# metaVAR: Internal Tests

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## Tests

```
#> test-metaVAR-fit-ct-var-id-mx-theta-null
#> Running CTVAR with 12 parameters
#>
#> Beginning initial fit attempt
#> Running CTVAR with 12 parameters
#>
#>  Lowest minimum so far:   -2707.31197426421
#>
#> Solution found
```

```
#>
#>  Solution found!   Final fit=-2707.312 (started at -2583.5637)  (1 attempt(s):  1
valid, 0 errors)
#>  Start values from best fit:
#> -0.545410808015616,0.655791704057053,-0.4319181053049,0.0684713570989829,-0.1952231790709,0.85913
#> Running CTVAR with 12 parameters
#>
#> Beginning initial fit attempt
#> Running CTVAR with 12 parameters
#>
#>  Lowest minimum so far:   -2726.62588111983
#>
#> Solution found
```

```
#>
#>  Solution found!   Final fit=-2726.6259 (started at -2584.9163)  (1 attempt(s):
1 valid, 0 errors)
#>  Start values from best fit:
#> -0.213900151770005,0.861186849501166,-0.405561461480421,-0.131907517647472,-0.523808720935904,0.8
#> Running Model with 90 parameters
#>
#> Beginning initial fit attempt
#> Running Model with 90 parameters
```

```
#>
#>  Lowest minimum so far:   -89.7692787740229
#>
#> Solution found


#>
#>  Solution found!   Final fit=-89.769279 (started at 49.63987)  (1 attempt(s):  1
valid, 0 errors)
#>  Start values from best fit:
#> -0.375137349077617,0.757131830409476,-0.414493586496051,-0.0312218385901363,-0.356491031738541,0.
#> Warning in tau_sqr + v_hat:  longer object length is not a multiple of shorter object
length
#> $estimates
#>                            est     se       z      p    2.5%   97.5%
#> beta0_phi_11            -0.3751 0.1567 -2.3942 0.0167 -0.6822 -0.0680
#> beta0_phi_21             0.7571 0.1330  5.6936 0.0000  0.4965  1.0178
#> beta0_phi_31            -0.4145 0.1134 -3.6545 0.0003 -0.6368 -0.1922
#> beta0_phi_12            -0.0312 0.1126 -0.2773 0.7815 -0.2519  0.1894
#> beta0_phi_22            -0.3565 0.1428 -2.4959 0.0126 -0.6364 -0.0765
#> beta0_phi_32             0.8570 0.0935  9.1697 0.0000  0.6738  1.0402
#> beta0_phi_13             0.0196 0.1039  0.1890 0.8501 -0.1841  0.2233
#> beta0_phi_23            -0.0906 0.1432 -0.6326 0.5270 -0.3712  0.1900
#> beta0_phi_33            -0.8613 0.1253 -6.8717 0.0000 -1.1069 -0.6156
#> beta0_sigma_11           0.0972 0.0049 19.7405 0.0000  0.0875  0.1068
#> beta0_sigma_22           0.1020 0.0059 17.2398 0.0000  0.0904  0.1136
#> beta0_sigma_33           0.1004 0.0066 15.2292 0.0000  0.0874  0.1133
#> tau_sqr_phi_11_phi_11    0.0232 0.0419  0.5529 0.5803 -0.0589  0.1053
#> tau_sqr_phi_21_phi_11    0.0145 0.0253  0.5705 0.5684 -0.0352  0.0641
#> tau_sqr_phi_31_phi_11    0.0019 0.0174  0.1098 0.9126 -0.0321  0.0359
#> tau_sqr_phi_12_phi_11   -0.0141 0.0261 -0.5398 0.5894 -0.0651  0.0370
#> tau_sqr_phi_22_phi_11   -0.0232 0.0326 -0.7112 0.4769 -0.0870  0.0407
#> tau_sqr_phi_32_phi_11    0.0003 0.0142  0.0206 0.9836 -0.0276  0.0282
