

Three Stylized Facts Regarding Farmland Values

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Introduction

Factors affecting farmland values is a perennial topic in agricultural economics literature. Brake and Melichar (1977) review such literature for the period beginning at the end of World War II and ending at the hyperinflation of the 1970s.

Other authors such as Schmitz (1995) provide a review of the more current literature. The purpose of this paper is to present three stylized facts about the valuation of agricultural real estate. These facts are: (1) Farmland values appear to be appropriately priced in the long run; (2) farmland values are characterized by excessive volatility in the short run, raising the possibility of rational bubbles; and (3) changes in relative risk affect the valuation of agricultural real estate over time.

Several recurrent themes characterize this literature. Early work by Nowell focuses on a perceived overvaluation of farmland values at the end of World War II. This theme is continued by Herdt and Cochrane (1966) who attribute this continual appreciation to changes in technology. The literature then culminates with analyses of the effects of unrealized capital gains by Melichar (1979) and Plaxico and Kletke (1978).

Research into changes in farmland values then continued during the 1980s with several new themes emerging. Increased attention was focused on the expectation process following the inflationary boom of the 1970s. Efforts include Burt's 1986 use of a moving average process for returns; Featherstone and Baker's (1987) vector autoregression, which allowed expectations to be formed based on several variables; and Phipps's (1984) contribution of the factors affecting the profit function. The crux of these writings is that, if the expectations process was understood, agricultural assets could be appropriately priced.

Another variant that grew in popularity during the mid-1980s was the effect of taxes. Research into these effects stemmed from speculation that farm assets might form a safe haven from inflation or a method by which to transform operating income into capital gains. Alston empirically tested the latter hypothesis originally proposed by Feldstein (1980).

The last set of empirical efforts into farmland values involved the use of nonstationary time series models. The use of cointegration analysis is typified by Falk (1991) who found that farmland prices fail to cointegrate with returns to farmland. This finding led to rejection of the traditional present value formulation for farmland values. Falk's result appears to support an infinite disequilibrium between prices and the return to farmland; however, other efforts, such as those of Baffes and Chambers (1989) and Clark, Fulton, and Scott (1993), may be characterized in terms of rational bubbles that need not imply permanent disequilibrium.

The valuation of agricultural real estate thus appears well supported by the literature. Further support is found in literature that focuses on the effect of changes in agricultural asset values on the farm sector and rural communities. Schmitz's Waugh lecture (1995) proposes the existence of wealth multipliers that capture the effect of changes in asset values on economic activity in the rural economy. Harl's (1999) chronology of the farm debt crisis of the mid-1980s also supports the importance of agricultural real estate. Moss, Schmitz, and Erickson (1997) provide additional support for the significance of real estate values in determining the economic well-being of agriculture. They demonstrate that 58.4 percent of the variation in the debt-to-asset ratio for domestic agriculture can be attributed to changes in farmland values as compared with 21.8 percent of the variation that can be attributed to changes in the interest rate and 19.8 percent that can be attributed to changes in farm income.

Long-Term Equilibrium in Farmland Prices

At the outset, Falk's (1991) rejection of the traditional present value formula would appear fairly discouraging to the argument that agricultural asset prices are in long-run equilibrium; however, in this section I will revisit a parameterization of the present value model originally presented by Schmitz (1995) and will discuss subsequent results by Moss and Schmitz (1996) that indicate agricultural real estate values are in long-run equilibrium. The results from this formulation also provide evidence for short-run disequilibrium in farmland valuation.

My development of a long-run model of farmland values begins with the traditional present value formulation

$$(1) \quad V_t = \sum_{j=1}^{\infty} \frac{E_t CF_{t+j}}{\prod_{s=t+1}^{t+j} (1 + r_s)}$$

where V_t is the value of farmland in period t , $E_t CF_{t+j}$ is the expected cash flow in period $t + j$ based on information available in period t , and r_s is the cost of capital in period s .

Time-differencing Equation 1 yields

$$(2) \quad \Delta V_t = -\frac{E_t CF_{t+1}}{1 + r_{t+1}} + \frac{1}{1 + r_{t+1}} \sum_{j=2}^{\infty} \frac{(1 + r_{t+1}) E_{t+1} CF_{t+j} - E_t CF_{t+j}}{\prod_{s=t}^J (1 + r_s)}$$

The second term on the right side can be rewritten to yield

$$(3) \quad \Delta V_t = -\frac{E_t CF_{t+1}}{1 + r_{t+1}} + \frac{r_{t+1}}{1 + r_{t+1}} V_{t+1} + \gamma_t$$

This equation then indicates that the change in farmland prices over time equals the value of the observed cash flow less a rental value, or the pure value of interest plus an error term.

