

Lecture XXV: Valuing Farmland – Three Stylized Facts

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Readings for next time

Basic Asset Valuation Model

Three Stylized Facts

Long-Term Equilibrium

Short-Run Disequilibrium

Changes in Certainty Equivalence

Readings for Monday

- ▶ Erickson, K., A.K. Mishra, and C.B. Moss. 2003. Cash Rents, Imputed Returns, and the Valuation of Farmland Revisited. *Government Policy and Farmland Markets*. Iowa State University Press, pp. 223-235.
- ▶ Featherstone, A.M. and C.B. Moss. 2003. Capital Markets, Land Values, and Boom-Bust Cycles. *Government Policy and Farmland Markets*. Iowa State University Press, pp. 159-178.
- ▶ Moss, C.B. and A. Katchova. 2005. Farmland Valuation and Asset Performance. *Agricultural Finance Review* 65, 119-130.

Basic Asset Valuation Model

- ▶ A basic question in finance is – how much can I afford to pay for an asset?
- ▶ Following up on the basic capital budgeting model – we invest if the **Net Present Value**

$$NPV = -I_0 + \sum_{i=1}^N \frac{NCF_i}{(1+r)^i} \quad (1)$$

where NPV is the Net Present Value, NCF_i is the Net Cash Flow from the investment at time i , and r is the appropriate discount rate.

- Solving for the break-even value of I_0 , we set Equation 4 equal to zero and solve

$$V_t = I_0 = \sum_{i=1}^N \frac{NCF_i}{(1+r)^i} \quad (2)$$

where V_t is the value of the asset.

- As developed in Appendix D of Moss, given a constant net cash flow and interest rate Equation 2 can be simplified to

$$V_t = \frac{NCF_t}{r_t} \quad (3)$$

Three Stylized Facts

- ▶ 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.

Long-Term Equilibrium

- ▶ A long-run model of farmland values starts with the traditional present value formulation

$$V_t = \sum_{j=1}^{\infty} \frac{E_t CF_{t+j}}{\prod_{s=t+1}^{t+j} (1 + r_s)} \quad (4)$$

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 4 yields

$$\Delta V_t = -\frac{E_t CF_{t+1}}{1 + r_{t+1}} + \frac{1}{1 + r_{t+1}} \sum_{j=2}^{\infty} \frac{(1 + r_{t+1}) E_{t+1} CF_{t+j} - E_t CF_{t+j}}{\prod_{s=t}^J (1 + r_s)} \quad (5)$$

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

$$\Delta V_t = -\frac{E_t CF_{t+1}}{1 + r_{t+1}} + \frac{r_{t+1}}{1 + r_{t+1}} V_{t+1} + \gamma_t \quad (6)$$

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

$$\Delta V_t = \beta_1 \frac{E_t CF_{t+1}}{1 + r_{t+1}} + \beta_2 \frac{r_{t+1} V_{t+1}}{1 + r_{t+1}} + \nu_t \quad (7)$$

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

Short-Run Disequilibrium

- ▶ Moss (1997) shifts to a simple single-period approach based on the infinite present value formulation

$$v(t) = \frac{R(t)}{r(t)} \quad (8)$$

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 8 can be transformed into

$$\frac{\partial \ln(v(t))}{\partial t} = \frac{\partial \ln(R(t))}{\partial t} - \frac{\partial \ln(r(t))}{\partial t}. \quad (9)$$

- ▶ Which can be empirically implemented as

$$Dv_t = \alpha_0 + \alpha_1 DR_t + \alpha_2 Dr_t + \alpha_3 Di_t + \epsilon_t \quad (10)$$

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.

- ▶ 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.

Changes in Certainty Equivalence

- ▶ A basic precept in financial economics is that the asset prices bear an appropriate price discount for risk.
- ▶ Mossin 1966

$$m_j = r_j - r_n = \frac{\mu_j - \frac{p_j}{q}}{p_j} \quad (11)$$

- ▶ 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

$$\frac{m_j}{m_k} = \frac{\mu_j - \frac{p_j}{q}}{\mu_k - \frac{p_k}{q}} \frac{p_k}{p_j} \quad (12)$$

- ▶ These equations define relationships between the prices of risky assets in terms of given parameters only.

- We can then write

$$\frac{m_j}{m_k} = \frac{\bar{x}_j \sum_{\alpha} \sigma_{j\alpha} \bar{x}_{\alpha}}{\bar{x}_k \sum_{\alpha} \sigma_{k\alpha} \bar{x}_{\alpha}} \frac{p_k \bar{x}_k}{p_j \bar{x}_j} \quad (13)$$

- $\bar{x} \sum_{\alpha} \sigma_{j\alpha} \bar{x}_{\alpha}$ 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.

$$\frac{m_j R_j}{V_j} = \frac{m_k R_k}{V_k} \quad (14)$$

- ▶ Following Mossin's results

$$\theta_j R_j = \theta_k R_k, \quad (15)$$

$\theta_j = m_j / V_j$, 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 4 we have

$$V_t = \theta_k \sum_{j=1}^{\infty} \frac{E_t CF_{t+j}}{\prod_{s=1}^j (1 + r_s)} \quad (16)$$

where θ_t is a certainty equivalent that could vary through time.

- ▶ an investment is made if the annual return exceeds a hurdle rate,

$$H = \frac{\beta}{\beta - 1} \rho K, \quad (17)$$

where β parameterizes the value of waiting

$$\beta = \frac{1}{2} \left[1 + \sqrt{1 + \frac{8\rho}{\sigma^2}} \right] \quad (18)$$

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.

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

$$K = \frac{\beta - 1}{\beta} \frac{H}{\rho} \quad (19)$$

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.