#> tau_sqr_phi_13_phi_11    0.0104 0.0213  0.4860 0.6270 -0.0314  0.0522
#> tau_sqr_phi_23_phi_11    0.0232 0.0326  0.7116 0.4767 -0.0407  0.0871
#> tau_sqr_phi_33_phi_11   -0.0176 0.0265 -0.6643 0.5065 -0.0696  0.0344
#> tau_sqr_sigma_11_phi_11 -0.0004 0.0009 -0.4594 0.6459 -0.0023  0.0014
#> tau_sqr_sigma_22_phi_11 -0.0008 0.0012 -0.6437 0.5198 -0.0032  0.0016
#> tau_sqr_sigma_33_phi_11  0.0010 0.0015  0.6946 0.4873 -0.0018  0.0039
#> tau_sqr_phi_21_phi_21    0.0090 0.0236  0.3818 0.7026 -0.0373  0.0553
#> tau_sqr_phi_31_phi_21    0.0012 0.0109  0.1092 0.9131 -0.0202  0.0225
#> tau_sqr_phi_12_phi_21   -0.0088 0.0165 -0.5323 0.5945 -0.0411  0.0235
#> tau_sqr_phi_22_phi_21   -0.0145 0.0279 -0.5184 0.6042 -0.0691  0.0402
#> tau_sqr_phi_32_phi_21    0.0002 0.0089  0.0206 0.9836 -0.0172  0.0176
#> tau_sqr_phi_13_phi_21    0.0065 0.0135  0.4781 0.6326 -0.0201  0.0330
#> tau_sqr_phi_23_phi_21    0.0145 0.0270  0.5372 0.5911 -0.0384  0.0673
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```
#> tau_sqr_phi_33_phi_21       -0.0110 0.0195 -0.5634 0.5732 -0.0493  0.0273
#> tau_sqr_sigma_11_phi_21     -0.0003 0.0006 -0.4439 0.6571 -0.0014  0.0009
#> tau_sqr_sigma_22_phi_21     -0.0005 0.0009 -0.5722 0.5672 -0.0022  0.0012
#> tau_sqr_sigma_33_phi_21      0.0006 0.0011  0.5809 0.5613 -0.0015  0.0028
#> tau_sqr_phi_31_phi_31        0.0002 0.0028  0.0553 0.9559 -0.0054  0.0057
#> tau_sqr_phi_12_phi_31       -0.0012 0.0106 -0.1097 0.9127 -0.0218  0.0195
#> tau_sqr_phi_22_phi_31       -0.0019 0.0174 -0.1098 0.9126 -0.0359  0.0321
#> tau_sqr_phi_32_phi_31        0.0000 0.0011  0.0228 0.9818 -0.0021  0.0021
#> tau_sqr_phi_13_phi_31        0.0009 0.0078  0.1093 0.9130 -0.0144  0.0162
#> tau_sqr_phi_23_phi_31        0.0019 0.0174  0.1098 0.9126 -0.0322  0.0360
#> tau_sqr_phi_33_phi_31       -0.0015 0.0127 -0.1139 0.9093 -0.0264  0.0235
#> tau_sqr_sigma_11_phi_31      0.0000 0.0003 -0.1086 0.9135 -0.0007  0.0006
#> tau_sqr_sigma_22_phi_31     -0.0001 0.0006 -0.1095 0.9128 -0.0012  0.0011
#> tau_sqr_sigma_33_phi_31      0.0001 0.0008  0.1105 0.9120 -0.0014  0.0016
#> tau_sqr_phi_12_phi_12        0.0085 0.0190  0.4486 0.6537 -0.0288  0.0458
#> tau_sqr_phi_22_phi_12        0.0141 0.0218  0.6441 0.5195 -0.0287  0.0568
#> tau_sqr_phi_32_phi_12       -0.0002 0.0086 -0.0206 0.9836 -0.0171  0.0168
#> tau_sqr_phi_13_phi_12       -0.0063 0.0154 -0.4099 0.6819 -0.0364  0.0238
#> tau_sqr_phi_23_phi_12       -0.0141 0.0219 -0.6447 0.5191 -0.0569  0.0287
#> tau_sqr_phi_33_phi_12        0.0107 0.0176  0.6085 0.5428 -0.0238  0.0452
#> tau_sqr_sigma_11_phi_12      0.0003 0.0006  0.4454 0.6560 -0.0009  0.0014
#> tau_sqr_sigma_22_phi_12      0.0005 0.0008  0.5947 0.5520 -0.0011  0.0020
#> tau_sqr_sigma_33_phi_12     -0.0006 0.0010 -0.6317 0.5276 -0.0025  0.0013
#> tau_sqr_phi_22_phi_22        0.0231 0.0370  0.6259 0.5314 -0.0493  0.0956
#> tau_sqr_phi_32_phi_22       -0.0003 0.0142 -0.0206 0.9836 -0.0282  0.0276