The test for long-run equilibrium is then based on the parameterization

$$(4) \quad \Delta V_t = \beta_1 \frac{E_t C F_{t+1}}{1 + r_{t+1}} + \beta_2 \frac{r_{t+1} V_{t+1}}{1 + r_{t+1}} + v_t$$

where β_1 and β_2 are estimated parameters and v_t is an error term. Long-run equilibrium under the present value formulation is guaranteed by $\beta_1 = -1$ and $\beta_2 = 1$.

Schmitz and Moss fail to reject $\beta_1 = -1$ and $\beta_2 = 1$; hence, they conclude that farmland values obey the traditional present value formula in the long run. Their finding appears inconsistent with Falk's finding that agricultural asset prices failed to cointegrate with returns from farmland. The difference, however, may involve the inclusion of a pure interest rate term in equation (4). Specifically, the pure rental value of agricultural assets changes with variations in the interest rate and asset value. Thus, any potential equilibrium, particularly in a cointegration formulation, that fails to take into account these changes may erroneously reject equilibrium between asset prices and returns.

Short-run Disequilibrium

Does the above formulation solve the disequilibrium problem between farmland values and returns per acre? The second hypothesis I propose is that agricultural asset values fluctuate too much in the short run, leading to short-run disequilibrium. This hypothesis is directly testable in the specification in equation (4). Given that the residual is white noise, additional information about the past fluctuations in asset prices cannot be used to improve the prediction of future asset prices. Unfortunately, the Ljung-Box test rejects white noise in the residuals. Thus, Moss and Schmitz (1996) conclude, as do Baffes and Chambers (1989) and Clark, Fulton, and Scott (1993), that farmland values in the short run exhibit bubbles.

As a first possible explanation of the additional information remaining in farmland values, they then augment the regression with changes in inflation and real interest rates. While changes in the interest rate are significant, neither augmentation eliminates the information

in the residuals. Thus, simple changes based on additional information from monetary and fiscal fluctuations appear inadequate in explaining deviations from the short-run equilibrium.

As an alternative to the structured analysis embodied in testing the long-term equilibrium above, Moss (1997) shifts to a simple single-period approach based on the infinite present value formulation:

$$(5) \quad v(t) = \frac{R(t)}{r(t)}$$

where $v(t)$ is the value of farmland, $R(t)$ is the annual return to farmland and $r(t)$ is the cost of capital. By logarithmic differentiation, Equation 5 can be transformed into

$$(6) \quad \frac{\partial \ln(v(t))}{\partial t} = \frac{\partial \ln(R(t))}{\partial t} - \frac{\partial \ln(r(t))}{\partial t}$$

which can be empirically implemented as

$$(7) \quad Dv_t = \alpha_0 + \alpha_1 DR_t + \alpha_2 Dr_t + \alpha_3 Di_t + \varepsilon_t$$

where $Dx_t = \ln(x_t) - \ln(x_{t-1})$. DR_t is then the discrete logarithmic change in returns to farm assets, Dr_t is the logarithmic change in the cost of capital to agriculture, Di_t is the logarithmic change in the price level, the α s are estimated parameters and ε_t is a random error.

Instead of focusing on the parametric estimates, I focused on the informational content of each variable. Specifically, the multiple correlation coefficient for any linear regression can be expressed as

$$(8) \quad (1 - R^2) = (1 - r_{01}^2) (1 - r_{02.1}^2) \cdots (1 - r_{0n.12 \dots (n-1)}^2)$$

where R^2 denotes the multiple correlation coefficient and $r_{02.1}^2$ denotes the partial correlation coefficient for the second variable, given that the effect of the first variable has been removed. Theil (1987) builds on a concept proposed by Kruskal (1987) by taking the $\log_2$ of the expression in Equation 8 to derive the bits of information in the regression.

The results of the information analysis then indicate that the majority of the information in the contemporaneous relationship between farmland prices, returns to agriculture, inflation and interest rates relates changes in farmland prices to changes in inflation over time. This then leads to a reexamination of the role of inflation through taxation. Alston (1986) examines the effect of changes in the tax code on agricultural assets by the inclusion of a polynomial lag term in a nonlinear regression for asset values. His findings indicate that lagged changes in asset values affect the current price of agricultural assets. This result is consistent with the Darby effect Investors attempt to keep the after-tax discount rate equal; however, Alstons specification lacks a systematic method by which to parameterize both the tax effect and the specification of the lag. Moss and Schmitz revisit Alston's specification by specifying a third degree Almond polynomial lag for lagged changes in asset values. Repeating the test, they simultaneously test for the statistical significance of both the lag specification and the tax effect. In addition, they expand the sample to allow for the estimation of the tax effect by state. The extended sample allows for the examination of the change in tax regime between the tax code that had capital gains exclusions and the tax code that treats capital gains as ordinary income. In contrast with Alstons original results, the experiments show little evidence of either a portfolio or a Darby effect. This lack of effect may be attributed to our use of aggregate data but is more likely attributable to the specification of structured lag effect.

