Agricultural and Rural Finance Markets in Transition

Proceedings of Regional Research Committee NC-1014
St. Louis, Missouri

October 4-5, 2007
Dr. Michael A. Gunderson, Editor
January 2008
Food and Resource Economics
University of Florida
PO Box 110240
Gainesville, Illinois 32611-0240

State Level Evidence of the Boom/Bust Cycle for Farmland

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This paper reexamines the evidence of the boom-bust hypothesized by Schmitz (1995). The boom-bust cycle has dramatic implications for the farm sector. As discussed by Mishra, Moss, and Erickson (2007) farmland values have historically accounted for 70 percent of the agricultural balance sheet. Thus, financial innovations that impinge farmland values can imply either stress for the farm sector (as experienced during the mid and late 1980s) or booms (as recently experienced in several states as increased urban pressures have increase farmland prices [Livanis et al. 2006]). Mishra, Moss, and Erickson determined that this effect may be amplified by failures in the agricultural capital market. The results of this study indicate that the present value model proposed by Schmitz holds between states, but not within a specific state. Part of this variation is explained by the effect of inflation on farmland values (consistent with the findings of Moss [1997]). However, the panel dimension of the boom-bust formulation raises as many questions as it answers.

Modeling Changes in Farmland Values

Financial theory suggests that a firm should adopt a project if the net present value of that project is positive

$$NPV = I_0 + \sum_{i=1}^{N} \frac{E_t CF_{t+i}}{\prod_{j=1}^{i} (1 + r_{t+j})} \quad (1)$$

where NPV_t is the net present value of the investment, I_0 is the purchase price of the investment, $E_t CF_{t+i}$ is the expected cash flow in period $t+j$ given information available in period t, r_{t+j} is the appropriate discount rate in period $t+j$, and N is the economic life of the investment. Using arbitrage arguments, the value of the asset in period t, V_t,, then becomes

$$V_t = \sum_{i=1}^{N} \frac{E_t CF_{t+i}}{\prod_{j=1}^{i}(1+r_{t+j})} \quad (2)$$

with $N \to \infty$ in the case of land.

We derive a model for asset values based on changes in the asset valuation equation over time. Specifically, taking the first difference of Equation 2 yields

$$\Delta V_t = V_t - V_{t-1} = \sum_{i=1}^{\infty} \frac{E_t CF_{t+i}}{\prod_{j=1}^{i}(1+r_{t+j})} - \sum_{i=0}^{\infty} \frac{E_{t-1} CF_{t+i}}{\prod_{j=0}^{i}(1+r_{t+j})}. \quad (3)$$

Aggregating over like exponents, we derive

$$\Delta V_t = -\frac{E_{t-1}CF_t}{(1+r_t)} + \frac{1}{(1+r_t)} \sum_{i=1}^{\infty} \frac{(1+r_t)E_t CF_{t+i} - E_{t-1}CF_{t+i}}{\prod_{j=1}^{i}(1+r_{t+j})} \qquad (4)$$

which can be rewritten as

$$\Delta V_t = -\frac{E_{t-1}CF_t}{(1+r_t)} + \frac{r_t V_t}{(1+r_t)} + \gamma_t. \qquad (5)$$

If expectations are rational, then we would expect γ_t to be “white noise”, or that no information remains in the error term.

In order to test for boom/bust cycles using the theoretical results in Equation 5, we assume that $E_{t-1}CF_t \to CF_t$ or that expected cash flow in the next period can be proxied by observed cash flow in the next period. With this substitution Equation 5 can be reformulated as

$$\Delta V_t = \beta_1 \frac{CF_t}{(1+r_t)} + \beta_2 \frac{r_t V_t}{(1+r_t)} + \gamma_t. \qquad (7)$$

Testing for boom/bust cycles is then a two step process. First, we estimate β_1 and β_2 using the sample data and test for $\beta_1 = -1$ and $\beta_2 = 1$. If we fail to reject this hypothesis, the data are consistent with the general present value formulation and we turn our attention to the possibility of anomalies in γ_t which would point to boom/bust cycles. Given that the general asset valuation hypothesis cannot be rejected, we impose $\beta_1 = -1$ and $\beta_2 = 1$ and generate the sequence of γ_t to test for "white noise". At this point we depart from Schmitz by using the Ljung-Box test to examine whether the residuals are "white noise".

Some alternative explanations for changes in farmland value outside the present value framework include capital market imperfections. Specifically, Mishra, Moss, and Erickson found that the farm sector's debt-to-asset position affects the price of farmland. Implicitly, this result raises questions about the equilibrium in the agricultural capital market. The disequilibrium in the capital market generates several possible asset market deviations. One as described by Feldstein (1980) is disequilibrium between farmland markets and stock markets. In essence farmland becomes an inflationary hedge. We modify the original Schmitz model to allow for this inflationary hedge effect as

$$\Delta V_t = \beta_0 + \beta_1 \frac{CF_t}{1 +_3 r_t} + \beta_2 \frac{r_t}{1 + r_t} V_t + \beta_3 V_t i_t + \varepsilon_t \qquad (3)$$

(8)

where $V_t i_t$ farmland value at time t times the inflation rate at time t. This formulation focuses on the effect of inflation on land appreciation. From one perspective, we would anticipate that changes in the interest rate contain information about changes in inflation. Thus, if $\beta_2 \rightarrow 1$ the opportunity cost of capital explains changes in land values.