#> tau_sqr_phi_13_phi_22       -0.0104 0.0187 -0.5543 0.5794 -0.0470  0.0263
#> tau_sqr_phi_23_phi_22       -0.0232 0.0359 -0.6469 0.5177 -0.0935  0.0471
#> tau_sqr_phi_33_phi_22        0.0176 0.0254  0.6946 0.4873 -0.0321  0.0674
#> tau_sqr_sigma_11_phi_22      0.0004 0.0009  0.5021 0.6156 -0.0012  0.0021
#> tau_sqr_sigma_22_phi_22      0.0008 0.0011  0.7051 0.4808 -0.0014  0.0029
#> tau_sqr_sigma_33_phi_22     -0.0010 0.0014 -0.7281 0.4666 -0.0037  0.0017
#> tau_sqr_phi_32_phi_32        0.0000 0.0004  0.0103 0.9918 -0.0007  0.0007
#> tau_sqr_phi_13_phi_32        0.0001 0.0064  0.0206 0.9836 -0.0124  0.0126
#> tau_sqr_phi_23_phi_32        0.0003 0.0143  0.0206 0.9836 -0.0276  0.0282
#> tau_sqr_phi_33_phi_32       -0.0002 0.0110 -0.0203 0.9838 -0.0217  0.0213
#> tau_sqr_sigma_11_phi_32      0.0000 0.0003 -0.0206 0.9836 -0.0005  0.0005
#> tau_sqr_sigma_22_phi_32      0.0000 0.0005 -0.0206 0.9836 -0.0009  0.0009
#> tau_sqr_sigma_33_phi_32      0.0000 0.0006  0.0206 0.9836 -0.0012  0.0012
#> tau_sqr_phi_13_phi_13        0.0046 0.0134  0.3462 0.7292 -0.0216  0.0309
#> tau_sqr_phi_23_phi_13        0.0104 0.0187  0.5546 0.5792 -0.0263  0.0471
#> tau_sqr_phi_33_phi_13       -0.0079 0.0149 -0.5303 0.5959 -0.0371  0.0213
#> tau_sqr_sigma_11_phi_13     -0.0002 0.0005 -0.4126 0.6799 -0.0011  0.0007
#> tau_sqr_sigma_22_phi_13     -0.0003 0.0007 -0.5219 0.6017 -0.0017  0.0010
#> tau_sqr_sigma_33_phi_13      0.0005 0.0008  0.5454 0.5854 -0.0012  0.0021
#> tau_sqr_phi_23_phi_23        0.0232 0.0372  0.6256 0.5316 -0.0496  0.0961
#> tau_sqr_phi_33_phi_23       -0.0177 0.0254 -0.6949 0.4871 -0.0675  0.0322
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#> tau_sqr_sigma_11_phi_23    -0.0004 0.0009 -0.5023 0.6154 -0.0021  0.0012
#> tau_sqr_sigma_22_phi_23    -0.0008 0.0011 -0.6961 0.4864 -0.0030  0.0014
#> tau_sqr_sigma_33_phi_23     0.0010 0.0014  0.7280 0.4666 -0.0017  0.0037
#> tau_sqr_phi_33_phi_33       0.0134 0.0259  0.5187 0.6039 -0.0373  0.0641
#> tau_sqr_sigma_11_phi_33     0.0003 0.0007  0.4842 0.6282 -0.0010  0.0016
#> tau_sqr_sigma_22_phi_33     0.0006 0.0009  0.6288 0.5295 -0.0013  0.0024
#> tau_sqr_sigma_33_phi_33    -0.0008 0.0012 -0.6438 0.5197 -0.0031  0.0016
#> tau_sqr_sigma_11_sigma_11   0.0000 0.0000  0.2984 0.7654  0.0000  0.0001
#> tau_sqr_sigma_22_sigma_11   0.0000 0.0000  0.4767 0.6336  0.0000  0.0001
#> tau_sqr_sigma_33_sigma_11   0.0000 0.0000 -0.4962 0.6197 -0.0001  0.0001
#> tau_sqr_sigma_22_sigma_22   0.0000 0.0001  0.4796 0.6315 -0.0001  0.0001
#> tau_sqr_sigma_33_sigma_22   0.0000 0.0001 -0.6544 0.5129 -0.0001  0.0001
#> tau_sqr_sigma_33_sigma_33   0.0000 0.0001  0.5830 0.5599 -0.0001  0.0002
#>
#> $heterogeneity
#>       beta0_1       beta0_2       beta0_3       beta0_4       beta0_5
#>        0.4837        0.3986        0.3335        0.4284        0.5350
#>       beta0_6       beta0_7       beta0_8       beta0_9      beta0_10
#>        0.3320        0.3878        0.5352        0.4635        0.3740
