

Finishing Touches – My Current Research Agenda: Lecture XL

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Returns to Research Expenditures – Cointegration in Panel Data

- The establishment of the Land Grant University System is usually touted as one of the "success stories" in American history.
 - Under the Morrill Act of 1862, each state was given land to sell in order to endow colleges dedicated to the pursuit of agricultural and technical studies.
 - The Hatch Act of 1887 extended the mandate by establishing Agricultural Experiment Stations in each state to conduct agricultural research.
 - The Smith-Lever Act of 1914 then provided for the establishment of the Cooperative Extension Service to put the technology developed in the Agricultural Experiment Station in the hands of farmers.

Returns to Research Expenditures – Continued

- After 150 years of give and take – increased funding in periods of the Great Society to relative periods of scarcity in recent years – most of the funding for agricultural education, research, and extension is provided by each state.
- The reoccurring question is: Are we getting a positive return for the money we spend?
- Moss, C.B. 2006. Valuing State Level Funding for Research: Results for Florida. *Journal of Agricultural and Applied Economics* 38(1), 169-183.

$$x_t = \begin{bmatrix} \ln(TFP_t) \\ \ln(RD_t) \\ \ln(NCI_t) \end{bmatrix} \Rightarrow \Delta x_t = \Pi x_{t-1} + \sum_{j=1}^k \Gamma_j \Delta x_{t-j} + \Phi D_t + \epsilon_t \quad (1)$$

Cointegration

- The vectors are cointegrated if $\Pi = \alpha\beta'$ or Π is singular

$$\Pi = (X'X)^{-1} (X \Delta X) \quad (2)$$

- Following Johansen (1995)

$$\begin{aligned} Z_{0t} &= \alpha\beta' Z_{1t} + \psi Z_{2t} + \epsilon_t \\ Z_{0t} &= \Delta x_t \\ Z_{1t} &= x_{t-1} \\ Z_{2t} &= \left(\begin{array}{cc} \{ \Delta x_{t-i} \}_{i=1}^k & D_t \end{array} \right) \end{aligned} \quad (3)$$

Cointegration – Continued

- Projected regression equations

$$Z_{0t} = \theta_1 Z_{1t} + \theta_2 Z_{2t} + \epsilon_t$$

$$V \begin{bmatrix} Z_{0t} \\ Z_{1t} \\ Z_{2t} \end{bmatrix} = \begin{bmatrix} M_{00} & M_{01} & M_{02} \\ M_{10} & M_{11} & M_{12} \\ M_{20} & M_{21} & M_{22} \end{bmatrix} \quad (4)$$

- Estimating the Cointegration

$$\hat{\theta}_1 = \Sigma_{11.2}^{-1} \Sigma_{01.2} \Leftarrow \begin{cases} \Sigma_{11.2} = M_{11} - M_{12} M_{22}^{-1} M_{21} \\ \Sigma_{01.2} = M_{00} - M_{02} M_{22}^{-1} M_{20} \end{cases} \quad (5)$$

Cointegration – Continued

- Following Johansen's notation

$$\begin{aligned} S_{00} &= M_{00} - M_{02}M_{22}^{-1}M_{20} \\ S_{01} &= M_{01} - M_{02}M_{22}^{-1}M_{21} \\ S_{11} &= M_{11} - M_{12}M_{22}^{-1}M_{21} \end{aligned} \quad (6)$$

- Solving for $\alpha(\beta)$ using ridge regression techniques

$$\alpha(\beta) = S_{01}\beta(\beta'S_{11}\beta)^{-1} \quad (7)$$

- The variance matrix for the endogeneous vector based on β can be expressed as

$$\Omega(\beta) = S_{00} - S_{01}\beta(\beta'S_{11}\beta)^{-1}\beta'S_{10} \quad (8)$$

