Staff Paper

A SIMPLE FRAMEWORK FOR DETERMINING THE FUNDAMENTAL AGRICULTURAL-USE VALUE OF MICHIGAN FARMLAND

Steven D. Hanson

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Department of Agricultural Economics
MICHIGAN STATE UNIVERSITY
East Lansing, Michigan 48824

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hansons@msu.edu

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There is considerable interest in the determination of farmland values. Although alternative models exist, present value models have played a central role in recent studies of agricultural land markets. Alston (1986) uses a present value model to examine the effects of inflation and real growth in net rental income on farmland prices (see also Melichar, 1979). Present value models also underlie analysis of the dynamic behavior of farmland prices by Burt (1986); investigation of causality relations between farmland rents and prices by Phipps (1984); and analysis of the relationship between agricultural and nonagricultural land markets by Robison et al. (1985).

Several recent studies have examined the performance of present value models based on their ability to explain movements in farmland prices. Some studies have suggested that the present value model does not fully explain farmland prices (Featherstone and Baker). Falk(1991, 1992) and Hanson and Myers (1995) formally test the present value model and reject it as a complete explanation of farmland prices. Most recently, Falk and Lee (1998) find that fads and overreactions play a key role in the short-run behavior of farmland prices, while long-run prices explained by fundamental pricing components. These results suggest that farmland prices may deviate from the values suggested by the present value model in the short-run but, eventually, will return to the present value price over time. This suggests the present value model can be used to determine the long-run equilibrium value of farmland.

Present Value Model of Farmland Pricing

Many different theories of investment behavior all suggest that the current value of farmland can be expressed as the sum of the discounted expected future cash flows to owning farmland (Myers and Hanson). The nature of the discount rate depends on the particular theory of investment behavior being applied. A general expression of the present value model can be written as:

$$(1) \qquad P_t = E_t \sum_{t=1}^{n} \frac{CF_{t+j}}{\prod_{m=1}^{j} (1 + r_{t+m} + \delta_{t+m})}$$

where P_t is the value of farmland at it, $E_t[\cdot]$ is the expectation operates conditional on information at time t, CF_t is the cash flow in period t to farmland, r_t is the risk-free interest rate in period t, and δ_t is the risk premium in period t.

The models says that the value of farmland depends on the expected discounted value of future cash flows given the information available today. In its general form, the present value model allows the discount rate to change over time as the risk-free rate or the risk premium changes. The model is often simplified by assuming that the risk premium is constant over time ($\delta_t = \delta$) and/or that the risk-free rate is constant over time ($r_t = r$). Under these assumptions, the present value model can be written as

$$(2) \qquad P_t = \frac{E_t[CF_{t+1}]}{(1 + k)} + \frac{E_t[CF_{t+2}]}{(1 + k)^2} + \ldots \frac{E_t[CF_{t+n}]}{(1 + k)^n}$$

where $k = r + \delta$.

The implementation of the present value model require estimates of the expected future cash flows and the appropriate discount rates for those cash flows. The cash flows should be the expected cash flows over time based on the information available at the time the forecast is made. The discount rates reflect the risk rate and the risk premium required based on the risk of the cash flow stream over time.

Some assets, such as land, might be expected to generate cash flows indefinitely, so that $n \rightarrow \infty$. In this case (1) and/or (2) become difficult to calculate and so some simplifying assumption is usually made about the pattern of the expected cash flows in the future. For example if the cash flows are expected to grow at a constant rate g, where the discount rate is greater than the growth rate (i.e., k > g), then the present value model in (2) simplifies to (Ross et. al.).

(3) $$P_t = \frac{E_t[CF_{t+1}]}{k - g}.$$

If cash flows are believed to grow at a constant rate, then the value of farmland can be determined based only on an estimate of next year's cash flow, the growth rate of future cash flows.

Expected Future Cash Flows

[Jim will complete this]

Risk Adjusted Discount Rates

After estimating the future cash flow stream, the next required input into the present value model is the discount rate. While estimating the appropriate discount rate with any degree of precision is extremely difficult, there are a variety of investment theories that provide clues about the nature of the discount rate. Most theories suggest that the discount rate will depend on the risk free rate of return plus a premium that accounts for the "risk" of the cash flows that the investment will provide (Myers and Hanson, 1996). Thus the appropriate discount rate k_t is determined by

$$k_t = r_t + rp_t \tag{4}$$

where r_t is the risk free return during period t and rp_t is the risk premium during period t.