Data and Methods

This analysis uses the data used by Mishra, Moss, and Erickson. The data is the U.S. Department of Agriculture, Economic Research Service state-level data from 1960 to 2002. These annual data on land values, interest rates, returns to farm assets, government payments, and debt servicing ratios are derived from a variety of sources such as the Census of Agriculture, various USDA agencies, Federal Deposit Insurance Corporation (FDIC) call reports, and the Farm Credit System. This study defines the return to farmland as the gross revenues per acre less the expenditures on variable inputs as described by Erickson, Mishra, and Moss (2003). Average real interest rate is the average interest rate on farm business debt (i.e., ratio of interest expenses minus interest expenses associated with operators dwelling expenses to average farm debt). Our measure of inflation is the logarithmic change in the Personal Consumption Expenditure component of the Implicit Gross Domestic Product deflator.

Given the panel structure of the dataset, we use generalized least squares applied to panel data as described by Hsiao (1986). Specifically, we let X_i be the data matrix for each state over time, the first column of this matrix is the observed cash flow for each year divided by one plus the corresponding interest rate (i.e., for that year/state combination), the second column is the land value for the preceding times the interest rate divided by one plus the interest rate, and the final column is the land value in the preceding year times the inflation rate value of farmland in the preceding year. The dependent variable matrix, Y_i, is the change in farmland values between year $t+1$ and year t. The generalized least squares results are then given by

$$\hat{\beta}_{GLS} = \left[\frac{1}{T}\sum_{i=1}^{M} X_i' Q X_i + \psi \sum_{i=1}^{M} \left(\bar{x}_i - \bar{x}\right)\left(\bar{x}_i - \bar{x}\right)'\right]^{-1} \left[\frac{1}{T}\sum_{i=1}^{M} X_i' Q Y_i + \psi \sum_{i=1}^{M} \left(\bar{x}_i - \bar{x}\right)\left(\bar{y}_i - \bar{y}\right)'\right] \quad (9)$$

where $Q = I_T - \frac{1}{T}ee'$ and e is a conformable vector of ones (this is the sweep matrix), ψ is a relative weighting of the variance components ($\psi = \sigma_u^2 / (\sigma_u^2 + T\sigma_\alpha^2)$), $\bar{x}_i$ denotes the average value of x for a given individual i over time, and $\bar{x}$ is the average value of x across all individuals and time periods. This specification allows for the decomposition of the overall estimator into two components: the within estimator and the between estimator. The within estimator (β_{cv}) is the average regression coefficient across all individuals

$$\hat{\beta}_{cv} = \left[\sum_{i=1}^{M} X_i' Q X_i\right]^{-1} \left[\sum_{i=1}^{M} X_i' Q Y_i\right] \qquad (5)$$

and the between estimator is the regression relationship defined between the average observations for each individual

$$\hat{\beta}_b = \left[\sum_{i=1}^{M} (\bar{x}_i - \bar{x})(\bar{x}_i - \bar{x})'\right]^{-1} \left[\sum_{i=1}^{M} (\bar{x}_i - \bar{x})(\bar{y}_i - \bar{y})'\right] \qquad (6)$$

Given this estimator, we can then define the average intercept value across all individuals ($\hat{\mu}$) as

$$\hat{\mu} = \bar{y} - \hat{\beta}_{GLS}\bar{x}. \qquad (7)$$

To complete this formulation, we estimate σ_u^2 using the estimated variance from the uncorrected (i.e., homoskedastic) estimates of $\hat{\beta}_{cv}$ and σ_α^2 using a similar regression based on the sample means.

Results

The results of our estimation are presented in Table 1. In general, neither the fixed effects nor random effects model conform to our expectations from Equation 1. In both specifications, the effect of cash flow on changes in farmland values is negative while the opportunity return on farmland values is positive. Further, the effect of inflation is positive and statistically significant at any conventional confidence level. However, the between estimator is largely consistent with Equation 1, the effect of cash flow is negative (but statistically insignificant) while the effect of the opportunity cost approaches one and is statistically significant at any conventional confidence level. The difficulty lies in the statistical significance of the inflation parameters. Specifically, this parameter is positive and statistically significant. Thus, bouts of inflation increase farmland values beyond that anticipated by the present value framework (i.e., the effect of inflation on the interest rate). This conclusion is consistent with Feldstein's conjecture that farmland values could form an inflationary hedge against stocks. The conclusion is also consistent with Moss who found that inflation contained more information on changes in farmland prices than either returns to farmland or interest rates.

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Table 1. Panel Estimates of the Boom/Bust Specification of Farmland Values

	Random Effects	Fixed Effects	Between Group
Constant	3.7739*	10.0321***	-5.4415**
	(2.1465)	(2.6178)	(2.0407)
Discounted Cash Flow	0.3261***	0.3622***	-0.0113
	(0.0328)	(0.0394)	(0.0530)
Interest on Land Value	-0.3073***	-0.5249***	0.9808***
	(0.0899)	(0.0974)	(0.2115)
Inflation	0.7152***	0.6112***	0.6047***
	(0.0713)	(0.0766)	(0.2170)

[a]Numbers in parenthesis denote standard errors
***Denotes statistical significance at the 0.01 level of confidence.
**Denotes statistical significance at the 0.05 level of confidence.
*Denotes statistical significance at the 0.10 level of confidence.