#>      beta0_11      beta0_12    tau_sqr_1_1   tau_sqr_2_1   tau_sqr_3_1
#>        0.4444        0.5051        0.0628        0.0235        0.0116
#>   tau_sqr_4_1   tau_sqr_5_1   tau_sqr_6_1   tau_sqr_7_1   tau_sqr_8_1
#>        0.0386        0.0564        0.0114        0.0260        0.0564
#>   tau_sqr_9_1  tau_sqr_10_1  tau_sqr_11_1  tau_sqr_12_1   tau_sqr_2_2
#>        0.0373        0.0210        0.0325        0.0477        0.0209
#>   tau_sqr_3_2   tau_sqr_4_2   tau_sqr_5_2   tau_sqr_6_2   tau_sqr_7_2
#>        0.0044        0.0105        0.0439        0.0044        0.0103
#>   tau_sqr_8_2   tau_sqr_9_2  tau_sqr_10_2  tau_sqr_11_2  tau_sqr_12_2
#>        0.0409        0.0210        0.0000        0.0176        0.0264
#>   tau_sqr_3_3   tau_sqr_4_3   tau_sqr_5_3   tau_sqr_6_3   tau_sqr_7_3
#>        0.1589        0.0042        0.0112        0.0000        0.0036
#>   tau_sqr_8_3   tau_sqr_9_3  tau_sqr_10_3  tau_sqr_11_3  tau_sqr_12_3
#>        0.0168        0.0091        0.0000        0.0000        0.0000
#>   tau_sqr_4_4   tau_sqr_5_4   tau_sqr_6_4   tau_sqr_7_4   tau_sqr_8_4
#>        0.8993        0.9159        0.6370        0.0089        0.0176
#>   tau_sqr_9_4  tau_sqr_10_4  tau_sqr_11_4  tau_sqr_12_4   tau_sqr_5_5
#>        0.0119        0.0000        0.0000        0.0001        0.0743
#>   tau_sqr_6_5   tau_sqr_7_5   tau_sqr_8_5   tau_sqr_9_5  tau_sqr_10_5
#>        0.0112        0.0189        0.9694        0.9364        0.0169
#>  tau_sqr_11_5  tau_sqr_12_5   tau_sqr_6_6   tau_sqr_7_6   tau_sqr_8_6
#>        0.0000        0.0001        0.0000        0.0024        0.0113
#>   tau_sqr_9_6  tau_sqr_10_6  tau_sqr_11_6  tau_sqr_12_6   tau_sqr_7_7
#>        0.0068        0.0000        0.0000        0.0000        0.8159
#>   tau_sqr_8_7   tau_sqr_9_7  tau_sqr_10_7  tau_sqr_11_7  tau_sqr_12_7
#>        0.8890        0.8388        0.0000        0.0000        0.0000
#>   tau_sqr_8_8   tau_sqr_9_8  tau_sqr_10_8  tau_sqr_11_8  tau_sqr_12_8
```

```
#>      0.0755        0.0352        0.0000        0.0001        0.0001
#>   tau_sqr_9_9  tau_sqr_10_9  tau_sqr_11_9  tau_sqr_12_9 tau_sqr_10_10
#>      0.0355        0.0111        0.0200        0.0327        0.0000
#> tau_sqr_11_10 tau_sqr_12_10 tau_sqr_11_11 tau_sqr_12_11 tau_sqr_12_12
#>      0.0000        0.0000        0.0000        0.0000        0.0000
```

```
#> Warning in tau_sqr + v_hat:  longer object length is not a multiple of shorter object
length
```

```
#> Test passed
```

```
#> test-metaVAR-fit-dt-var-id-mx-theta-null
#> Running DTVAR with 12 parameters
#>
#> Beginning initial fit attempt
#> Running DTVAR with 12 parameters
#>
#>  Lowest minimum so far:   741.858019666399
#>
#> Solution found
```

```
#>
#>  Solution found!   Final fit=741.85802 (started at 3195.3436)  (1 attempt(s):  1
valid, 0 errors)
#>  Start values from best fit:
#> 0.744102359401248,0.471983549669145,-0.123485840970363,-0.00232191598171461,0.652661527232958,0.
