

# Tricks with Hicks: Stata GMM code for nonlinear IV estimation

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- Arthur Lewbel and Krishna Pendakur “Tricks with Hicks: the EASI Demand System,” *American Economic Review*, June, 2009.
- Consumer demand estimation based on  $e(p, u) = \min_q \{p \cdot q \mid U(q) = u\}$
- Functional forms invertible in  $u$  to obtain empirical equations.
- Almost always express  $\ln e(\ln p, u)$ . Differentiation yields budget shares  $s_j = p_j q_j / w$ .
- Gorman and Lewbel show the maximum number of expenditure arguments is 3.
- Curvature of budget shares no greater than quadratic.

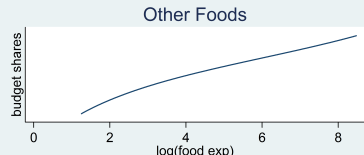
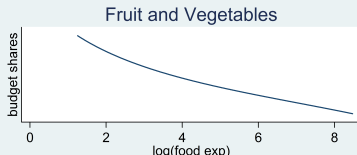
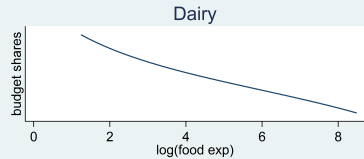
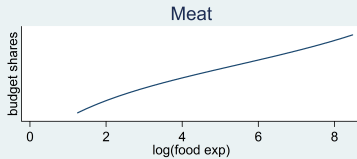
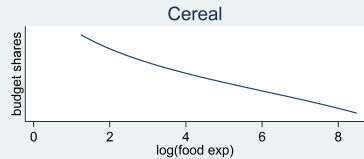
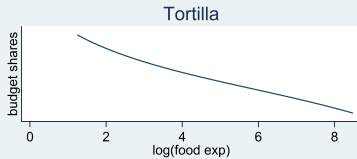
# Rank example – Mexican food demand

EASI demand system

The estimation problem

The Stone Index Approach

Estimation Procedure



- Utility,  $u$ , is ordinally equivalent to the Stone index  $y = w - s' \ln p$
- Introduce demographics  $z$  and preference heterogeneity  $\varepsilon$ .
- Example:  $\ln(e(p, u, z, \varepsilon)) = u + \ln(p)m(u, z) + \ln(p)\varepsilon$
- $s = m(u, z) + \varepsilon \Rightarrow u = y = \ln(w) - \ln(p)s \Rightarrow s = m(y, z) + \varepsilon$
- In general, no closed form solution for  $u$ , except for special forms of  $m(u, z)$ .
- Estimable, because function of observables after substitution of  $y$ .
- $u$  is linear function of  $\ln p$ .

- The Exact Stone Index is too restrictive for representation of consumer behavior.
- Make  $u$  ordinally equivalent to an affine function of  $y$ .
- $$e(p, u, z, \varepsilon) = u + p' \left[ \sum_{r=0}^5 b_r u^r + Cz + Dzu \right] + \sum_{l=0}^L \frac{1}{2} z_l p' A_l p + \frac{1}{2} p' B p u + p' \varepsilon$$
- $$m(u, z) = \sum_{r=0}^5 b_r u^r + Cz + Dzu$$
- $$s = \sum_{r=0}^5 b_r u^r + Cz + Dzu + \sum_{l=0}^L z_l A_l p + B p u + \varepsilon$$
- So, 
$$y = \frac{w - p' s + \sum_{l=0}^L z_l p' A_l p / 2}{1 - p' B p / 2}$$
- And 
$$s = \sum_{r=0}^5 b_r y^r + Cz + Dzy + \sum_{l=0}^L z_l A_l p + B p y + \varepsilon$$

- Substitute  $y$  in  $s$ . Then  $s$  is endogenous and can be instrumented by  $p$ ,  $z$  and their functions.
- IV estimation of nonlinear system of equations by FRML in TSP.
- AER Software archive contains Stata code for estimation.
- Iterative linear estimation with linear 3SLS in the second stage treating  $y$  as endogenous.
- Introduction of `gmm` command in Stata 10 makes IV estimation of nonlinear system in Stata feasible.