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In econometrics, seemingly unrelated regressions (SUR)[1]:306[2]:279[3]:332 or seemingly unrelated regression equations (SURE)[4][5]:2 model, Proposed by Arnold zellner in (1962), it is a generalization of a linear regression model consisting of several regression equations, each with its own dependent variable and potentially different groups of exogenous explanatory variables. Each equation is a linear regression valid on its own and can be estimated separately, which is why the system is called seemingly unrelated,[3]:332 although some authors suggest that the apparently related term would be more appropriate,[1]:306 since error terms are assumed to be related between equations. The model can be estimated equation by equation using standard less ordinary squares (OLS). These estimates are consistent, but generally inefficient as the SUR method, which is equivalent to less generalized squares feasible with a specific form of the variance-covariance matrix. Two important cases where SUR is actually equivalent to OLS are when error terms are actually unrelated between equations (so that they are truly unrelated) and when each equation contains exactly the same set of regressors on the right side. The SUR model can be considered as the simplification of the general linear model in which certain coefficients in array B (the display style, mathrm) are limited to zero, or as the generalization of the general linear model in which the regressors on the right side can be different in each equation. The SUR model can be further generalized in the concurrent equation model, in which the regressors on the right side can also be endogenous variables. The model Suppose there are m regression equations m y i r , x i r T β i , ε i r , i , i , 1 , ... , m . display style y_ir x_ ir , mathsf . . . . Here i represents the number of the equation, r : 1, ..., R is the time period and we are taking the transposition of the column vector x i r - displaystyle x_ ir . The number of observations R is assumed to be high, so that R → ∞ is taken in the analysis, while the number of equations m remains fixed. Every equation i has a single yir response variable, and a ki-dimensional vector of xir regreds. If I stack the observations corresponding to equation i-th vectors and dimensional matrices R, so the model can be written in vector form like y i β i , ε i , i , i , i , 1 , ... , m , , , , , , , , , y_ , , , , , , , , X_ , × , , , , , , , , , , , , , , Xi is an array R×ki and βi is a ki×1 vector. Finally, if you stack these vector equations m on top of each other, the system will take the form [4](eq. (2.2)) (y 1 y 2 ⋮ y m) - (X 1 0 ... 0 0 X 2 ... 0 ⋮ ⋮ ⋱ ⋮ 0 0 ... X m) (β 1 β 2 ⋮ β m) (ε 1 ε 2 ⋮ ε m) - X β ε . Display style , begin , pmatrix , y_{1} , y_{2} , vdots , y_ , m , fine , pmatrix , X_{1} &gt; X_{1} &gt; &amp;0&X_{2}&ldots &0&amp;vdots &amp; vdots &amp; vdots &amp; vdots &amp; 0&amp;ldots &X_ &X_ -end-pmatrix'begin'pmatrix'beta _{1}'beta _{2}'beta _{2}''vdots _beta _<8>'m'end'pmatrix'pmatrix'begin'pmatrix'pmatrix'begin'pmatrix'pmatrix'begin'pmatrix'pmatrix'begin'pmatrix'begin'pm atrix'pmatrix'begin'pmatrix'pmatrix''begin'pmatrix'pmatrix'begin'pmatrix'pmatrix'begin'pmatrix'pmatrix'begin'pmatrix'pmatrix'pmatrix''begin'pmatrix'pmatrix'<a1>&</a1> varepsilon _{1} _{2} _ _{1} The model hypothesis is that the error terms are independent over time. but they can have contemporary correlations between equations. This assumes that e[X] : 0 every ≠ r s, while E[X] - oij. Denoting Σ : [oij] the skedasticity matrix m×m of each observation, the covariance matrix of the stacked error terms ε will be equal to [4](eq. (2.4) [3]:332 Ω = And [ε ε T X] - Σ ⊗ I R , , display style , Omega , operator name, operator name, IR is the I_ matrix of dimensional identity R and the ⊗ the Kronecker matrix.

Estimate The SUR model is typically estimated using the feasible Randomized least squares (FGLS) method. This is a two-step method in which the first step regressions the least ordinary squares by (1). The residues of this regression are used to estimate the elements of the matrix Σ : visual style :[6]:198 σ : i j ε 1 R ε i T ε j . display style and hat {1} you are insaddisf_ In the second step, you perform generalized regression of squares by (1) using the variance matrix Ω , or Σ , ⊗ I R , display style , script style , hat , Omega , I_ β (X T (Σ) : 1 ⊗ I R) X) : 1 X T (Σ I R) - 1 X T (Σ) - 1 ⊗ I R) y . display style and hat I_ beta version, large (X, Mathsf, T,)X Large (Large) ,!-1, X, Mathsf , T , ,,I_,e. This estimator is impartial in small samples assuming that the terms error -ir have symmetric distribution; in large samples it is consistent and asyntally normal with the limitation of distribution[6]:198 R (β̂) β̂ → d N (0 , (1 R X T (Σ x 1 ⊗ I R) X) - 1). style of sqrt , sqrt , R , (1) tfrac {1} R, X, Mathsf , Sigma otimes I_) X , Big). Other estimation techniques besides FGLS have been suggested for the SUR model:[7] the most likely method (ML) assuming that errors are normally distributed; the less generalized iterative squares (IGLS), were the residues of the second phase of FGLS are used to recalculate the matrix Σ β̂ . beta hat using GLS again, and so on, until convergence is achieved; the iterative Ordinary least Squares (IOLS) scheme, in which the estimate is executed on an equation-by-equation basis, but each equation includes as additional regressors the remnants of the equations previously estimated to account for correlations between equations, the estimate is executed iteratively until convergence is reached. Kmenta and Gilbert (1968) conducted a Monte-Carlo study and established that all three methods - IGLS, IOLS and ML - produce numerically equivalent results, they also found that the asymptotic distribution of these estimators is the same as the distribution of the FGLS estimator, while in small samples none of the estimators were higher than the others. Ando (2010) has developed a direct Monte Carlo method for bayesian analysis of the SUR model. [9] OLS equivalence There are two important cases where SUR estimates evolved to be equivalent to the OLS equation-per-equation, so that there is no gain in the system estimation jointly. These cases are: when the matrix Σ is known to be diagonal, that is, there are no cross equation correlations between the error terms. In this case the system does not become apparently but really unrelated. When each equation contains exactly the same set of regressors, which is X1 x X2... Xm. That admirers are numerically identical to OLS estimates derives from the Kruskal tree theorem,[1]:313 or can be shown by direct calculation. [6]:197 Statistical packages In R, SUR can estimate using the systemfit package. [10] [11] In SAS, SUR can be estimated using the syslin procedure. In State, SUR can be estimated using the sureg and suest commands. [15] In Limdep, SUR can be estimated using the safe command [18] In Python, SUR can be estimated using the SUR command in the linearmodels package. [19] See also general linear model Simultaneous equations models References - a b c Davidson, Russell; MacKinnon, James G. (1993). Estimation and inference in econometrics. Oxford University Press. ISBN 978-0-19-506011-9.CS1 maint: ref-harv (link) - Hayashi, Fumio (2000). Econometrics. Princeton University Press. ISBN 978-0-691-01018-2.CS1 maint: ref-harv (link) - a b c Greene, William H. (2012). Econometric analysis (Seventh ed. Upper Saddle River: Pearson Prentice-Hall. 332–344. 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