AGGREGATE EVIDENCE OF BOOM/BUST CYCLES IN DOMESTIC AGRICULTURE†

Andrew Schmitz and Charles B. Moss *University of Florida*

Abstract

Schmitz's 1980 Waugh lecture focused on the presence of boom/bust cycles for farm land values in Canadian data. This study finds evidence for the same phenomenon in U.S. data. Further, the boom/bust results cannot be explained by information on real interest rates or *ex post* observations on inflation.

keywords: present value, land values, boom/bust cycles

JEL Numbers: Q1, E3, C2

1. Introduction

Few topics seem to hold the perennial interest of policy makers, farmers, and agricultural economics as the relationship between farm income and farm asset values. In the recent past such issues as the elimination of government price support programs and macro/monetary policy's effect on the exchange rate have been discussed within the context of their effect on agricultural asset values. The reason for this focus is relatively straightforward. The dominant asset in production agriculture's balance sheet tends to be real estate. Further, agricultural real estate may be the ultimate in trapped productive assets. Hence, any fluctuation in agricultural returns tends to be reflected in farmland values.

The direct relationship between agricultural returns and agricultural asset values is not without detractions. Figure 1 depicts nominal agricultural asset values in the United States from 1950 to 1992 along with nominal returns to farmland and the nominal commercial paper interest rate. This graph depicts a general upward trend in agricultural asset values in the United States from 1950 to 1980 followed by a downward spiral in agricultural asset values which persisted until the late 1980s. This fluctuation in nominal agricultural asset values did not arise from fluctuations in nominal agricultural returns which remained fairly constant through the same time period, but bears some semblance to changes in the nominal interest rate over the same time period.

Schmitz's 1995 Waugh lecture at the American Agricultural Economics Association meeting in Indianapolis focused on micro evidence of boom/bust cycles in agricultural land values. Concisely stated, the boom/bust cycle is the tendency of markets to overvalue land in periods of prosperity while undervaluing land in periods of relative decline. Schmitz found evidence of boom/bust cycles in farmland in the Moose Jaw area of Saskatchewan. This paper extends his previous analysis in two ways. First, the study

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uses aggregate data for agricultural asset values in the United States. Second, and more importantly, the study attempts to explain factors leading to the boom/bust cycles by using ancillary information to remove the memory form the error structure.

2. An Empirical Model of Asset 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+i 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.

Following the approach in Schmitz, we first estimate asset values as a linear function of cash flows and the nominal interest rate

$$V_t = \alpha_0 + \alpha_1 CF_t + \alpha_2 r_t + \varepsilon_t (3)$$

where α_0, α_1, and α_2 are estimated coefficients and ε_t is an error term. Equation (3) gives rise to a host of hypothesis regarding asset valuation. The first hypothesis is that changes in the value of assets over time can be explained by changes in the level of cash flow and the nominal interest rate. Figure 1 would tend to support the idea that the nominal value of agricultural assets is positively correlated with the level of the nominal interest rates, but this result would appear inconsistent with the asset valuation formula in equation (2). The second hypothesis to be tested is that the error from equation (3) are "white noise" implying that past information about errors in the asset value cannot be used to predict future movements in the asset value. This "white noise" hypothesis is better formulated within the context of expectations, as will be discussed in the development of the next model.

After estimating the simple model for asset values, 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

$$\Delta V_t = V_t - V_{t-1} = \sum_{i=1}^{\infty} \frac{E_t CF_{t+i}}{\prod_{j=1}^{i}(1+r_{t+j})} - \sum_{i=0}^{\infty} \frac{E_{t-1} CF_{t+i}}{\prod_{j=0}^{i}(1+r_{t+j})} . \quad (4)$$

Aggregating over like exponents, we derive

$$\Delta V_t = -\frac{E_{t-1}CF_t}{(1+r_t)} + \frac{1}{(1+r_t)}\sum_{i=1}^{\infty}\frac{(1+r_t)E_tCF_{t+i} - E_{t-1}CF_{t+i}}{\prod_{j=1}^{i}(1+r_{t+j})} \quad (5)$$

which can be rewritten as

$$\Delta V_t = -\frac{E_{t-1}CF_t}{(1+r_t)} + \frac{r_tV_t}{(1+r_t)} + \gamma_t. \quad (6)$$

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 (6), 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 (6) can be reformulated as

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

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".

