Tricks with Hicks: Stata GMM code for nonlinear IV estimation

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Consumer demand estimation based on 
\[ e(p, u) = \min_q \{ p \cdot q | U(q) = u \} \]

Functional forms invertible in \( u \) to obtain empirical equations.

Almost always express \( \ln e(\ln p, u) \). Differentiation yields budget shares \( s_i = p_i q_i / w \).

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

- Tortilla
- Cereal
- Meat
- Dairy
- Fruit and Vegetables
- Other Foods
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 $s = \sum_{r=0}^{5} b_r y^r + Cz + D z y + \sum_{l=0}^{L} z_l A_l p + B p y + \varepsilon$
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.