Cointegration – Continued

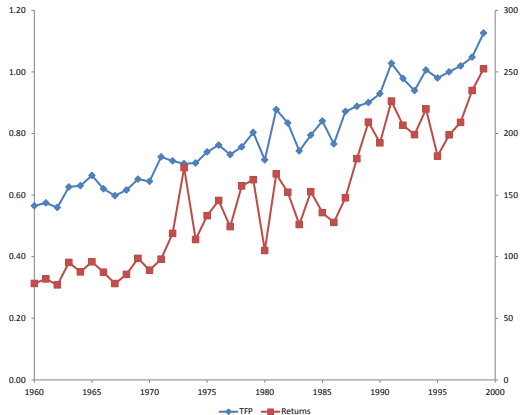
- The Likelihood function for cointegration then becomes

$$L_{\max}^{-\frac{2}{T}} = \frac{|S_{00}| |\beta' (S_{11} - S_{10} S_{00}^{-1} S_{01}) \beta|}{|\beta' S_{11} \beta|} \quad (9)$$

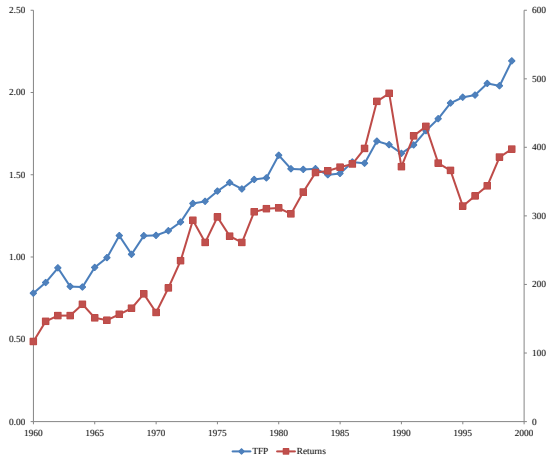
$$\Rightarrow |\lambda S_{11} - (S_{11} - S_{10} S_{00}^{-1} S_{01})| = 0$$

- So, all I need is the correct variance matrix?
- What about a fixed-effect variance matrix?

Returns and TFP – Alabama, 1960-1999



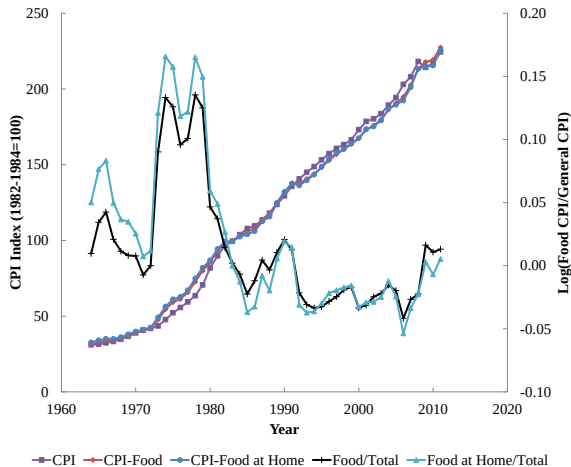
Returns and TFP – Florida, 1960-1999



Biofuels and Relative Agricultural Outputs

- Most of us grew up thinking that the long-run agricultural supply was relatively flat.
 - Supply expanded in the mid 1970s to offset increased international demand for wheat.
 - Periods of high prices are relatively short-lived as the supply of crops and livestock expand.
- The high energy prices and the onset of the recession coupled with the emergence of biofuels appears to bring these assumptions into question.
- Recently, some have suggested that food price inflation has systematically exceeded the overall rate of inflation since the onset of the recession of 2009. They attribute this persistence to biofuels.

Fact or Fiction



Translog Cost Function

- One way to investigate this question is by the estimation of a Translog Cost function

