**Motivation**

Many theoretical models consist of more than one equation:
- contemporaneous correlation of disturbance terms (likely)
- simultaneous estimation of all equations as “Seemingly Unrelated Regression” (SUR) leads to efficient results
- Theoretically derived cross-equation parameter restrictions
- simultaneous estimation of all equations required
- Endogeneity of some variables
  - estimation using “Two-Stage Least Squares” (2SLS) or “Three-Stage Least Squares” (3SLS) required

⇒ All these models can be estimated by `systemfit`

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**Outline**

- Introduction
- Features of `systemfit`
- Example
- Plans for the Future

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**Estimation Methods**

- Ordinary Least Squares (OLS)
- Two-Stage Least Squares (2SLS)
- Seemingly Unrelated Regression (SUR)
- Three-Stage Least Squares (3SLS)
  - ...
Estimation Control

- imposition of linear restrictions
- instrumental variables
- iteration of FGLS estimation
- formulas for the residual covariance matrix
- formulas for 3SLS estimation
- ...

Other Tools

- systemfitClassic: wrapper function for (classical) panel-like data in long format
- testing linear hypotheses using the F-, Wald-, and LR-statistic
- Hausman test for the consistency of the 3SLS estimator

Example: Commands

- from Kmenta (1986): Elements of Econometrics, p. 685
- specification of the equation system:
  eqDemand <- consump ~ price + income
eqSupply <- consump ~ price + farmPrice + trend
eqSystem <- list(demand=eqDemand, supply=eqSupply)
- estimation using method “SUR”:
  fitsur <- systemfit("SUR", eqSystem, data=Kmenta)
- printing summary results:
  summary( fitsur )

Results of the Entire System

systemfit results
method: SUR

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>DF</th>
<th>SSR</th>
<th>MSE</th>
<th>RMSE</th>
<th>R2</th>
<th>Adj R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>demand</td>
<td>20</td>
<td>17</td>
<td>65.6829</td>
<td>3.86370</td>
<td>1.96563</td>
<td>0.755019</td>
<td>0.726198</td>
</tr>
<tr>
<td>supply</td>
<td>20</td>
<td>16</td>
<td>104.0584</td>
<td>6.50365</td>
<td>2.55023</td>
<td>0.611888</td>
<td>0.539117</td>
</tr>
</tbody>
</table>

[...]

The correlations of the residuals

<table>
<thead>
<tr>
<th></th>
<th>demand</th>
<th>supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>demand</td>
<td>1.000000</td>
<td>0.982348</td>
</tr>
<tr>
<td>supply</td>
<td>0.982348</td>
<td>1.000000</td>
</tr>
</tbody>
</table>

The determinant of the residual covariance matrix: 0.879285

OLS R-squared value of the system: 0.683453
McElroy's R-squared value for the system: 0.788722
Results of a Single Equation

SUR estimates for 'demand' (equation 1)
Model Formula: consump ~ price + income

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|---------|
| (Intercept) | 99.332894 | 7.514452 | 13.218913 | 0.000000 *** |
| price | -0.275486 | 0.088509 | -3.112513 | 0.006332 ** |
| income | 0.29855 | 0.041945 | 7.117605 | 2e-06 *** |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.96563 on 17 degrees of freedom
Number of observations: 20 Degrees of Freedom: 17
SSR: 65.682902 MSE: 3.8637 Root MSE: 1.96563
Multiple R-Squared: 0.755019 Adjusted R-Squared: 0.726198

Plans for the Future

- estimation with unbalanced data sets
- estimation methods: LIML, FIML, and GMM
- fitting equation systems with serially correlated and heteroscedastic disturbances
- spatial econometric methods
- simplify specification of parameter restrictions
- improving the function `nlsystemfit` to estimate systems of non-linear equations
- ...

User Interface: Arguments

Arguments of `systemfit`:
- `method`
- `eqns`
- `eqnlabels`
- `inst`
- `data`
- `R.restr`
- `q.restr`
- `TX`
- `maxiter`
- `tol`
- `rcovformula`
- `formula3sls`
- `probdfsys`
- `single.eq.sigma`
- `solvetol`
- `saveMemory`
- `centerResiduals`
- `single.eq.sigma`
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- `saveMemory`
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- `probdfsys`
- `single.eq.sigma`
- `solvetol`
- `saveMemory`
- `centerResiduals`

Too many?

Reducing arguments?
- `method`
- `eqns`
- `inst`
- `data`
- `R.restr`
- `q.restr`
- `TX`
- `control` (like in `optim`)

However: This would break existing code!
Thank you for your attention!