In summation, I must conclude this section where I began. Empirical evidence suggests that changes in farmland values in the short run do not conform with traditional efficient market assumptions, and while the empirical results seem to indicate that this deviation may be explained in part by changes in inflation, we reject the traditional story that changes in

inflation affect agricultural assets through changes in taxation. Further, additional information along the lines of changes in real interest rate or unexpected changes in inflation do not remove the noise from the regression.

Changes in Certainty Equivalence

I conclude with some findings regarding changes in the riskiness of agricultural assets through time. A basic precept in financial economics is that the asset prices bear an appropriate price discount for risk. Following the development of risk in the Capital Asset Pricing Model (CAPM), Lintner (1965) states:

The analysis thus justifies viewing the market values as riskless-rate present values of certainty-equivalents of random future receipts, where certainty-equivalents are related to expected values by way of variances and covariances weighted by adjustment factors, γ_{it} , which may or may not be the same for each future period t (Lintner 1965, p.27).

In his development of the general equilibrium price for assets under risk, Mossin (1966) constructs a risk margin for asset j , m_j , defined as

$$m_j = r_j - r_n = \frac{\mu_j - \frac{p_j}{q}}{p_j}$$

[where r_j is the expected rate of return on asset j , r_n is the rate of return on the risk-free asset, μ_j is the expected price plus dividends for equity j in the next period, p_j is the price of asset j in the current period, and q is the price of the risk-free asset]. To compare the risk margins of two assets, j and k , we write

$$\frac{m_j}{m_k} = \frac{\mu_j - \frac{p_j}{q}}{\mu_k - \frac{p_k}{q}} \frac{p_k}{p_j}$$

These equations define relationships between the prices of risky assets in terms of given parameters only. We can then write

$$\frac{m_j}{m_k} = \frac{\bar{x}_j \sum_{\alpha} \sigma_{j\alpha} \bar{x}_{\alpha} p_k \bar{x}_k}{\bar{x}_k \sum_{\alpha} \sigma_{k\alpha} \bar{x}_{\alpha} p_j \bar{x}_j}$$

Now, $\bar{x} \sum_{\alpha} \sigma_{j\alpha} \bar{x}_{\alpha}$ is the variance of yield on the total outstanding stock of asset j ; $p_j \bar{x}_j$ is similarly the total value at market prices, of all asset j . Let us denote these magnitudes by V_j and R_j , respectively. In equilibrium, therefore, the risk margins satisfy

$$\frac{m_j R_j}{V_j} = \frac{m_k R_k}{V_k}$$

that is, the risk margins are such that the ratio between the total risk compensation paid for an asset and the variance of the total stock of the asset is the same for all assets (Mossin 1966, pp. 774-775).

Following Mossin's results

$$(9) \quad \theta_j R_j = \theta_k R_k,$$

$\theta_j = m_j/V_j$, or the certainty equivalents (or risk-compensated prices as denoted by Mossin) are the same in equilibrium.

Integrating this concept of certainty equivalence into the present value equation in Equation 1 we have

$$(10) \quad V_t = \theta_k \sum_{j=1}^{\infty} \frac{E_t C F_{t+j}}{\prod_{s=1}^j (1 + r_s)}$$

where θ_t is a certainty equivalent that could vary through time. This approach is also found in financial management texts (Weston and Brigham 1981, pp.480-490) and texts on agricultural asset valuation (Robison and Barry 1996, p.253).

The traditional CAPM models, such as those of Lintner and Mossin, relate the certainty equivalent with the covariance of the asset under study divided by the variance of the market portfolio. This result is typically denoted as the assets beta; however, it is dependent on arbitrage between all possible investment opportunities. Barry's (1980) results indicate:

Besides the low-systematic risk, positive alpha values imply that farm real estate has offered substantial premiums above those for systematic risk. Hence, for this historic period, returns data, and market index, investments in farm real estate by well-diversified investors appeared to outperform the market and most individual assets, too (Barry 1980, p.552).

This seemingly innocuous statement implies that selling the market index and buying farm assets could yield significant arbitrage gains. Thus, we conclude that farm assets over this period are not in risk equilibrium under the Lintner-Mossin framework. Barry also indicates one possible reason for this disequilibrium

Real estate generally is considered a relatively illiquid asset caused by high transaction costs, tax obligations, indivisibilities, and thin markets with less than 5% of total farmland changing hands annually. Hence, CAPMs failure to account for these effects may bias upwards the resulting returns to farmland. Farmers also are not considered well-diversified with farm ownership resting heavily in rural areas (USDA).