While the risk-free rate and the risk premium can vary over time, most practical capital budgeting applications use a single discount rate to discount all cash flows. This appears to be a reasonable simplification in the current economy and application. First, the current term structure of interest rates is relatively flat, providing some indication that the risk-free rate of return is not expected to change much in the foreseeable future. Second, while accounting for time-varying risk premiums may have some merit (Bjornson), it is complex and difficult to implement in practical applications. In addition, Hanson and Myers find no evidence of a time varying risk premium for farmland for at least one popular theory of investment behavior. Given the difficulty and lack of precision in estimating required discount rates in practice, it seems reasonable to estimate a single discount rate and apply it to all cash flows.

Estimating the Risk-Free Return

The risk free rate of return is typically estimated by using the current annualized rate of return for Treasury bills (T-bills) at the time the analysis is undertaken. The current rate or return on a one year T-bill, as of February 19, 1999, is about 4.7% (Federal Reserve Bank of Chicago). This number is easily obtained and updated from virtually any source that provides financial information. The only caution is that the rate is often presented in term of discount from a par value of 100 and needs to be slightly adjusted to obtain the correct measure of the risk-free return.

Estimating the Risk Premium

The risk premium is more difficult to estimate than the risk-free rate. The nature of the risk premium depends on the particular investment theory that is applied. Two major theories of investment behavior have been developed in recent years: Sharpe's Capital Assest Pricing Model (CAPM) and Ross's Arbitrage Pricing Theory (APT). Several studies have attempted to apply these theories to land and/or agricultural assets (e.g., Barry; Hanson and Myers; Bjornson and Innes). In general theses researchers have found these theories don't do a very good job of completely explaining the required returns to farmland or agricultural assets. What we are left with an inconclusive literature regarding the appropriate theory to apply to determine the risk premium for farmland. While it is difficult to specify exactly how investor behavior determines the appropriate size of the risk premium for land, we can look at the size of historical risk premiums paid to owners of farmland in order to gain some insights into the size of the risk premium required to hold farmland.

We face additional difficulties in determining the discount rate for a particular parcel of farmland because we seldom have enough information (cash flows, market values, etc.) necessary to calculate the return series necessary implement the above theories. Even if this information is available, there is usually so much "noise" in the data that the estimated risk premium is not very precise. The usual approach is to examine risk premiums for portfolios of similar assets for which the necessary data is available (Brealey and Meyers). In this application, we can look at historical land returns for Michigan and other areas to gain some insights into the size of the risk premium that is typically required for land investments.

Table 1. shows the average return and standard deviation of returns to both U.S. farmland and buildings and Iowa farmland from 1910 to 1989. The average return to farmland and buildings during the period was nearly 15% which provided a risk premium of around 10% over and above the risk -free rate during the period. Unfortunately, the risk premium also provides compensation for a number of factors of production, in addition to farmland, such as management, and needs to be adjusted downward to reflect the returns to land alone. The risk premium estimate, while clearly high, does provide information about the upper limits we might expect for the risk premium to farmland. That is, it is likely that the risk premium is below 10% as long as Michigan farmland is not significantly riskier than the average farmland in the U.S.

We also have market information available that provides an estimate of the lower bound of the risk premium. Because owners of farmland are residual claimants to returns and asset liquidation, they must bear risk that is greater than the suppliers of farm real estate debt capital. Because land owners bear additional risk, they must require a higher risk premium than required on real estate loans for farmland. The average interest rates on real estate loans for farmland during the third quarter of 1988 was 8.87% in Michigan (Federal Reserve Bank of Chicago, 1998). The interest rate on one-year treasury securities during that time period was about 5.1% implying a current risk premium to real estate lenders of 8.9% -5.1% = 3.8%. Thus it is reasonable to expect the risk premium to owners of farmland to be above 3.8% and less than 10%.

It would useful to get an estimate the risk premium paid directly to holders of farmland. The Iowa land value data series is one of the best long-term data series available on farmland and cash rent values and provides a measure of the return to holders of farmland in Iowa. The realized return over the period was about 10% per year which corresponds to nearly a 6% risk premium over and above the risk-free return during the period. This estimate is for farmland in Iowa, but does fall within our range of 3.8% to 10% for the risk premium. Note the relative large standard deviations for the return series and keep this in mind when making inferences about the accuracy at the estimates.