3. Data and Empirical Results

To examine the possibility of an aggregate boom/bust cycle in domestic agriculture, we use annual observations on asset values, returns to agricultural assets, and commercial paper rates from 1950 to 1992. Aggregate agricultural asset values are taken from the USDA data set along with net farm income. Returns for agricultural assets were computed by adding interest payments and rent paid to nonfarm landlords back to net farm income. The commercial paper rate taken from the Federal Reserve Board of Governors.

The 1950 to 1992 data period was selected based on prior results from Moss, Shonkwiler, and Schmitz. Specifically, Moss, Shonkwiler, and Schmitz examine the implied certainty equivalence for agricultural asset values from 1910 to 1992. Their findings suggest that the certainty equivalence on agricultural assets is an increasing function of the relative volatility of the real interest rate and the rate of return to agriculture. Thus, changes in asset values for the 1910 to 1992 period may be contaminated by changes in the underlying valuation of assets. However, their results also suggest a relatively homogenous relationship between the present value of agricultural assets and their market value from 1950 to 1992.

First, we fit the simple linear model proposed in equation (3). These results are given in table 1. The significance of the regression is undeniable with an $\bar{R}^2$ of 89.4% and statistically significant parameters for both income and interest. However, the Ljung-

Box test yields a test statistic of 30.72 distributed $\chi^2_{(10)}$ which can be rejected at any conventional level of significance.

Given the rejection of the most basic model, we turn to adjusting for significant structural shifts. One concept is the Russian grain deal and oil crisis in 1973; an anomaly which could potentially effect the information in the residuals. In addition, the shift in monetary policy and financial difficulties in the Farm Credit System in 1983 also have the potential to contaminate the results. To correct for this potential difficulty, we estimate the same linear model with two dummy variables to remove the effect of any anomalous behavior in 1973 and 1983. The results for this estimation given in table 2 indicate that the inclusion of these dummy variables did not significantly change the model's fit. In addition, the Ljung-Box test statistic of 34.42 indicates that information still remains in the residuals. Hence the linear model supports the concept of boom/bust cycles.

The regression coefficients for the most basic parameterization of equation (7) are given in table 3. The test for $\beta_1 = -1$ and $\beta_2 = 1$ yields an statistic of 1.82 which is distributed F(2,29). Thus, the present value restrictions cannot be rejected at any conventional confidence level. Next, we impose the restriction on the model to generate γ_t. The Ljung-Box test produces a test statistic of 78.331 which is distributed $\chi^2_{(10)}$ so the possibility that the errors are "white noise" is rejected at any traditional confidence level. Therefore, the aggregate domestic results agree with Schmitz findings for the Moose Jaw region. Specifically, the results confirm the existence of boom/bust cycles in aggregate agricultural asset values.

As in the simple linear model, we next adjust for anomalies by dummying 1973 and 1983 from the rest of the sample. Thus, we respecified the empirical model in equation (6) as

$$\Delta V_t = \beta_1 \frac{CF_t}{(1+r_t)} + \beta_2 \frac{r_t V_t}{(1+r_t)} + \beta_3 \delta_{1t} + \beta_4 \delta_{2t} + \gamma_t \quad (8)$$

where δ_{1t} and δ_{2t} are dummy variables which will remove the effect of any anomalous behavior in these two time periods. The results for this regression are found in table 4. Again testing $\beta_1 = -1$ and $\beta_2 = 1$ shows that the data are consistent with the general asset valuation process yielding a test statistic of 1.219 which is distributed F(2,37). In this instance, we impose the asset valuation equation by setting $\beta_1 = -1$ and $\beta_2 = 1$ and reestimating equation (7). These results are given in table 5. The residuals from this regression are used to test for "white noise" using the Lung-Box test yielding a test statistic of 57.54 which is distributed $\chi^2_{(10)}$. Thus, simply removing these observations does not explain the boom/bust cycle.

4. Testing Other Boom/Bust Hypothesis

Given the boom/bust findings from the asset model we turn to the problem of explaining how expectations could be wrong. An initial hypothesis is that farmland is acting as a "safe haven" in times of inflation. Thus, the information may be proxying information about either real interest rates or inflation. To test this hypothesis we estimate an ancillary regression based on the results from equations (8) with the asset valuation restrictions imposed. Specifically, we regress γ_t on first the real interest rate and then inflation. These results given in table 6 indicate that *ex post* inflation is statistically significant in explaining variation in the residuals from equation (8). However, the Ljung-Box test still rejects the hypothesis of "white noise" residuals.

