Model Test Baseline Model:

  Test statistic                             53597.773   43159.977
  Degrees of freedom                                55          55
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.242

User Model versus Baseline Model:
```

```
  Comparative Fit Index (CFI)                    0.986       0.978
  Tucker-Lewis Index (TLI)                       0.981       0.971

  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Root Mean Square Error of Approximation:

  RMSEA                                          0.037       0.041
  90 Percent confidence interval - lower         0.035       0.039
  90 Percent confidence interval - upper         0.039       0.044
  P-value RMSEA <= 0.05                          1.000       1.000

  Robust RMSEA                                                  NA
  90 Percent confidence interval - lower                        NA
  90 Percent confidence interval - upper                        NA

Standardized Root Mean Square Residual:

  SRMR                                           0.073       0.073

Parameter Estimates:

  Standard errors                           Robust.sem
  Information                                 Expected
  Information saturated (h1) model        Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  s =~
    s_sentpauvrisq    1.000                                0.674    0.674
    s_infminidecla    1.132    0.018   63.490    0.000    0.763    0.763
  m =~
    m_quantilnv_nv    1.000                                0.846    0.846
    m_locatif_inv     0.698    0.019   36.523    0.000    0.590    0.590
    m_financier_nv    0.714    0.018   39.366    0.000    0.604    0.604
  i =~
    i_log             1.000                                0.880    0.880
    i_rsa             0.847    0.015   55.299    0.000    0.746    0.746
    i_chom            0.401    0.017   23.587    0.000    0.353    0.353
    i_handi           0.403    0.020   20.465    0.000    0.355    0.355
    i_bourse          0.497    0.020   25.268    0.000    0.437    0.437
    i_hlm             0.746    0.013   56.923    0.000    0.656    0.656

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  s ~~
    m                 0.589    0.008   74.532    0.000    1.034    1.034
```

```
    i                 0.462    0.009   50.563    0.000    0.779    0.779
  m ~~
    i                 0.681    0.008   90.677    0.000    0.916    0.916

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .s_sentpauvrisq    0.000                               0.000    0.000
   .s_infminidecla    0.000                               0.000    0.000
   .m_quantilnv_nv    0.000                               0.000    0.000
   .m_locatif_inv     0.000                               0.000    0.000
   .m_financier_nv    0.000                               0.000    0.000
   .i_log             0.000                               0.000    0.000
   .i_rsa             0.000                               0.000    0.000
   .i_chom            0.000                               0.000    0.000
   .i_handi           0.000                               0.000    0.000
   .i_bourse          0.000                               0.000    0.000
   .i_hlm             0.000                               0.000    0.000
    s                 0.000                               0.000    0.000
    m                 0.000                               0.000    0.000
    i                 0.000                               0.000    0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    s_sentpvrsq|t1    0.267    0.011   24.326    0.000    0.267    0.267
    s_sentpvrsq|t2    1.020    0.013   77.484    0.000    1.020    1.020
    s_infmindcl|t1   -0.123    0.011  -11.357    0.000   -0.123   -0.123
    m_qntlnv_nv|t1   -0.852    0.012  -68.664    0.000   -0.852   -0.852
    m_qntlnv_nv|t2   -0.266    0.011  -24.223    0.000   -0.266   -0.266
    m_qntlnv_nv|t3    0.252    0.011   22.964    0.000    0.252    0.252
    m_qntlnv_nv|t4    0.836    0.012   67.760    0.000    0.836    0.836
    m_locatf_nv|t1   -1.435    0.016  -89.369    0.000   -1.435   -1.435
    m_finncr_nv|t1   -1.380    0.016  -88.614    0.000   -1.380   -1.380
    i_log|t1          0.693    0.012   58.531    0.000    0.693    0.693
    i_rsa|t1          1.543    0.017   90.111    0.000    1.543    1.543
    i_chom|t1         1.139    0.014   82.368    0.000    1.139    1.139
    i_handi|t1        1.451    0.016   89.539    0.000    1.451    1.451
    i_bourse|t1       1.593    0.018   90.139    0.000    1.593    1.593
    i_hlm|t1          0.675    0.012   57.238    0.000    0.675    0.675

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .s_sentpauvrisq    0.546                               0.546    0.546
   .s_infminidecla    0.418                               0.418    0.418
   .m_quantilnv_nv    0.285                               0.285    0.285
   .m_locatif_inv     0.652                               0.652    0.652
   .m_financier_nv    0.635                               0.635    0.635
   .i_log             0.226                               0.226    0.226
   .i_rsa             0.444                               0.444    0.444
   .i_chom            0.875                               0.875    0.875
```

```
   .i_handi           0.874                                   0.874    0.874
   .i_bourse          0.809                                   0.809    0.809
   .i_hlm             0.569                                   0.569    0.569
    s                 0.454    0.012   37.338    0.000    1.000    1.000
    m                 0.715    0.015   46.200    0.000    1.000    1.000
    i                 0.774    0.014   55.899    0.000    1.000    1.000