Table 1. Historical Arithmetic Average Returns for US Farmland, Iowa Farmland, and Short-Term Treasury Securities from 1910-1989

	US Farmland and Other Assets	Iowa Farmland	Risk-Free Return	Risk Premium US Farmland Iowa and Other Assets	Risk Premium Iowa Farmland
Average Return	14.77%	10.18%	4.43%	10.34%	5.82%
Standard Deviation	10.99	12.22	3.06	12.56	13.15

Notes: The U.S. return series was taken from the data used in Hanson and Myers. The cash flow estimates used to construct the returns provides a return to operator labor and management, household assets and production assets, buildings and land. Thus the return estimates are clearly above those required to hold land by itself. The Iowa data series was obtained from Iowa State University. This series is constructed of cash rent and land values and provides a direct estimate of the return to farmland in Iowa.

Estimating Risk Premiums Using the Constant Growth Assumption

Equation (3) can also be used to approximate the required return to farmland and the associated risk premium. Assuming cash flows grow at a constant rate and rearranging (3) allows us to estimate the required return as

(5)
$$k_t = \frac{E_t[CF_{t+1}]}{V_t} + g$$

Table 2 provides estimates of the growth rates and rent to value ratios using the results from an annual land value survey conducted at Michigan State University. Using (5) this implies the average required return to untiled land was 5% + 4.8% = 9.8% and the return to tiled land was 5.5% + 5.6% = 11.1% in the Southern lower peninsula of Michigan. The risk free rate of return during this period was approximately 5% which results in a risk premium of around 4.8% and 6.1% for untiled and tiled Michigan farmland during the period. These estimates appear consistent with the 6% long-term risk premium to Iowa farmland.

Table 2. Arithmetic Average Growth Rate and Rent to Value Ratio for Michigan Farmland from 1992 to 1997

	Untiled Land	**Tiled Land**
Growth Rate	4.81%	5.64%
Rent to Value Ratio	5.0%	5.5%

Note: Estimated from data reported various land value reports published by Michigan State University. See the Agricultural Economics Reports by Hanson et al.

Estimated Discount Rate

For a variety of reasons discussed earlier it is difficult to estimate the discount for a particular parcel of farmland with any degree of precision. Practical applications often base discount rates on returns for portfolios of similar assets. The required risk adjusted return for farmland will depend on the risk free rate plus the a premium to compensate investors for bearing risk. The risk-free rate is easy to approximate using treasury securities, currently about 4.7%. The appropriate risk premium is more difficult to estimate. Examination of historical data on U.S. farmland and borrowing rates in Michigan suggest that the risk premium to farmland likely falls between 3.8% and 10%. Assuming a constant growth for cash flows to land and using recent data on Michigan farmland yields an estimated risk premium of around 5% for untiled farmland and 6% for tiled farmland. These estimates are consistent with the 6% long-term risk premium estimated for Iowa farmland. Based on these data and assumptions, a reasonable discount rate to use to discount cash flows to farmland is the risk-free rate plus and 6% risk premium, or currently 10.7% (4.7% + 6%). Obviously, assuming precision to a fraction of percent is inappropriate given all the difficulties faced in the deriving the estimates and the discount rate used in the analysis can be rounded to the nearest percent (11% in this case). In addition, it would make sense to explore the impacts of slightly higher and lower risk premium, say in the 5 to 7% range. So the analysis could consider these alternative estimated discount rates: a low 10% rate; a best guess of 11%; and a high 12% rate.

Leverage and Tax Impacts

The required return is also complicated by the level of debt employed to finance the farmland purchase (Copeland and Weston). The returns estimated for the U.S. farmland series were returns to equity funds alone; while the returns to Iowa and Michigan farmland were returns to both debt and equity funds. This is another factor causing the estimated returns to U.S. farmland to be higher than the estimated returns to Iowa and Michigan farmland (remember equity funds will require a higher return than debt funds). The cash flows to Michigan and Iowa farmland provide a return to both debt and equity funds used to finance the land. Thus the estimated discount rate implicitly assumes a capital structure that is the same as the average capital structure used by firms that were sampled to generate the data series. Adjustments would need to be made to the discount rate if an alternative capital structure is used.

Taxes can also impact the required return (Copeland and Weston). The Iowa and Michigan farmland return estimates are before tax estimates to both debt and equity holders. These returns can be used to discount before-tax cash flows to farmland. If after-tax cash flows are estimated, then the returns will need to be adjusted to an after-tax basis. There are additional tax complications that are beyond the scope of most practical valuation projects.

Land Value Estimates

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