Hence, following Levy about the effects of limited diversification, these CAPM results for farm real estate may understate the true beta values and overstate the true alpha values (Barry 1980, p.552).

These shortcomings of CAPM would appear to point to an alternative formulation that explicitly accounts for rigidities, which could distort the equilibrium risk/return relationship. Moss, Shonkwiler, and Schmitz (2003) propose an empirical model based on the investment under uncertainty and irreversibility framework proposed by Dixit and Pindyck (1994).

Under this framework, an investment is made if the annual return exceeds a hurdle rate,

$$(11) \quad H = \frac{\beta}{\beta - 1} \rho K,$$

where β parameterizes the value of waiting

$$(12) \quad \beta = \frac{1}{2} \left[1 + \sqrt{1 + \frac{8\rho}{\sigma^2}} \right]$$

where ρ is a risk-appropriate discount rate, σ is the standard deviation on the geometric Brownian motion process for changes in the value of the investment, and K is the cost of investment. (For a concise review of the approach and an explanation of β see Dixit (1992)). Intuitively, k would be the required average rate of return for an investment under certainty. The $\beta/\beta - 1$ has the effect of increasing the required rate of return to adjust for increases in uncertainty.

Given that the returns are in equilibrium, equation (11) can be rearranged to obtain

$$(13) \quad K = \frac{\beta - 1}{\beta} \frac{H}{\rho}$$

where K is defined as the market price for farmland values, H/ρ is the present value of returns and $\beta - 1/\beta$ is a certainty equivalent. Moss, Shonkwiler and Schmitz then estimate a first-order Taylor series expansion as a function of the risk-free rate of return, the rate of return on agricultural assets, the variance of the risk-free interest rate and the variance of

the rate of return on agricultural assets. Their results suggest that the risk adjustment for agricultural assets changes over time. More specifically, the certainty equivalent declines as risk increases, implying that the price of agricultural assets falls as risk in agriculture rises.

The results from Moss, Shonkwiler and Schmitz are important in understanding the behavior of agricultural assets on two counts. First, changes in government programs, trade scenarios, etc., that affect the riskiness of the farm sector have an effect on agricultural assets aside from the mean effect. This is especially important in the wake of the new farm legislation that eliminates traditional programs such as CCC loans, which effectively provided a price floor and deficiency payments which also tended to stabilize incomes. The results of Moss, Shonkwiler and Schmitz indicate that the elimination of these programs implies lower asset values on two counts. The expected return on agricultural assets in the absence of these programs should lead to decreased farmland values. In addition, the increased risk implied by the elimination in the stabilization mechanisms will also decrease the farmland values.

Second, an explicit model of asset irreversibility may help develop a model of liquidity risk for agricultural real estate. A recurrent theme in Harls chronology of the farm debt crisis of the mid-1980s is the notion that insufficient buyers existed to absorb farmland being liquidated by commercial banks as farm loans failed. This narrowness in the farm asset market led to severe declines in farmland values at the same time farmers needed the liquidity most.

Conclusions and Suggestions for Further Development

In reading a book by F.F. Bruce (1984) I was introduced to the concept of writing on ancient papyrus scrolls, which evidently consisted of one smooth surface and another that was too rough for practical use. A manuscript was then considered long if it covered sides of the scroll. An unfavorable comment often used in ancient reviews noted that the manuscript

under review was written on both sides of the scroll but was still incomplete. This analogy is appropriate for research into farmland prices in agriculture. The brief literature review provided at the beginning of the paper indicates that agricultural economists have spent vast amounts of time attempting to understand the process by which farmland values are generated; however, the copious efforts have possibly raised more questions than they have answered.

This paper provides an overview of some major areas that may yield additional insight into the problem, but it is by no means all-encompassing. I see three major areas for further development in our understanding of farmland price changes. The first area involves further refinement of the expectations process for testing short- and long-run equilibriums in farmland markets. Specifically, I wish to apply the rational versus adaptive expectations framework used by Chow on stock market data to gain additional insight into the expectations process. Similar advances may be possible by reformulating Campbell and Shillers cointegration model for farmland values into a stochastic trend framework. The latter approach may rekindle research into the effect of technology on land prices.

A second major area of development involves the analysis of the local market for farmland. Our typical analysis is based on aggregate data and leaves some basic questions about the operation of the market unanswered. One hypothesis is that rational bubbles in the short run may be the result of these markets. A testable form of this hypothesis is that the coefficient of variation for farmland prices increases as the number of sales declines. Hence, the market may be underdetermined and more prone to using past sales data as information on current farmland values.

The answers to a final set of questions regarding liquidity premiums and lender reaction may facilitate our understanding of farmland prices.

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