Scales y*:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    s_sentpauvrisq    1.000                               1.000    1.000
    s_infminidecla    1.000                               1.000    1.000
    m_quantilnv_nv    1.000                               1.000    1.000
    m_locatif_inv     1.000                               1.000    1.000
    m_financier_nv    1.000                               1.000    1.000
    i_log             1.000                               1.000    1.000
    i_rsa             1.000                               1.000    1.000
    i_chom            1.000                               1.000    1.000
    i_handi           1.000                               1.000    1.000
    i_bourse          1.000                               1.000    1.000
    i_hlm             1.000                               1.000    1.000
```

- p-valeur du test du chi-2 de 0, très mauvais car un résultat non significatif veut dire que le modèle “fits” mais il ne faut pas faire très attention à cette statistique car elle est très souvent significative quand l'échantillon est grand.
- Le CFI doit être supérieur à 0,95.
- Le RMSEA doit être dans l'intervalle [0.05,0.10].
- Le SRMR doit être inférieur à 0.08.

3.4.3 Comment améliorer le modèle ?

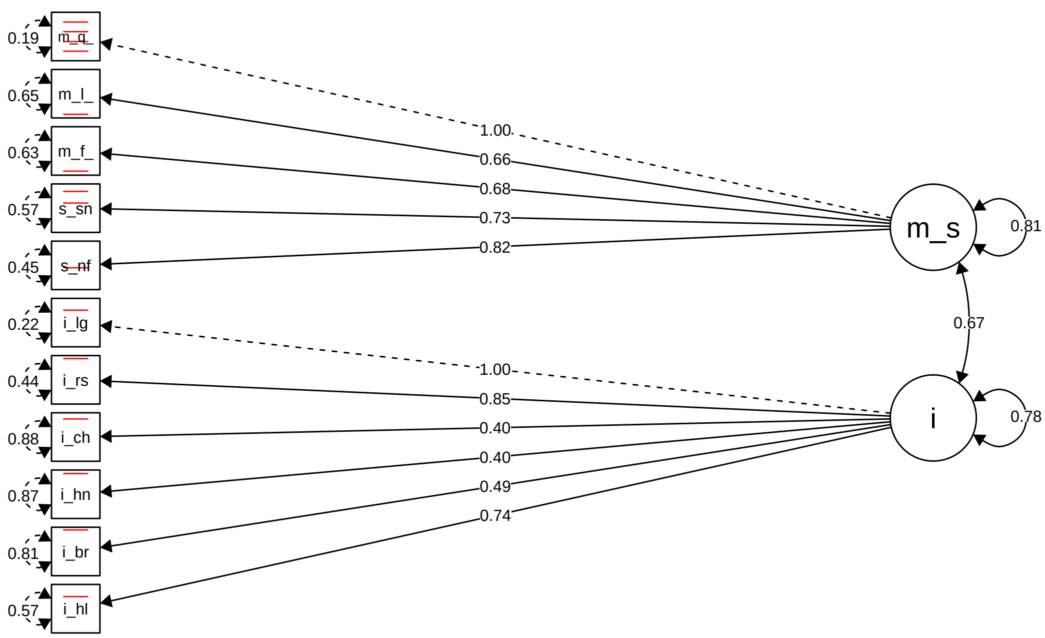
```
  lhs op                  rhs   est    se      z pvalue ci.lower ci.upper
1   s =~    s_sentpauvrisque 1.000 0.000     NA     NA    1.000    1.000
2   s =~      s_infminidecla 1.132 0.018 63.490      0    1.097    1.167
3   m =~ m_quantilenivie_inv 1.000 0.000     NA     NA    1.000    1.000
4   m =~       m_locatif_inv 0.698 0.019 36.523      0    0.660    0.735
5   m =~     m_financier_inv 0.714 0.018 39.366      0    0.679    0.750
6   i =~               i_log 1.000 0.000     NA     NA    1.000    1.000
```

```
  id              lhs            rhs  nobs row col obs.freq obs.prop est.prop
1  1 s_sentpauvrisque s_infminidecla 13359   1   1     4704    0.352    0.354
2  1 s_sentpauvrisque s_infminidecla 13359   2   1     1038    0.078    0.074
3  1 s_sentpauvrisque s_infminidecla 13359   3   1      281    0.021    0.023
4  1 s_sentpauvrisque s_infminidecla 13359   1   2     3383    0.253    0.251
5  1 s_sentpauvrisque s_infminidecla 13359   2   2     2179    0.163    0.167
6  1 s_sentpauvrisque s_infminidecla 13359   3   2     1774    0.133    0.131
     X2
1 0.133
2 2.975
3 2.725
4 0.187
```

```
5 1.311
6 0.484
```

```
                 lhs  op                  rhs        mi    epc sepc.lv sepc.all
44  s_sentpauvrisque ~*~    s_sentpauvrisque 32617.545 47.544  47.544    1.000
1                  s  =~    s_sentpauvrisque 32617.545 47.544  32.032   32.032
78                 m  =~    s_sentpauvrisque 12979.550 13.128  11.101   11.101
86                 i  =~    s_sentpauvrisque  3597.071  3.394   2.986    2.986
101   s_infminidecla  ~~ m_quantilenivie_inv   926.292  0.378   0.378    1.097
45    s_infminidecla ~*~      s_infminidecla   657.697  0.587   0.587    1.000
    sepc.nox
44     1.000
1     32.032
78    11.101
86     2.986
101    1.097
45     1.000
```

3.4.4 Modèle avec 2 dimensions de la pauvreté (i,m+s) comme dans EFA




```
lavaan 0.6-8 ended normally after 20 iterations

  Estimator                                       DWLS
  Optimization method                           NLMINB
  Number of model parameters                        27

  Number of observations                         13359

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               857.410    1054.887
```

```
  Degrees of freedom                                43          43
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.815
  Shift parameter                                            3.368
       simple second-order correction

Model Test Baseline Model:

  Test statistic                             53597.773   43159.977
  Degrees of freedom                                55          55
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.242

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.985       0.977
  Tucker-Lewis Index (TLI)                       0.981       0.970

  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Root Mean Square Error of Approximation:

  RMSEA                                          0.038       0.042
  90 Percent confidence interval - lower         0.035       0.040
  90 Percent confidence interval - upper         0.040       0.044
  P-value RMSEA <= 0.05                          1.000       1.000

  Robust RMSEA                                                  NA
  90 Percent confidence interval - lower                        NA
  90 Percent confidence interval - upper                        NA

Standardized Root Mean Square Residual:

  SRMR                                           0.072       0.072

Parameter Estimates:

  Standard errors                           Robust.sem
  Information                                 Expected
  Information saturated (h1) model        Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  m_s =~
    m_quantilnv_nv    1.000                                0.900    0.900
    m_locatif_inv     0.660    0.017   39.376    0.000    0.595    0.595
    m_financier_nv    0.677    0.016   42.759    0.000    0.610    0.610
    s_sentpauvrisq    0.727    0.010   70.919    0.000    0.654    0.654
```

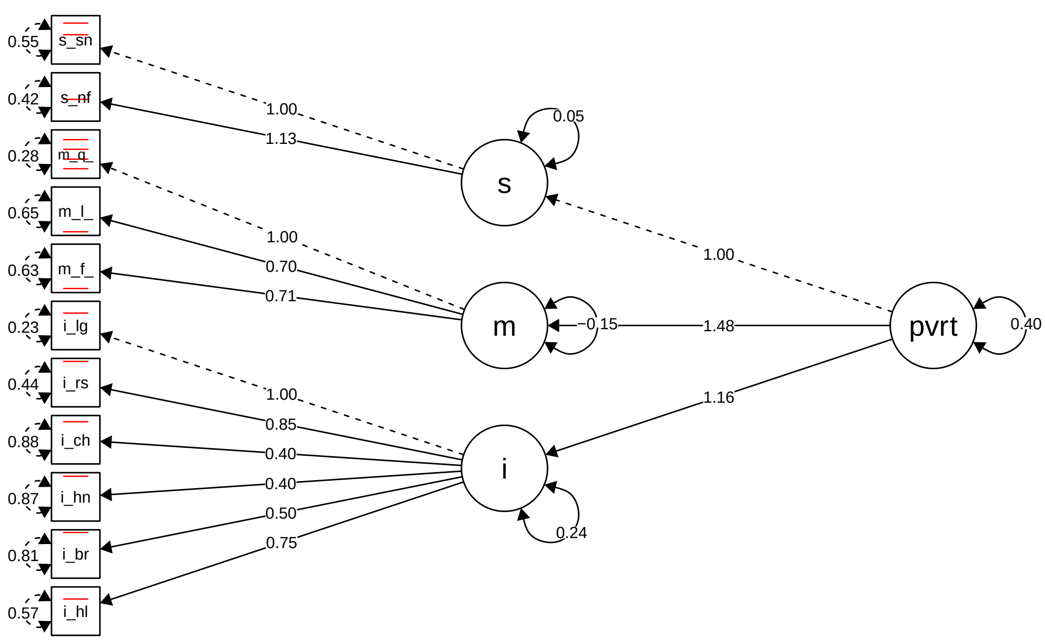
```
    s_infminidecla    0.823    0.011   74.334    0.000    0.741    0.741
  i =~
    i_log             1.000                               0.881    0.881
    i_rsa             0.847    0.015   55.154    0.000    0.746    0.746
    i_chom            0.401    0.017   23.604    0.000    0.353    0.353
    i_handi           0.403    0.020   20.519    0.000    0.355    0.355
    i_bourse          0.495    0.020   25.172    0.000    0.436    0.436
    i_hlm             0.743    0.013   56.793    0.000    0.655    0.655

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  m_s ~~
    i                 0.670    0.007   89.840    0.000    0.845    0.845

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .m_quantilnv_nv    0.000                               0.000    0.000
   .m_locatif_inv     0.000                               0.000    0.000
   .m_financier_nv    0.000                               0.000    0.000
   .s_sentpauvrisq    0.000                               0.000    0.000
   .s_infminidecla    0.000                               0.000    0.000
   .i_log             0.000                               0.000    0.000
   .i_rsa             0.000                               0.000    0.000
   .i_chom            0.000                               0.000    0.000
   .i_handi           0.000                               0.000    0.000
   .i_bourse          0.000                               0.000    0.000
   .i_hlm             0.000                               0.000    0.000
    m_s               0.000                               0.000    0.000
    i                 0.000                               0.000    0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    m_qntlnv_nv|t1   -0.852    0.012  -68.664    0.000   -0.852   -0.852
    m_qntlnv_nv|t2   -0.266    0.011  -24.223    0.000   -0.266   -0.266
    m_qntlnv_nv|t3    0.252    0.011   22.964    0.000    0.252    0.252
    m_qntlnv_nv|t4    0.836    0.012   67.760    0.000    0.836    0.836
    m_locatf_nv|t1   -1.435    0.016  -89.369    0.000   -1.435   -1.435
    m_finncr_nv|t1   -1.380    0.016  -88.614    0.000   -1.380   -1.380
    s_sentpvrsq|t1    0.267    0.011   24.326    0.000    0.267    0.267
    s_sentpvrsq|t2    1.020    0.013   77.484    0.000    1.020    1.020
    s_infmindcl|t1   -0.123    0.011  -11.357    0.000   -0.123   -0.123
    i_log|t1          0.693    0.012   58.531    0.000    0.693    0.693
    i_rsa|t1          1.543    0.017   90.111    0.000    1.543    1.543
    i_chom|t1         1.139    0.014   82.368    0.000    1.139    1.139
    i_handi|t1        1.451    0.016   89.539    0.000    1.451    1.451
    i_bourse|t1       1.593    0.018   90.139    0.000    1.593    1.593
    i_hlm|t1          0.675    0.012   57.238    0.000    0.675    0.675

Variances:
```

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.m_quantilnv_nv	0.189				0.189	0.189
.m_locatif_inv	0.646				0.646	0.646
.m_financier_nv	0.628				0.628	0.628
.s_sentpauvrisq	0.572				0.572	0.572
.s_infminidecla	0.451				0.451	0.451
.i_log	0.224				0.224	0.224
.i_rsa	0.443				0.443	0.443
.i_chom	0.875				0.875	0.875
.i_handi	0.874				0.874	0.874
.i_bourse	0.810				0.810	0.810
.i_hlm	0.571				0.571	0.571
m_s	0.811	0.010	82.529	0.000	1.000	1.000
i	0.776	0.014	55.869	0.000	1.000	1.000

Scales y*:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
m_quantilnv_nv	1.000				1.000	1.000
m_locatif_inv	1.000				1.000	1.000
m_financier_nv	1.000				1.000	1.000
s_sentpauvrisq	1.000				1.000	1.000
s_infminidecla	1.000				1.000	1.000
i_log	1.000				1.000	1.000
i_rsa	1.000				1.000	1.000
i_chom	1.000				1.000	1.000
i_handi	1.000				1.000	1.000
i_bourse	1.000				1.000	1.000
i_hlm	1.000				1.000	1.000

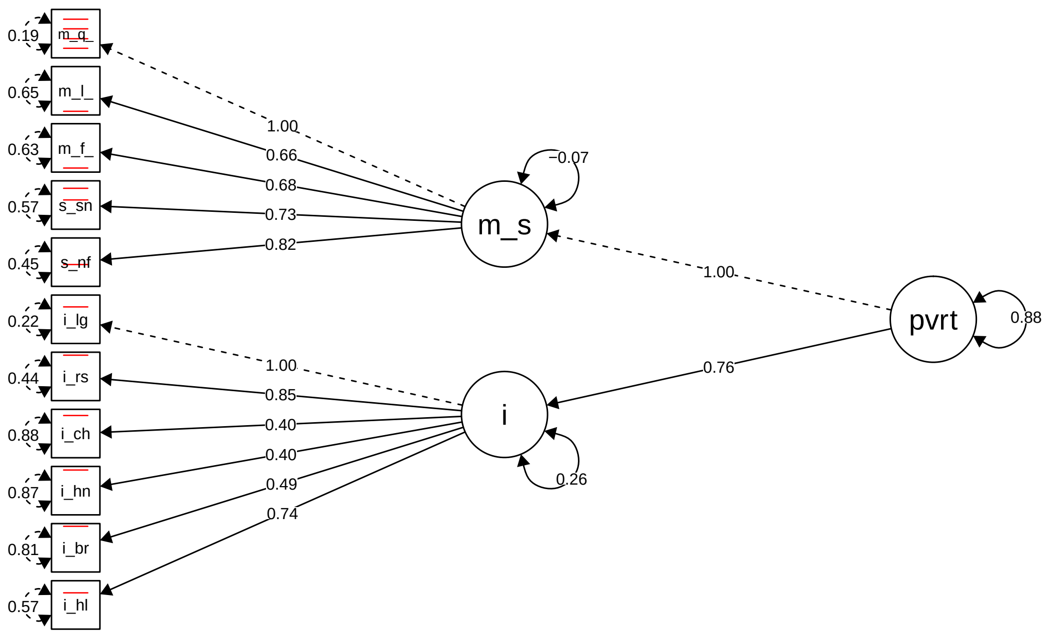
3.4.5 CFA hiérarchique