#> Running DTVAR with 12 parameters
#>
#> Beginning initial fit attempt
#> Running DTVAR with 12 parameters
#>
#>  Lowest minimum so far:   823.404995013856
#>
#> Solution found
```

```
#>
#>  Solution found!   Final fit=823.405 (started at 2764.6005)  (1 attempt(s):  1 valid,
0 errors)
#>  Start values from best fit:
#> 0.654633086676883,0.509278984394305,-0.134962902847776,0.0271964367580654,0.606323423068992,0.42
#> Running Model with 90 parameters
#>
#> Beginning initial fit attempt
#> Running Model with 90 parameters
#>
#>  Lowest minimum so far:   -138.575994362116
```

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```
#>
#> Solution found
```

```
#>
#>  Solution found!   Final fit=-138.57599 (started at 47.339574)  (1 attempt(s):  1
valid, 0 errors)
#>  Start values from best fit:
#> 0.700071716679852,0.490649474432429,-0.129219715320958,0.0121929267879254,0.6299210837978,0.43908
#> Warning in tau_sqr + v_hat:  longer object length is not a multiple of shorter object
length

#> $estimates
#>                                est     se       z      p    2.5%   97.5%
#> beta0_beta_11                0.7001 0.0382 18.3126 0.0000  0.6251  0.7750
#> beta0_beta_21                0.4906 0.0287 17.0922 0.0000  0.4344  0.5469
#> beta0_beta_31               -0.1292 0.0253 -5.1061 0.0000 -0.1788 -0.0796
#> beta0_beta_12                0.0122 0.0225  0.5417 0.5880 -0.0319  0.0563
#> beta0_beta_22                0.6299 0.0260 24.2568 0.0000  0.5790  0.6808
#> beta0_beta_32                0.4391 0.0217 20.2404 0.0000  0.3966  0.4816
#> beta0_beta_13                0.0088 0.0211  0.4190 0.6752 -0.0325  0.0502
#> beta0_beta_23               -0.0204 0.0263 -0.7761 0.4377 -0.0719  0.0311
#> beta0_beta_33                0.4874 0.0250 19.4586 0.0000  0.4383  0.5364
#> beta0_psi_11                 0.0956 0.0065 14.6338 0.0000  0.0828  0.1084
#> beta0_psi_22                 0.1039 0.0047 21.9215 0.0000  0.0946  0.1132
#> beta0_psi_33                 0.0959 0.0044 21.7818 0.0000  0.0873  0.1045
#> tau_sqr_beta_11_beta_11  0.0017 0.0027  0.6276 0.5302 -0.0035  0.0069
#> tau_sqr_beta_21_beta_11 -0.0007 0.0013 -0.5165 0.6055 -0.0033  0.0019
#> tau_sqr_beta_31_beta_11  0.0002 0.0011  0.2033 0.8389 -0.0019  0.0023
#> tau_sqr_beta_12_beta_11 -0.0006 0.0012 -0.4707 0.6379 -0.0028  0.0017
#> tau_sqr_beta_22_beta_11  0.0009 0.0013  0.6433 0.5201 -0.0018  0.0035
#> tau_sqr_beta_32_beta_11  0.0004 0.0010  0.4351 0.6635 -0.0015  0.0023
#> tau_sqr_beta_13_beta_11  0.0002 0.0009  0.2192 0.8265 -0.0016  0.0019
#> tau_sqr_beta_23_beta_11  0.0009 0.0014  0.6340 0.5261 -0.0018  0.0035
#> tau_sqr_beta_33_beta_11 -0.0008 0.0013 -0.6265 0.5310 -0.0033  0.0017
#> tau_sqr_psi_11_beta_11  -0.0003 0.0004 -0.7458 0.4558 -0.0010  0.0005