$$\begin{aligned} \ln(C_t) = & \alpha_0 + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix}' \begin{bmatrix} \ln(w_{1t}) \\ \ln(w_{2t}) \\ \ln(w_{3t}) \\ \ln(w_{4t}) \end{bmatrix} + \frac{1}{2} \begin{bmatrix} \ln(w_{1t}) \\ \ln(w_{2t}) \\ \ln(w_{3t}) \\ \ln(w_{4t}) \end{bmatrix}' \begin{bmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{12} & A_{22} & A_{23} & A_{24} \\ A_{13} & A_{23} & A_{33} & A_{34} \\ A_{13} & A_{23} & A_{34} & A_{44} \end{bmatrix} \begin{bmatrix} \ln(w_{1t}) \\ \ln(w_{2t}) \\ \ln(w_{3t}) \\ \ln(w_{4t}) \end{bmatrix} \\ & + \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \end{bmatrix}' \begin{bmatrix} \ln(y_{1t}) \\ \ln(y_{2t}) \\ \ln(y_{3t}) \end{bmatrix} + \frac{1}{2} \begin{bmatrix} \ln(y_{1t}) \\ \ln(y_{2t}) \\ \ln(y_{3t}) \end{bmatrix}' \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{12} & B_{22} & B_{23} \\ B_{13} & B_{23} & B_{33} \end{bmatrix} \begin{bmatrix} \ln(y_{1t}) \\ \ln(y_{2t}) \\ \ln(y_{3t}) \end{bmatrix} \\ & + \begin{bmatrix} \ln(w_{1t}) \\ \ln(w_{2t}) \\ \ln(w_{3t}) \\ \ln(w_{4t}) \end{bmatrix}' \begin{bmatrix} \Gamma_{11} & \Gamma_{12} \\ \Gamma_{21} & \Gamma_{22} \\ \Gamma_{31} & \Gamma_{32} \\ \Gamma_{41} & \Gamma_{42} \end{bmatrix} \begin{bmatrix} \ln(y_{1t}) \\ \ln(y_{2t}) \\ \ln(y_{3t}) \end{bmatrix} \end{aligned} \quad (10)$$

- 36 parameters (without covariance terms 46 with covariance terms) – 62 observations (tight)

Dynamic Translog

- One possible response to this fixity is the estimation of a dynamic form of the Translog

$$\ln(\tilde{C}_t) = m \ln(C_t) + (1 - m) \ln(C_{t-1}) +$$

$$(1 - m) \left(\sum_{i=1}^n \tilde{s}_{i,t-1} \ln(w_{it}) - \sum_{i=1}^n s_{i,t-1} \ln(w_{i,t-1}) \right) + \sum_{i=1}^n \sum_{j=1}^n b_{ij} (s_{j,t-1} - \tilde{s}_{j,t-1}) \ln(w_{it})$$

$$\tilde{s}_t = m s_t^* + (1 - m) \tilde{s}_t + B (s_{t-1} - \tilde{s}_{t-1}) \quad (11)$$

where $\tilde{C}_t$ and $\tilde{s}_t$ are the observed cost and shares of input expenditures in year t (respectively), m is the error-correction coefficient for the overall cost function, and B is a matrix of error-correction coefficients specific to each factor of production.

Dynamic Translog – Continued

- 53 parameters (without covariance terms 63 with covariance terms) – 61 observations (singular).
- Solution – Bayesian Estimation of Seemingly Unrelated Regression.

Test Questions – Theory

- **Generalized Least Squares:** A discussion of Aiken's theorem probably within the context of seemingly unrelated regression.
 - Traditionally, cost function systems are estimated using seemingly unrelated regression an imposing cross equation restrictions – explain the efficiency and/or consistency advantages to this approach.

Theory – Continued

- **Endogeneity:** A discussion of the effect of endogeneity on estimation.
 - Assume that you are interest in estimating the effect of the price of high fructose corn syrup on the demand for sugar used by agribusiness in the United States

$$q_{st} = \alpha_0 + \alpha_1 p_{st} + \alpha_2 p_{ht} + \alpha_3 q_{ct} + \alpha_4 q_{St} + \epsilon_t \quad (12)$$

where q_{st} is the quantity of sugar used by agribusinesses in the United States, p_{st} is the price of sugar in the United States, p_{ht} is the price of high fructose corn syrup, q_{ct} is the quantity of confectionary ouputs, q_{St} is the quantity of soft drinks sold in the United States, and ϵ_t is the residual. What could bias the estimation of these parameters?

- **Selection Bias**
 - Bid on farmland values as a function of creditworthiness.
 - Reduction in poverty as a function of a coffee program.

Test Questions – Empirical

- Estimate a Just and Pope production function, adjusting for heteroskedasticity.

$$y_t = \alpha_0 + \alpha_1 x_{1t} + \alpha_2 x_{2t} + A_{11} x_{1t} x_{1t} + A_{12} x_{1t} x_{2t} + A_{22} x_{2t} x_{2t} + \epsilon_t \quad (13)$$

- Estimate a system of cost equations or a differential supply system using either seemingly unrelated regression or maximum likelihood.
- Estimate a fixed effect model of a production function.