```
lavaan 0.6-8 ended normally after 30 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          29

  Number of observations                           13359

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               792.116     979.597
  Degrees of freedom                                41          41
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.811
  Shift parameter                                            2.975
       simple second-order correction

Model Test Baseline Model:

  Test statistic                             53597.773   43159.977
  Degrees of freedom                                55          55
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.242

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.986       0.978
  Tucker-Lewis Index (TLI)                       0.981       0.971

  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Root Mean Square Error of Approximation:

  RMSEA                                          0.037       0.041
  90 Percent confidence interval - lower         0.035       0.039
  90 Percent confidence interval - upper         0.039       0.044
  P-value RMSEA <= 0.05                          1.000       1.000

  Robust RMSEA                                                  NA
  90 Percent confidence interval - lower                        NA
  90 Percent confidence interval - upper                        NA

Standardized Root Mean Square Residual:

  SRMR                                           0.073       0.073

Parameter Estimates:
```

```
  Standard errors                           Robust.sem
  Information                                 Expected
  Information saturated (h1) model        Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  s =~
    s_sentpauvrisq    1.000                               0.674    0.674
    s_infminidecla    1.132    0.018   63.490    0.000    0.763    0.763
  m =~
    m_quantilnv_nv    1.000                               0.846    0.846
    m_locatif_inv     0.698    0.019   36.523    0.000    0.590    0.590
    m_financier_nv    0.714    0.018   39.366    0.000    0.604    0.604
  i =~
    i_log             1.000                               0.880    0.880
    i_rsa             0.847    0.015   55.299    0.000    0.746    0.746
    i_chom            0.401    0.017   23.587    0.000    0.353    0.353
    i_handi           0.403    0.020   20.465    0.000    0.355    0.355
    i_bourse          0.497    0.020   25.268    0.000    0.437    0.437
    i_hlm             0.746    0.013   56.923    0.000    0.656    0.656
  pauvrete =~
    s                 1.000                               0.938    0.938
    m                 1.476    0.026   57.362    0.000    1.103    1.103
    i                 1.156    0.019   62.405    0.000    0.830    0.830

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .s_sentpauvrisq    0.000                               0.000    0.000
   .s_infminidecla    0.000                               0.000    0.000
   .m_quantilnv_nv    0.000                               0.000    0.000
   .m_locatif_inv     0.000                               0.000    0.000
   .m_financier_nv    0.000                               0.000    0.000
   .i_log             0.000                               0.000    0.000
   .i_rsa             0.000                               0.000    0.000
   .i_chom            0.000                               0.000    0.000
   .i_handi           0.000                               0.000    0.000
   .i_bourse          0.000                               0.000    0.000
   .i_hlm             0.000                               0.000    0.000
   .s                 0.000                               0.000    0.000
   .m                 0.000                               0.000    0.000
   .i                 0.000                               0.000    0.000
    pauvrete          0.000                               0.000    0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    s_sentpvrsq|t1    0.267    0.011   24.326    0.000    0.267    0.267
    s_sentpvrsq|t2    1.020    0.013   77.484    0.000    1.020    1.020
    s_infmindcl|t1   -0.123    0.011  -11.357    0.000   -0.123   -0.123
    m_qntlnv_nv|t1   -0.852    0.012  -68.664    0.000   -0.852   -0.852
```

```
    m_qntlnv_nv|t2   -0.266    0.011  -24.223    0.000   -0.266   -0.266
    m_qntlnv_nv|t3    0.252    0.011   22.964    0.000    0.252    0.252
    m_qntlnv_nv|t4    0.836    0.012   67.760    0.000    0.836    0.836
    m_locatf_nv|t1   -1.435    0.016  -89.369    0.000   -1.435   -1.435
    m_finncr_nv|t1   -1.380    0.016  -88.614    0.000   -1.380   -1.380
    i_log|t1          0.693    0.012   58.531    0.000    0.693    0.693
    i_rsa|t1          1.543    0.017   90.111    0.000    1.543    1.543
    i_chom|t1         1.139    0.014   82.368    0.000    1.139    1.139
    i_handi|t1        1.451    0.016   89.539    0.000    1.451    1.451
    i_bourse|t1       1.593    0.018   90.139    0.000    1.593    1.593
    i_hlm|t1          0.675    0.012   57.238    0.000    0.675    0.675