#> tau_sqr_psi_22_beta_11   0.0001 0.0002  0.2616 0.7936 -0.0003  0.0004
#> tau_sqr_psi_33_beta_11  -0.0001 0.0002 -0.2999 0.7642 -0.0004  0.0003
#> tau_sqr_beta_21_beta_21  0.0003 0.0009  0.3103 0.7563 -0.0015  0.0021
#> tau_sqr_beta_31_beta_21 -0.0001 0.0005 -0.1955 0.8450 -0.0010  0.0008
#> tau_sqr_beta_12_beta_21  0.0002 0.0005  0.4205 0.6741 -0.0008  0.0013
#> tau_sqr_beta_22_beta_21 -0.0004 0.0009 -0.4180 0.6760 -0.0021  0.0013
#> tau_sqr_beta_32_beta_21 -0.0002 0.0005 -0.3716 0.7102 -0.0011  0.0008
#> tau_sqr_beta_13_beta_21 -0.0001 0.0004 -0.2119 0.8322 -0.0008  0.0007
#> tau_sqr_beta_23_beta_21 -0.0004 0.0007 -0.4906 0.6237 -0.0018  0.0011
#> tau_sqr_beta_33_beta_21  0.0003 0.0007  0.4710 0.6376 -0.0011  0.0017
#> tau_sqr_psi_11_beta_21   0.0001 0.0002  0.5158 0.6060 -0.0003  0.0006
```

```
#> tau_sqr_psi_22_beta_21   0.0000 0.0001 -0.2456 0.8060 -0.0002  0.0002
#> tau_sqr_psi_33_beta_21   0.0000 0.0001  0.2765 0.7821 -0.0001  0.0002
#> tau_sqr_beta_31_beta_31  0.0000 0.0003  0.1041 0.9171 -0.0005  0.0005
#> tau_sqr_beta_12_beta_31 -0.0001 0.0004 -0.1957 0.8448 -0.0008  0.0006
#> tau_sqr_beta_22_beta_31  0.0001 0.0006  0.2007 0.8409 -0.0010  0.0012
#> tau_sqr_beta_32_beta_31  0.0001 0.0002  0.2267 0.8207 -0.0004  0.0005
#> tau_sqr_beta_13_beta_31  0.0000 0.0002  0.1530 0.8784 -0.0003  0.0003
#> tau_sqr_beta_23_beta_31  0.0001 0.0005  0.2004 0.8412 -0.0010  0.0012
#> tau_sqr_beta_33_beta_31 -0.0001 0.0005 -0.2041 0.8383 -0.0011  0.0009
#> tau_sqr_psi_11_beta_31   0.0000 0.0002 -0.2032 0.8389 -0.0004  0.0003
#> tau_sqr_psi_22_beta_31   0.0000 0.0000  0.1644 0.8695 -0.0001  0.0001
#> tau_sqr_psi_33_beta_31   0.0000 0.0000 -0.1726 0.8630 -0.0001  0.0001
#> tau_sqr_beta_12_beta_12  0.0002 0.0006  0.3132 0.7541 -0.0010  0.0013
#> tau_sqr_beta_22_beta_12 -0.0003 0.0006 -0.4810 0.6305 -0.0014  0.0009
#> tau_sqr_beta_32_beta_12 -0.0001 0.0004 -0.3726 0.7095 -0.0009  0.0006
#> tau_sqr_beta_13_beta_12 -0.0001 0.0003 -0.1879 0.8509 -0.0007  0.0006
#> tau_sqr_beta_23_beta_12 -0.0003 0.0006 -0.4764 0.6338 -0.0014  0.0009
#> tau_sqr_beta_33_beta_12  0.0003 0.0006  0.4733 0.6360 -0.0008  0.0014
#> tau_sqr_psi_11_beta_12   0.0001 0.0002  0.5191 0.6037 -0.0003  0.0004
#> tau_sqr_psi_22_beta_12   0.0000 0.0001 -0.2460 0.8056 -0.0002  0.0001
#> tau_sqr_psi_33_beta_12   0.0000 0.0001  0.2770 0.7818 -0.0001  0.0002
#> tau_sqr_beta_22_beta_22  0.0004 0.0010  0.4447 0.6565 -0.0015  0.0024
#> tau_sqr_beta_32_beta_22  0.0002 0.0005  0.4111 0.6810 -0.0008  0.0013
#> tau_sqr_beta_13_beta_22  0.0001 0.0005  0.2186 0.8270 -0.0008  0.0010
#> tau_sqr_beta_23_beta_22  0.0004 0.0007  0.6815 0.4956 -0.0008  0.0017
#> tau_sqr_beta_33_beta_22 -0.0004 0.0007 -0.5608 0.5749 -0.0019  0.0010
