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The dynamic factor model revisited: the identification problem remains

Abstract:
The lack of identification of short run run effects in a system of regression equations consisting of a dynamic translog cost function and cost share equations derived from this cost function is shown.

Keywords: Dynamic cost function

JEL classification: C32; D21

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1. Introduction

Urga (1996) claims that he has solved the identification problem concerning dynamic effects within singular dynamic demand systems in the producer case by joint estimation of the underlying dynamic cost function based on the Translog and (n-1) of the derived dynamic cost share functions, where n is the total number of inputs. The modeling framework has later been utilized by Allen and Urga (1999), Urga (1999) and Urga and Walters (2003). Urga (1996) builds upon work by Berndt and Savin (1975), Norsworthy and Harper (1981) and Anderson and Blundell (1982). For instance Anderson and Blundell (1982) considering a dynamic model in cost shares emphasized the inherent identification problem as far as short run effects are concerned. Urga (1996) asserts that the identification problem is overcome when the underlying dynamic cost function is added to the analysis. However, in this note we show that the modifications Urga proposes do not resolve the original problem, when formulated in a usual linear regression framework taking the singularity constraints into account: the design matrix still does not have full rank. Below we demonstrate this for the case when the system consists of three inputs. We show that a constrained dynamic case considered by Urga (1999) is also not identified.

2. The dynamic translog cost function and the derived cost share equations

The point of departure is equation (9) in Urga (1996, p. 208). In the following we assume that the long-run parameters are known, and we also assume that the parameter m, which is relevant for the dynamic adjustment is known and focus on the identification of the remaining parameters. In the following let $p_{i,t} = \log(P_{i,t})$, i=1,2,3 and t=1,…,T. Equations (1)-(3) below show the dynamic cost function and the two first derived dynamic share equations

$$(1)\ \ln C_t - m\ln C_t^* - (1-m)\ln C_{t-1}^* - (1-m)\left(\sum_{i=1}^{3} S_{i,t-1}p_{i,t-1} - \sum_{i=1}^{3} S_{i,t-1}^* p_{i,t-1}\right) = \sum_{i=1}^{3}\sum_{j=1}^{3} b_{ij} z_{j,t-1} p_{i,t},$$

$$(2)\ \Delta s_{1,t} - m\Delta s_{1,t}^* - m z_{1,t-1} = \sum_{j=1}^{3} b_{1j} z_{j,t-1} \text{ and}$$

$$(3)\ \Delta s_{2,t} - m\Delta s_{2,t}^* - m z_{2,t-1} = \sum_{j=1}^{3} b_{2j} z_{j,t-1}.$$

The starred variables are the long-run variables, and since the long-run parameters are assumed known we can treat these as ordinary variables. The deviation between the long-run share and the actual share is defined as

(4) $z_{j,t} = S^{*}_{j,t} - S_{j,t}$, j=1,2,3.

Again since the long-run parameters are known we can treat the z-variables as known. From adding-up we furthermore have that

(5) $\sum_{j=1}^{3} z_{j,t} = 0 \; \forall t = 1,...,T.$

The question is can we identify the parameters b_{ij} (i,j=1, 2, 3) using Eqs. (1)-(3).

Let the matrix B be defined by $B = \{b_{ij}\}_{ij=1,2,3}$. Because of the singularity of the system we have, as also Urga (1996) does, to impose the restriction that the rowsum is equal for all the columns of B. Let $\iota' = (1, \;\; 1, \;\; 1)$. The restrictions then imply that

(6) $\iota' B = b\iota'$,

where b is a scalar. In the following we operationalize the restrictions as

(7a) $b_{11} = b - b_{21} - b_{31}$,

(7b) $b_{22} = b - b_{12} - b_{32}$ and

(7c) $b_{33} = b - b_{13} - b_{23}$.

Thus we now only have the 7 parameters which we collect in the vector θ,
$\theta = (b, \;\; b_{12}, \;\; b_{21}, \;\; b_{13}, \;\; b_{31}, \;\; b_{23}, \;\; b_{32})'$.

3. Identification of short-run effects

Let us introduce some simplifying notation and define y_t [i.e. the variables on the left hand side of (1)-(3)] as

$$(8)\; y_t = \begin{pmatrix} \ln C_t - m\ln C_t^* - (1-m)\ln C_{t-1}^* - (1-m)\left(\sum_{i=1}^{3} S_{i,t-1}p_{i,t-1} - \sum_{i=1}^{3} S_{i,t-1}^* p_{i,t-1}\right) \\ \Delta s_{1,t} - m\Delta s_{1,t}^* - mz_{1,t-1} \\ \Delta s_{2,t} - m\Delta s_{2,t}^* - mz_{2,t-1} \end{pmatrix}$$