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .s_sentpauvrisq    0.546                               0.546    0.546
   .s_infminidecla    0.418                               0.418    0.418
   .m_quantilnv_nv    0.285                               0.285    0.285
   .m_locatif_inv     0.652                               0.652    0.652
   .m_financier_nv    0.635                               0.635    0.635
   .i_log             0.226                               0.226    0.226
   .i_rsa             0.444                               0.444    0.444
   .i_chom            0.875                               0.875    0.875
   .i_handi           0.874                               0.874    0.874
   .i_bourse          0.809                               0.809    0.809
   .i_hlm             0.569                               0.569    0.569
   .s                 0.055    0.010    5.614    0.000    0.120    0.120
   .m                -0.155    0.018   -8.516    0.000   -0.216   -0.216
   .i                 0.240    0.013   17.828    0.000    0.310    0.310
    pauvrete          0.399    0.011   36.427    0.000    1.000    1.000

Scales y*:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    s_sentpauvrisq    1.000                               1.000    1.000
    s_infminidecla    1.000                               1.000    1.000
    m_quantilnv_nv    1.000                               1.000    1.000
    m_locatif_inv     1.000                               1.000    1.000
    m_financier_nv    1.000                               1.000    1.000
    i_log             1.000                               1.000    1.000
    i_rsa             1.000                               1.000    1.000
    i_chom            1.000                               1.000    1.000
    i_handi           1.000                               1.000    1.000
    i_bourse          1.000                               1.000    1.000
    i_hlm             1.000                               1.000    1.000
```




```
lavaan 0.6-8 ended normally after 20 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          28

  Number of observations                           13359

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               857.410     857.410
  Degrees of freedom                                42          42
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                     NA
  Shift parameter
                                                            Robust

Model Test Baseline Model:

  Test statistic                             53597.773   43159.977
  Degrees of freedom                                55          55
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.242

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.985       0.981
  Tucker-Lewis Index (TLI)                       0.980       0.975

  Robust Comparative Fit Index (CFI)                            NA
```

```
  Robust Tucker-Lewis Index (TLI)                               NA

Root Mean Square Error of Approximation:

  RMSEA                                         0.038       0.038
  90 Percent confidence interval - lower        0.036       0.036
  90 Percent confidence interval - upper        0.040       0.040
  P-value RMSEA <= 0.05                         1.000       1.000

  Robust RMSEA                                                  NA
  90 Percent confidence interval - lower                        NA
  90 Percent confidence interval - upper                        NA

Standardized Root Mean Square Residual:

  SRMR                                          0.072       0.072

Parameter Estimates:

  Standard errors                          Robust.sem
  Information                                Expected
  Information saturated (h1) model       Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  m_s =~
    m_quantilnv_nv    1.000                                0.900    0.900
    m_locatif_inv     0.660       NA                       0.595    0.595
    m_financier_nv    0.677       NA                       0.610    0.610
    s_sentpauvrisq    0.727       NA                       0.654    0.654
    s_infminidecla    0.823       NA                       0.741    0.741
  i =~
    i_log             1.000                                0.881    0.881
    i_rsa             0.847       NA                       0.746    0.746
    i_chom            0.401       NA                       0.353    0.353
    i_handi           0.403       NA                       0.355    0.355
    i_bourse          0.495       NA                       0.436    0.436
    i_hlm             0.743       NA                       0.655    0.655
  pauvrete =~
    m_s               1.000                                1.041    1.041
    i                 0.763       NA                       0.812    0.812

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .m_quantilnv_nv    0.000                                0.000    0.000
   .m_locatif_inv     0.000                                0.000    0.000
   .m_financier_nv    0.000                                0.000    0.000
   .s_sentpauvrisq    0.000                                0.000    0.000
   .s_infminidecla    0.000                                0.000    0.000
```

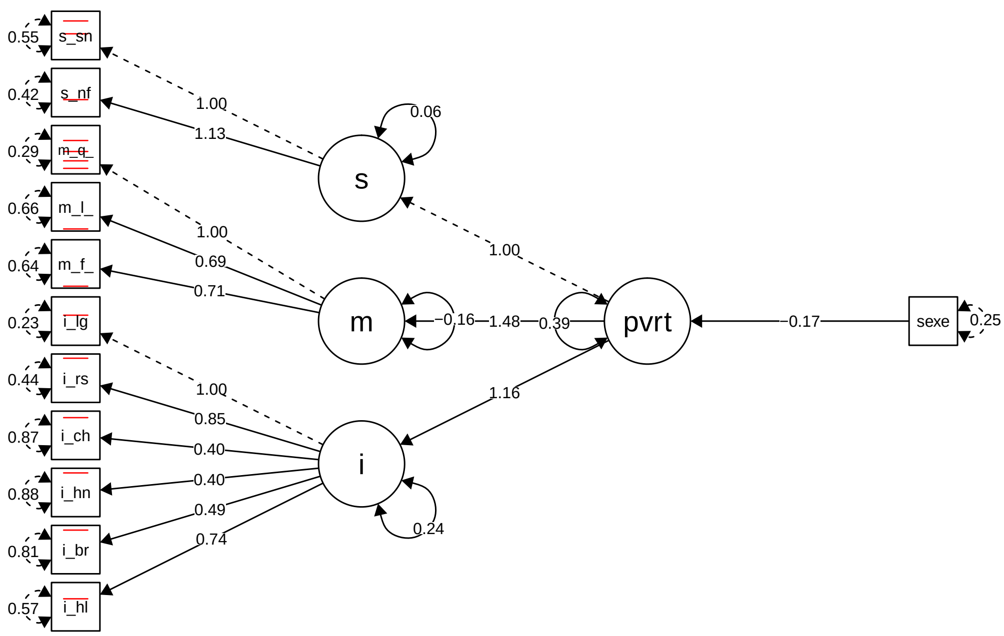
```
   .i_log             0.000                                      0.000    0.000
   .i_rsa             0.000                                      0.000    0.000
   .i_chom            0.000                                      0.000    0.000
   .i_handi           0.000                                      0.000    0.000
   .i_bourse          0.000                                      0.000    0.000
   .i_hlm             0.000                                      0.000    0.000
   .m_s               0.000                                      0.000    0.000
   .i                 0.000                                      0.000    0.000
    pauvrete          0.000                                      0.000    0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    m_qntlnv_nv|t1   -0.852       NA                     -0.852   -0.852
    m_qntlnv_nv|t2   -0.266       NA                     -0.266   -0.266
    m_qntlnv_nv|t3    0.252       NA                      0.252    0.252
    m_qntlnv_nv|t4    0.836       NA                      0.836    0.836
    m_locatf_nv|t1   -1.435       NA                     -1.435   -1.435
    m_finncr_nv|t1   -1.380       NA                     -1.380   -1.380
    s_sentpvrsq|t1    0.267       NA                      0.267    0.267
    s_sentpvrsq|t2    1.020       NA                      1.020    1.020
    s_infmindcl|t1   -0.123       NA                     -0.123   -0.123
    i_log|t1          0.693       NA                      0.693    0.693
    i_rsa|t1          1.543       NA                      1.543    1.543
    i_chom|t1         1.139       NA                      1.139    1.139
    i_handi|t1        1.451       NA                      1.451    1.451
    i_bourse|t1       1.593       NA                      1.593    1.593
    i_hlm|t1          0.675       NA                      0.675    0.675