#> tau_sqr_psi_11_beta_22  -0.0001 0.0002 -0.6420 0.5209 -0.0006  0.0003
#> tau_sqr_psi_22_beta_22   0.0000 0.0001  0.2562 0.7978 -0.0002  0.0002
#> tau_sqr_psi_33_beta_22   0.0000 0.0001 -0.2918 0.7704 -0.0002  0.0002
#> tau_sqr_beta_32_beta_32  0.0001 0.0004  0.2461 0.8056 -0.0008  0.0010
#> tau_sqr_beta_13_beta_32  0.0000 0.0002  0.2048 0.8377 -0.0004  0.0005
#> tau_sqr_beta_23_beta_32  0.0002 0.0005  0.4092 0.6824 -0.0008  0.0013
#> tau_sqr_beta_33_beta_32 -0.0002 0.0006 -0.3538 0.7235 -0.0013  0.0009
#> tau_sqr_psi_11_beta_32  -0.0001 0.0002 -0.4348 0.6637 -0.0004  0.0003
#> tau_sqr_psi_22_beta_32   0.0000 0.0001  0.2350 0.8142 -0.0001  0.0001
#> tau_sqr_psi_33_beta_32   0.0000 0.0001 -0.2617 0.7936 -0.0001  0.0001
#> tau_sqr_beta_13_beta_13  0.0000 0.0002  0.1142 0.9091 -0.0004  0.0004
#> tau_sqr_beta_23_beta_13  0.0001 0.0005  0.2180 0.8274 -0.0008  0.0010
#> tau_sqr_beta_33_beta_13 -0.0001 0.0004 -0.2177 0.8276 -0.0009  0.0008
#> tau_sqr_psi_11_beta_13   0.0000 0.0002 -0.2218 0.8245 -0.0003  0.0003
#> tau_sqr_psi_22_beta_13   0.0000 0.0000  0.1738 0.8621 -0.0001  0.0001
#> tau_sqr_psi_33_beta_13   0.0000 0.0000 -0.1837 0.8543 -0.0001  0.0001
#> tau_sqr_beta_23_beta_23  0.0004 0.0010  0.4330 0.6650 -0.0015  0.0024
#> tau_sqr_beta_33_beta_23 -0.0004 0.0007 -0.5553 0.5787 -0.0019  0.0010
#> tau_sqr_psi_11_beta_23  -0.0001 0.0002 -0.6331 0.5267 -0.0006  0.0003
#> tau_sqr_psi_22_beta_23   0.0000 0.0001  0.2556 0.7983 -0.0002  0.0002
```

```
#> tau_sqr_psi_33_beta_23   0.0000 0.0001 -0.2909 0.7711 -0.0002  0.0002
#> tau_sqr_beta_33_beta_33  0.0004 0.0009  0.4234 0.6720 -0.0014  0.0022
#> tau_sqr_psi_11_beta_33   0.0001 0.0002  0.6255 0.5317 -0.0003  0.0006
#> tau_sqr_psi_22_beta_33   0.0000 0.0001 -0.2550 0.7987 -0.0002  0.0002
#> tau_sqr_psi_33_beta_33   0.0000 0.0001  0.2902 0.7717 -0.0002  0.0002
#> tau_sqr_psi_11_psi_11    0.0000 0.0001  0.6242 0.5325 -0.0001  0.0002
#> tau_sqr_psi_22_psi_11    0.0000 0.0000 -0.2615 0.7937 -0.0001  0.0001
#> tau_sqr_psi_33_psi_11    0.0000 0.0000  0.2998 0.7643 -0.0001  0.0001
#> tau_sqr_psi_22_psi_22    0.0000 0.0000  0.1363 0.8916  0.0000  0.0000
#> tau_sqr_psi_33_psi_22    0.0000 0.0000 -0.2044 0.8381  0.0000  0.0000
#> tau_sqr_psi_33_psi_33    0.0000 0.0000  0.1584 0.8741  0.0000  0.0000
#>
#> $heterogeneity
#>       beta0_1      beta0_2      beta0_3      beta0_4      beta0_5
#>        0.5384       0.3777       0.3381       0.3780       0.4282
#>       beta0_6      beta0_7      beta0_8      beta0_9     beta0_10
#>        0.3607       0.3389       0.4228       0.4186       0.5357
#>      beta0_11     beta0_12   tau_sqr_1_1   tau_sqr_2_1   tau_sqr_3_1
#>        0.3416       0.3446       0.0056       0.0013       0.0009
#>   tau_sqr_4_1   tau_sqr_5_1   tau_sqr_6_1   tau_sqr_7_1   tau_sqr_8_1