5. Conclusions and Suggestions for Further Research

This study examines aggregate asset values confirms Schmitz's results for Canadian land values. Specifically, agricultural asset values are an increasing function of both nominal interest rates and cash income. Further development shows that information remains in the residual terms resulting in asset bubbles. These bubbles could be responsible for the boom/bust cycle postulated by Schmitz and others. Additional results indicate that these informational bubbles cannot be explained by changes in the real interest rate or *ex post* information on inflation.

References

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Table 1. Estimates of the Linear Asset Value Equation

Variable	Parameter Estimate	Std Error	t-Value
Constant	-109.093	35.150	-3.104
Income	10.898	1.071	10.171
Interest	37.367	6.541	5.712

Table 2. Estimates of the Linear Asset Value Equation with Dummy Variables

Variable	Parameter Estimate	Std Error	t-Value
Constant	-107.391	29.490	-3.642
Income	11.066	0.898	12.320
Interest	36.085	5.537	6.517
1973 Dummy	-253.091	87.537	-2.891
1983 Dummy	277.063	87.939	3.151

Table 3. Estimates from Basic Asset Valuation Equation

Variable	Parameter Estimate	Std Error	t-Value
β_1	-0.306	0.3794	-0.806
β_2	0.634	0.280	2.264

Table 4. Estimates of the Asset Valuation Equation with Removing 1973 and 1983

Variable	Parameter Estimate	Std Error	t-Value
β_1	-0.474	0.380	-1.251
β_2	0.761	0.286	2.662
β_3	68.855	41.219	1.670
β_4	-49.965	43.010	-1.162

Table 5. Parameter Estimates for the Dummy Variables Imposing Asset Valuation

Variable	Parameter Estimate	Std Error	t-Value
β_3	80.849	40.666	1.988
β_4	-51.245	40.666	-1.26

Table 6. Coefficients for the Ancillary Regressions to Test for the Effect of Inflation

Independent Variable	Parameter Estimate	Std Error	t-Value
Real Interest Rate	-3.627	2.005	-1.809
Ex Post Inflation	3.298	1.175	2.806

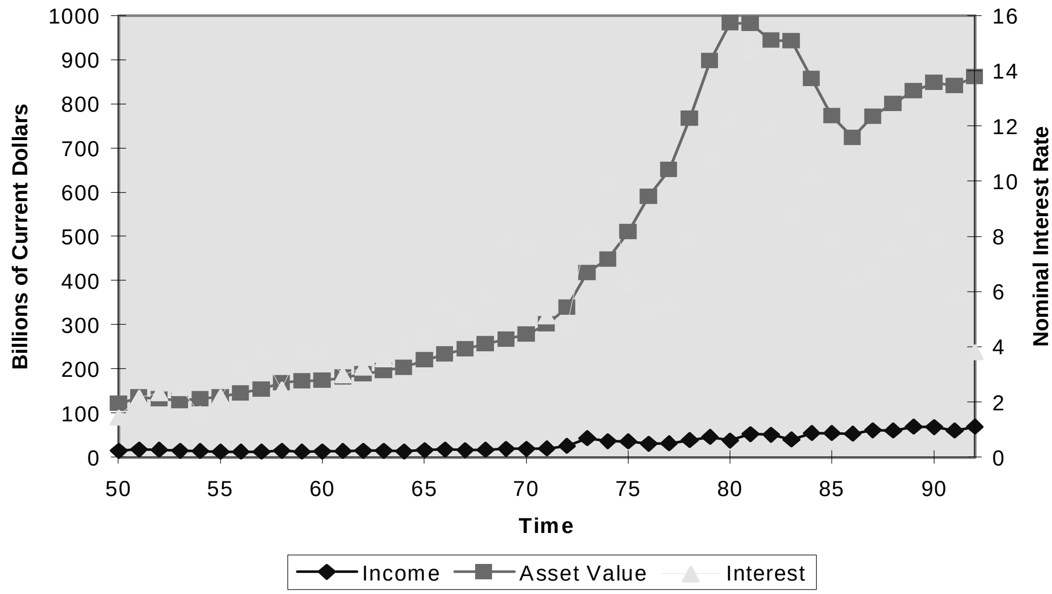

Figure 1. Historical Nominal Aggregate Agricultural Asset Values, Nominal Returns to Agricultural Assets, and Commercial Paper Rates in the United States (1950-1990)