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
   .m_quantilnv_nv    0.189                               0.189    0.189
   .m_locatif_inv     0.646                               0.646    0.646
   .m_financier_nv    0.628                               0.628    0.628
   .s_sentpauvrisq    0.572                               0.572    0.572
   .s_infminidecla    0.451                               0.451    0.451
   .i_log             0.224                               0.224    0.224
   .i_rsa             0.443                               0.443    0.443
   .i_chom            0.875                               0.875    0.875
   .i_handi           0.874                               0.874    0.874
   .i_bourse          0.810                               0.810    0.810
   .i_hlm             0.571                               0.571    0.571
   .m_s              -0.067       NA                     -0.083   -0.083
   .i                 0.265       NA                      0.341    0.341
    pauvrete          0.878       NA                      1.000    1.000

Scales y*:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    m_quantilnv_nv    1.000                               1.000    1.000
    m_locatif_inv     1.000                               1.000    1.000
```

```
m_financier_nv    1.000                                   1.000    1.000
s_sentpauvrisq    1.000                                   1.000    1.000
s_infminidecla    1.000                                   1.000    1.000
i_log             1.000                                   1.000    1.000
i_rsa             1.000                                   1.000    1.000
i_chom            1.000                                   1.000    1.000
i_handi           1.000                                   1.000    1.000
i_bourse          1.000                                   1.000    1.000
i_hlm             1.000                                   1.000    1.000
```

3.5 CFA avec des covariables (MIMIC)

MIMIC stands for multiple indicators multiple independent causes (Jöreskog and Goldberger, 1975) and is a general structural latent variable concept where CFA is extended in terms of linking covariates with latent variables. MIMIC models can be used to control for sociodemographic or other types of covariates in CFA and more general SEM specifications.

Remarque : ne marche qu'avec les covariates exogènes de moins de 2 facteurs (à transformer en indicatrices j'imagine)

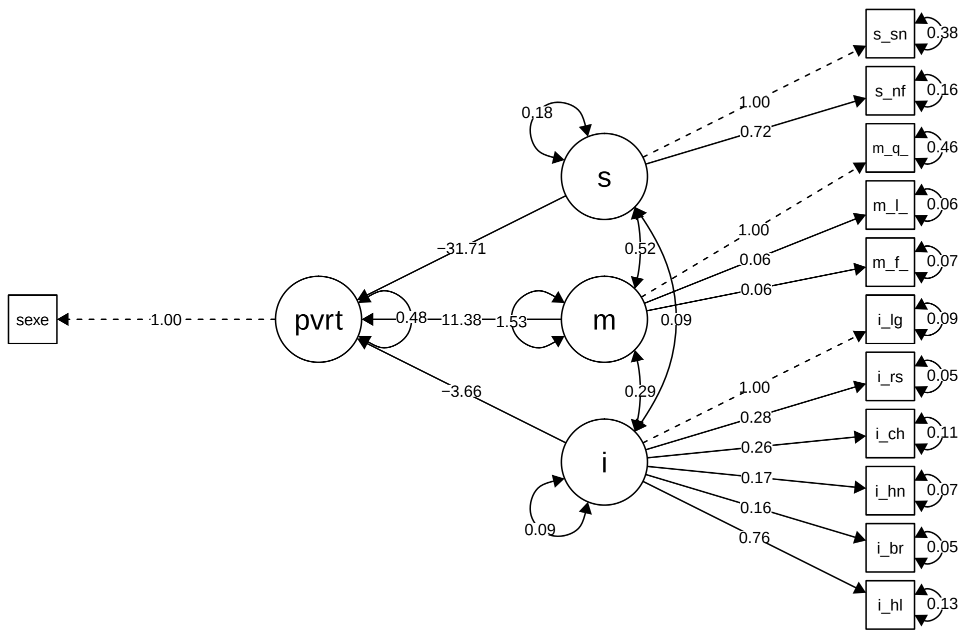


3.6 Structural equation models (SEM)

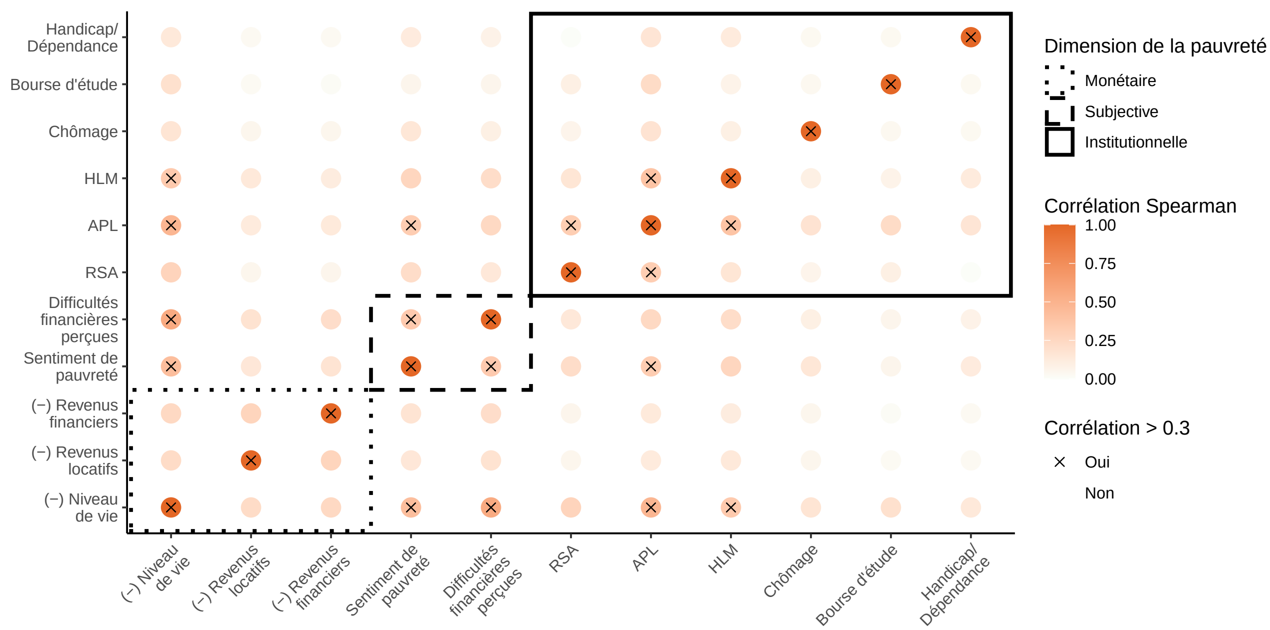
Structural equation models (SEM) integrate confirmatory factor analysis (CFA) into a larger path analytic framework. Formally, we extend the basic CFA expression (measurement model) by an additional linear specification reflecting dependencies among the latent variables (structural model).

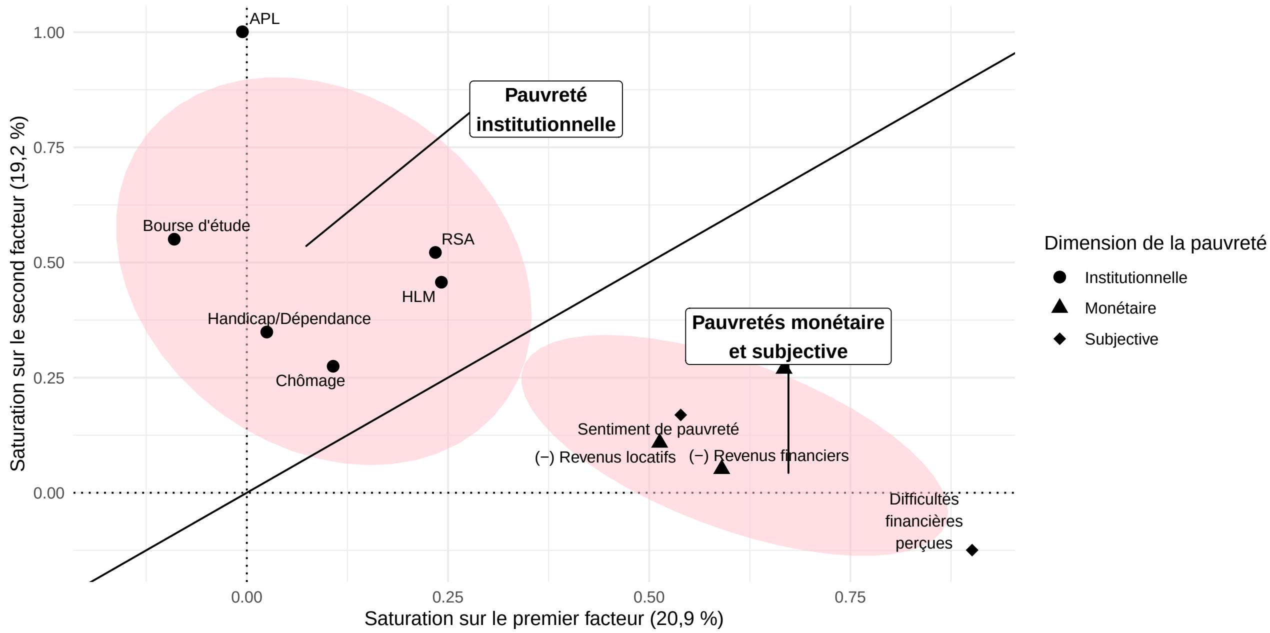
Remarque : ne marche pas pour les facteurs non ordonnés (en gros, considère les facteurs comme des variables numériques)