#>        0.0016       0.0020       0.0011       0.0009       0.0019
#>   tau_sqr_9_1  tau_sqr_10_1  tau_sqr_11_1  tau_sqr_12_1   tau_sqr_2_2
#>        0.0019       0.0039       0.0009       0.0010       0.0007
#>   tau_sqr_3_2   tau_sqr_4_2   tau_sqr_5_2   tau_sqr_6_2   tau_sqr_7_2
#>        0.0002       0.0002       0.0009       0.0003       0.0002
#>   tau_sqr_8_2   tau_sqr_9_2  tau_sqr_10_2  tau_sqr_11_2  tau_sqr_12_2
#>        0.0006       0.0005       0.0001       0.0002       0.0002
#>   tau_sqr_3_3   tau_sqr_4_3   tau_sqr_5_3   tau_sqr_6_3   tau_sqr_7_3
#>        0.0019       0.0001       0.0002       0.0000       0.0000
#>   tau_sqr_8_3   tau_sqr_9_3  tau_sqr_10_3  tau_sqr_11_3  tau_sqr_12_3
#>        0.0003       0.0003       0.0000       0.0000       0.0000
#>   tau_sqr_4_4   tau_sqr_5_4   tau_sqr_6_4   tau_sqr_7_4   tau_sqr_8_4
#>        0.0090       0.0081       0.0038       0.0001       0.0003
#>   tau_sqr_9_4  tau_sqr_10_4  tau_sqr_11_4  tau_sqr_12_4   tau_sqr_5_5
#>        0.0002       0.0000       0.0000       0.0000       0.0012
#>   tau_sqr_6_5   tau_sqr_7_5   tau_sqr_8_5   tau_sqr_9_5  tau_sqr_10_5
#>        0.0003       0.0002       0.0113       0.0125       0.0014
#>  tau_sqr_11_5  tau_sqr_12_5   tau_sqr_6_6   tau_sqr_7_6   tau_sqr_8_6
#>        0.0000       0.0000       0.0002       0.0001       0.0003
#>   tau_sqr_9_6  tau_sqr_10_6  tau_sqr_11_6  tau_sqr_12_6   tau_sqr_7_7
#>        0.0004       0.0000       0.0000       0.0000       0.0011
#>   tau_sqr_8_7   tau_sqr_9_7  tau_sqr_10_7  tau_sqr_11_7  tau_sqr_12_7
#>        0.0049       0.0050       0.0000       0.0000       0.0000
#>   tau_sqr_8_8   tau_sqr_9_8  tau_sqr_10_8  tau_sqr_11_8  tau_sqr_12_8
#>        0.0012       0.0006       0.0001       0.0000       0.0000
#>   tau_sqr_9_9  tau_sqr_10_9  tau_sqr_11_9  tau_sqr_12_9 tau_sqr_10_10
```

```
#>         0.0009         0.0013         0.0002         0.0002         0.0000
#> tau_sqr_11_10 tau_sqr_12_10 tau_sqr_11_11 tau_sqr_12_11 tau_sqr_12_12
#>         0.0000         0.0000         0.0000         0.0000         0.0000
```

```
#> Warning in tau_sqr + v_hat:  longer object length is not a multiple of shorter object
length
```

```
#> Test passed
#> [[1]]
#> [[1]][[1]]
#> [[1]][[1]]$value
#> [[1]][[1]]$value[[1]]
#> [1] TRUE
#>
#>
#> [[1]][[1]]$visible
#> [1] TRUE
#>
#>
#> [[1]][[2]]
#> [[1]][[2]]$value
#> [[1]][[2]]$value[[1]]
#> [1] TRUE
#>
#>
#> [[1]][[2]]$visible
#> [1] TRUE
```

## Environment

```
ls()

#> [1] "root"
```

## Class

```
#> [[1]]
#> [1] "root_criterion"
```

## References

R Core Team. (2023). *R: A language and environment for statistical computing.* R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org/