Let furthermore x_t be a 12×1 vector (consisting of (i) products of log-prices and shares and (ii) shares), where the respective elements are given below

$$(9)\quad x_t^{/} = \left(z_{1,t-1}p_{1,t},\; z_{2,t-1}p_{1,t},\; z_{3,t-1}p_{1,t},\; z_{1,t-1}p_{2.,t},\; z_{2,t-1}p_{2,t},\; z_{3,t-1}p_{2,t},\; z_{1,t-1}p_{3,t},\; z_{2,t-1}p_{3,t},\; z_{3,t-1}p_{3,t},\; z_{1,t-1},\; z_{2,t-1},\; z_{3,t-1}\right).$$

Let us now write the system using all observations t=1,…,T. Let y be the T×3 matrix defined by $y^{/} = [y_1,\quad y_2,\quad \cdots\quad, y_T]$ and let x be the T×12 matrix defined by $x^{/} = [x_1,\quad x_2,\quad \cdots\quad, x_T]$.

Stacking the columns of y and including additive errors, (1)-(3) take the following form:

$$(10)\;\; \text{vec}(y) = (I_3 \otimes x)D\theta + \text{vec}(\varepsilon),$$

where $H = (I_3 \otimes x)D$ is a 3T×7 design matrix, ε is a T×3 matrix of errors and $\otimes$ is the Kronecker product. The matrix D has dimension 36×7 and is given in appendix A. The design matrix takes explicitly account of the (singularity) restrictions represented by (7a)-(7c). The matrix H is given in Eq. (11).

$$
(11)\quad H = \begin{bmatrix}
\sum_{j=1}^{3} z_{j,o}p_{j,1} & z_{2,0}(p_{1,1}-p_{2,1}) & z_{1,0}(p_{2,1}-p_{1,1}) & z_{3,0}(p_{1,1}-p_{3,1}) & z_{1,0}(p_{3,1}-p_{1,1}) & z_{3,0}(p_{2,1}-p_{3,1}) & z_{2,0}(p_{3,1}-p_{2,1}) \\
\sum_{j=1}^{3} z_{j,1}p_{j,2} & z_{2,1}(p_{1,2}-p_{2,2}) & z_{1,1}(p_{2,2}-p_{1,2}) & z_{3,1}(p_{1,2}-p_{3,2}) & z_{1,1}(p_{3,2}-p_{1,2}) & z_{3,1}(p_{2,2}-p_{3,2}) & z_{2,1}(p_{3,2}-p_{2,2}) \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\sum_{j=1}^{3} z_{j,T-1}p_{j,T} & z_{2,T-1}(p_{1,T}-p_{2,T}) & z_{1,T-1}(p_{2,T}-p_{1,T}) & z_{3,T-1}(p_{1,T}-p_{3,T}) & z_{1,T-1}(p_{3,T}-p_{1,T}) & z_{3,T-1}(p_{2,T}-p_{3,T}) & z_{2,T-1}(p_{3,T}-p_{2,T}) \\
z_{1,0} & z_{2,0} & -z_{1,0} & z_{3,0} & -z_{1,0} & 0 & 0 \\
z_{1,1} & z_{2,1} & -z_{1,1} & z_{3,1} & -z_{1,1} & 0 & 0 \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
z_{1,T-1} & z_{2,T-1} & -z_{1,T-1} & z_{3,T-1} & -z_{1,T-1} & 0 & 0 \\
z_{2,0} & -z_{2,0} & z_{1,0} & 0 & 0 & z_{3,0} & -z_{2,0} \\
z_{2,1} & -z_{2,1} & z_{1,1} & 0 & 0 & z_{3,1} & -z_{2,1} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
z_{2,T-1} & -z_{2,T-1} & z_{1,T-1} & 0 & 0 & z_{3,T-1} & -z_{2,T-1}
\end{bmatrix}.
$$

For identification of θ H must have full column rank. However if we add columns 1, 5 and 7 in H we obtain the zero-vector and hence H has reduced rank. Thus the b-parameters are not identified.

Urga (1999) considered a constrained symmetric model in which $b_{21} = b_{12}, b_{31} = b_{13}$ and $b_{32} = b_{23}$. Below we show that identification is not obtained even in this model. Instead of (10) we now have

$$
(12)\quad \mathrm{vec}(y) = (I_3 \otimes x)D_s\theta_s + \mathrm{vec}(\varepsilon),
$$

where $\theta_s = (b, \quad b_{12}, \quad b_{13} \quad b_{23})'$.