Remarque : estimator ML for ordered data is not supported yet. Use WLSMV instead.

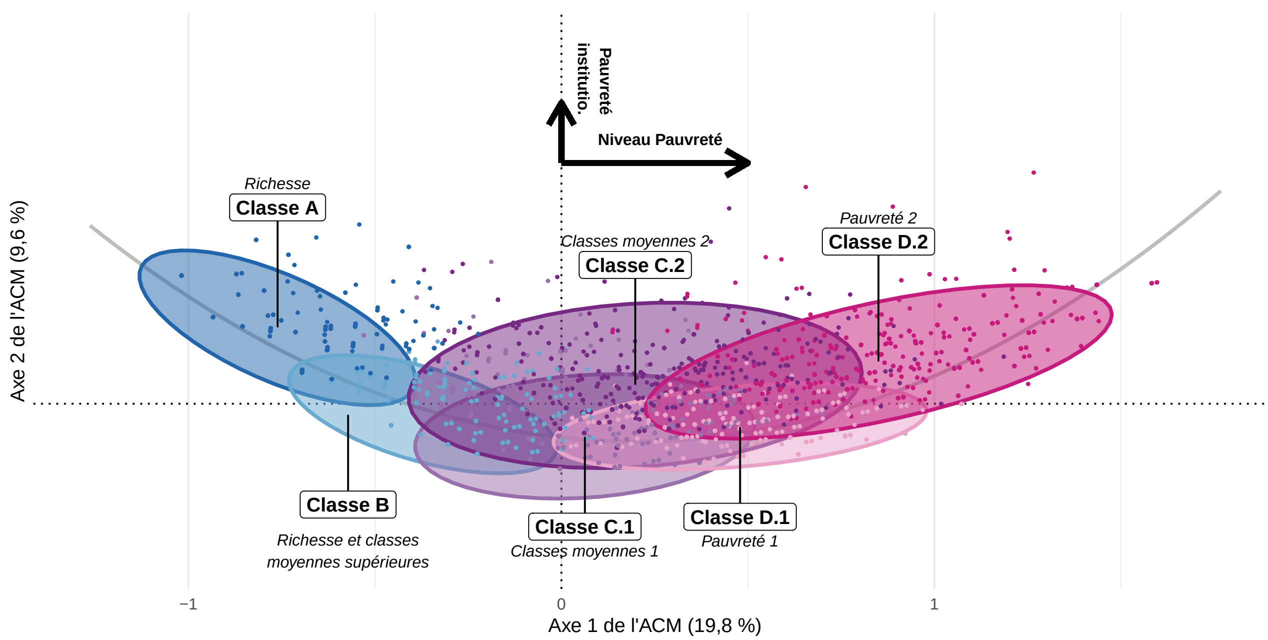


3.7 Figures rapport

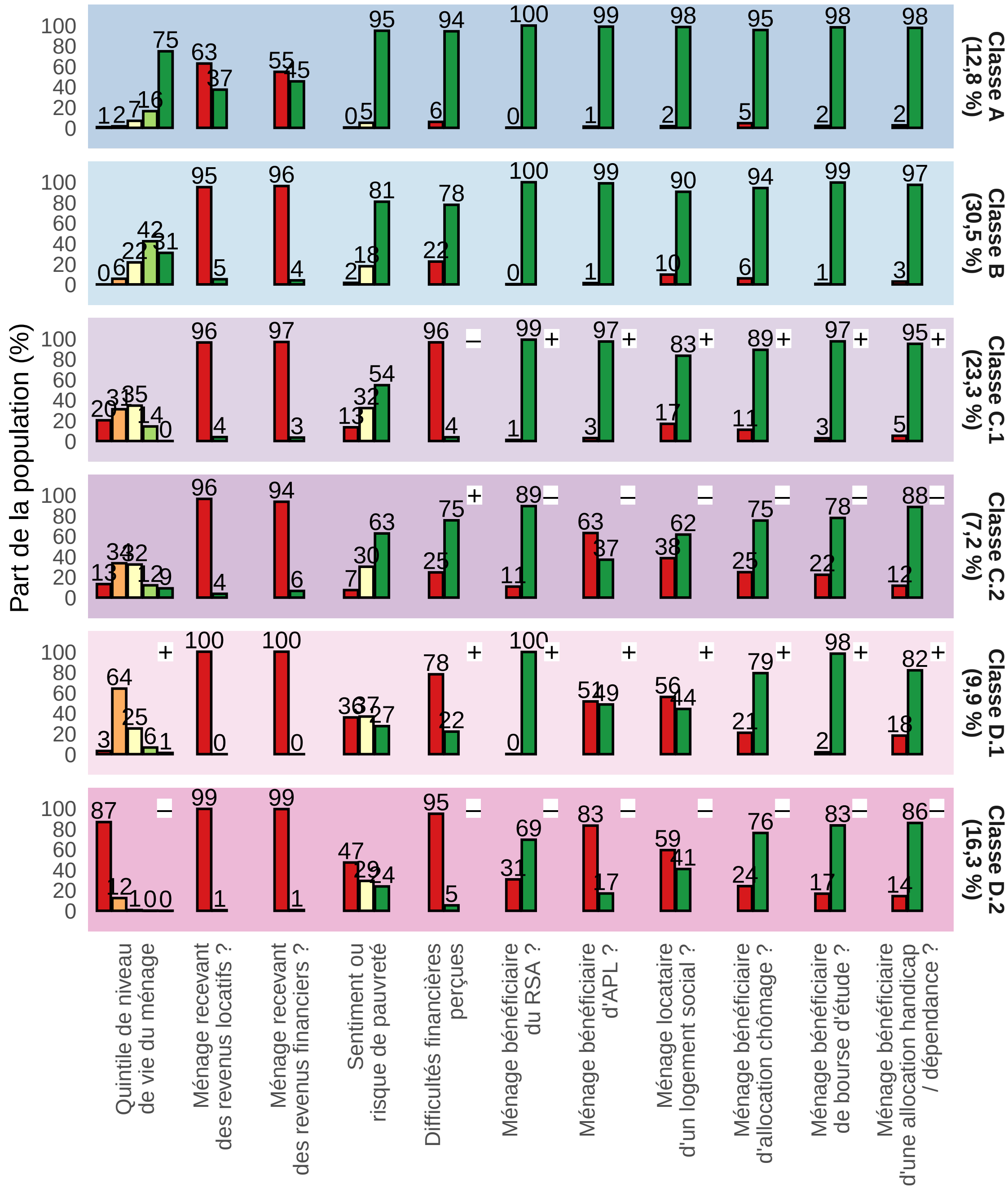




APL
Pauvreté institutionnelle
Bourse d'étude
RSA
HLM
Handicap/Dépendance
Chômage
Pauvretés monétaire et subjective
Sentiment de pauvreté
(−) Revenus locatifs
(−) Revenus financiers
Difficultés financières perçues
Saturation sur le second facteur (19,2 %)
Saturation sur le premier facteur (20,9 %)
1.00
0.75
0.50
0.25
0.00
0.00
0.25
0.50
0.75
Dimension de la pauvreté
Institutionnelle
Monétaire
Subjective



Pauvreté institutio.
Niveau Pauvreté
Richesse
Classe A
Classe B
Richesse et classes moyennes supérieures
Classes moyennes 2
Classe C.2
Classe C.1
Classes moyennes 1
Pauvreté 2
Classe D.2
Classe D.1
Pauvreté 1
Axe 2 de l'ACM (9,6 %)
Axe 1 de l'ACM (19,8 %)
−1
0
1



4 Notes méthodologiques

Pour ces modèles cinq vagues du Baromètre ont été empilées : 2015, 2016, 2017, 2018 et 2019 (15 137 observations). Le nombre d'observations utilisées est différent dans chaque modèle, il s'agit uniquement des individus où toutes les variables utilisées dans les modèles sont renseignées (voir notes en bas des tableaux).

Bibliographie

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— En bouquins : https://books.google.es/books?hl=fr&lr=&id=qKrumJ4CsboC&oi=fnd&pg=PT180&ots=TDmmzvQP5X&sig=7gFjzxbPC49Tz7IkGT-4gXMzx8U&redir_esc=y#v=onepage&q&f=false et slides https://slideplayer.com/slide/5080/

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