The matrix D_s is of dimension 36×4 and is given in Appendix A. We can now derive the 3T×4 matrix $H_s = (I_3 \otimes x)D_s$ as

$$
(13)\quad H_s = \begin{bmatrix}
\sum_{i=1}^{3} z_{i,0}p_{i,1} & z_{1,0}(p_{2,1}-p_{1,1}) + z_{2,0}(p_{1,1}-p_{2,1}) & z_{1,0}(p_{3,1}-p_{1,1}) + z_{3,0}(p_{1,1}-p_{3,1}) & z_{2,0}(p_{3,1}-p_{2,1}) + z_{3,0}(p_{2,1}-p_{3,1}) \\
\sum_{i=1}^{3} z_{i,1}p_{i,2} & z_{1,1}(p_{2,2}-p_{1,2}) + z_{2,1}(p_{1,2}-p_{2,2}) & z_{1,1}(p_{3,2}-p_{1,2}) + z_{3,1}(p_{1,2}-p_{3,2}) & z_{2,1}(p_{3,2}-p_{2,2}) + z_{3,1}(p_{2,2}-p_{3,2}) \\
\vdots & \vdots & \vdots & \vdots \\
\sum_{i=1}^{3} z_{i,T-1}p_{i,T} & z_{1,T-1}(p_{2,T}-p_{1,T}) + z_{2,T-1}(p_{1,T}-p_{2,T}) & z_{1,T-1}(p_{3,T}-p_{1,T}) + z_{3,T-1}(p_{1,T}-p_{3,T}) & z_{2,T-1}(p_{3,T}-p_{2,T}) + z_{3,T-1}(p_{2,T}-p_{3,T}) \\
z_{1,0} & z_{2,0}-z_{1,0} & z_{3,0}-z_{1,0} & 0 \\
z_{1,1} & z_{2,1}-z_{1,1} & z_{3,1}-z_{1,1} & 0 \\
\vdots & \vdots & \vdots & \vdots \\
z_{1,T-1} & z_{2,T-1}-z_{1,T-1} & z_{3,T-1}-z_{1,T-1} & 0 \\
z_{2,0} & z_{1,0}-z_{2,0} & 0 & z_{3,0}-z_{2,0} \\
z_{2,1} & z_{1,1}-z_{2,1} & 0 & z_{3,1}-z_{2,1} \\
\vdots & \vdots & \vdots & \vdots \\
z_{2,T-1} & z_{1,T-1}-z_{2,T-1} & 0 & z_{3,T-1}-z_{2,T-1}
\end{bmatrix}.
$$

This matrix is also of reduced rank. Multiplying column one with column three and adding the three remaining columns yields the zero matrix. Thus even adding symmetry does not secure identification. A more rigid restriction which leads to identification is to assume a *simple independent adjustment error correction mechanism.* This model is implemented by assuming that $b_{ij}=\delta_{ij}\, b$ (i,j = 1,2,3) , where $\delta_{ij} = 1$ for i=j and 0 for i≠j.

References

Allen, C., Urga G. 1999. Interrelated factor demands from dynamic cost functions: An application to the non-energy business sector of the UK economy. Economica 66, 403-413.

Anderson, G.J., Blundell, R.W. 1982. Estimation and hypothesis testing in dynamic singular equation systems. Econometrica 50, 1559-1571.

Berndt, E.R., Savin, N.E. 1975. Estimation and hypothesis testing in singular equation systems with autoregressive disturbances. Econometrica 43, 937-957.

Norsworthy, J.R., Harper, M.J. 1981. Dynamic models of energy substitution in US manufacturing. In: Berndt, E.R., Field, B.C. (Eds.), Modeling and Measuring Natural Resource Substitution. MIT Press, Cambridge, MA, Chapter 9.

Urga, G. 1996. On the identification problem in testing the dynamic specification of factor-demand equations. Economics Letters 52, 205-210.

Urga, G. 1999. An application of dynamic specifications of factor demand equations to interfuel substitution in US industrial energy demand. Economic Modelling 16, 503-513.

Urga, G., Walters, C. 2003. Dynamic translog and linear logit models: A factor demand analysis of interfuel substitution in US industrial energy demand. Energy Economics 25, 1-21.

Appendix A

The design of matrix D and D_s

The unrestricted case: Matrix D

For ease of exposition the matrix D is partitionned in the three submatrices $D_{1,}$ D_2 and D_3, each of dimension 12×7.

(A1) $$D = \begin{bmatrix} D_1 \\ D_2 \\ D_3 \end{bmatrix}.$$

The submatrices are given by

(A2) $$D_1 = \begin{bmatrix} 1 & 0 & -1 & 0 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & -1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}; \; D_2 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & -1 & 0 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}; \; D_3 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}.$$

The restricted (symmetric) case: Matrix D_s

The matrix D_s is partitioned in the three submatrices $D_{s,1,}$ $D_{s,2}$ and $D_{s,3}$ each of dimension 12×4.

(A3) $$D_s = \begin{bmatrix} D_{s,1} \\ D_{s,2} \\ D_{s,3} \end{bmatrix}.$$

The submatrices are given by

$$D_{s,1} = \begin{bmatrix} 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & -1 & 0 & -1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 0 & -1 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}; \quad D_{s,2} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}; \quad D_{s,3} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & -1 & 0 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \tag{A4}$$

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