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John R. Fiske

Significant farm investment decisions, such as the farmland investment decision should be considered in the context of farm financial planning because of the important interactions that exist between investment and financing choices. These interactions arise for several reasons. For one, the earnings characteristics of different farm assets may yield varying debt capacities. For another, the earnings patterns may impinge differently on the liquidity of the farm business. To the extent that debt and liquidity have impacts on asset value, they may influence the price a buyer is willing to pay.

Financial planning, with its focus on feasibility, requires the simultaneous consideration of investment and financing choices as well as an assessment of the firm's liquidity needs. Capital budgeting models that employ the weighted average cost of capital largely ignore these interactions by assuming that financing and investment decisions can be made separately. Similarly, methods that incorporate financing terms in the cash flows of the project being analyzed treat the financing choice as if it were exogenous.

The purpose of this paper is to present a farm financial planning model in which the planned stock of debt and the planned investment in liquid assets are endogenous. The model is formulated as a linear programming problem. It will yield insights into the impact of debt financing and liquidity requirements on the bidding potential for farmland under different sets of expectations regarding farmland value and under different initial conditions of buyer wealth and liquidity.

The Conceptual Model

In the context of this model the problem facing the farmland buyer is to determine the maximum price to bid on farmland. It is hypothesized that he or she does this by assessing the after-tax income stream produced by the tract and the risk associated with that stream. Importantly, though, the buyer must also consider the cash flow effects of debt financing and liquid investments on that stream. The buyer is also subject to a series of constraints that impose limits on cash availability, borrowing capacity, and the desired liquid reserve. All of these considerations are made with the objective of maximizing the net present value of the owner's equity.

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Formulating the problem in terms of net present value creates some conceptual difficulties. For one, the maximization of net present value is consistent with utility maximization only in the situation where the investor is free to borrow or lend at the market rate of interest. In reality, investors often face capital markets in which borrowing and lending rates diverge. Furthermore, the concept of net present value assumes value additivity (or risk independence) which, in practical terms, means ignoring the portfolio effects of an incremental investments. Owners of proprietary firms or small, closely held corporations, however, may rely heavily on business diversification as a risk management strategy.

The net present value approach is in contrast with the farmland bid price model of Harris and Nehring which sets utility maximization as its objective function and explicitly considers the investor's existing portfolio and the covariance between it and the farmland acquisition. According to Adams (p. 538), the two approaches would be equal only where the investor were risk neutral or the acquisition of the farmland does not change the riskiness of the investor's portfolio.

Conceptual problems notwithstanding, the widespread acceptance of net present value and its relatively easy application to practical problems favor its use. In addition, the approach followed in this paper avoids the question of whether to use a weighted average cost of capital or to subtract debt principal and interest from project cash flows. Instead, the investment is first analyzed as if it were all-equity financed and only then are the impacts of financing "side-effects" considered. The conceptual basis for this approach was presented by Myers, Myers and Pogue, and Martin and Scott. Among the prominent side effects already mentioned are debt choice and liquidity requirements. Other important side effects may arise from dividend policy and equity financing in the case of the corporate firm, and from project interactions. In fact, the approach is sufficiently general to include any interaction that may be deemed important.

The agricultural economics literature has long recognized the importance of debt and liquidity management to the farm firm. Baker noted the existence of a financial component to the firm and the central role of liquidity in that component. Moreover, he stressed the importance of unused debt capacity as a source of liquidity. His conclusion was that asset selection would be influenced by the rate at which alternative assets absorbed credit.

Subsequent research imputed reservation prices on unused debt capacity to suggest how borrower risk aversion leads to internal credit rationing (Barry and Baker). Further work developed a conceptual basis for defining an optimal leverage ratio for the firm and the impact of credit risk on that optimum (Barry, Baker, and Sanint).

While concentrating on the limits of debt use to achieve firm growth, this research also has strong implications for capital budgeting in that it establishes a motivation for borrowers to optimize with respect to debt use. However, it does not establish the unique contribution of debt financing or liquidity needs in the formation of asset values.

For the purposes of this paper, two important assumptions are made with respect to the impact of debt financing and investment in liquid assets on asset valuation. First, the contribution of debt financing to the present value of the firm lies in the tax shield generated by the interest payments on debt. In other words, the value of the levered investment equals the value of the unlevered investment plus the present value of the tax shield from debt incurred in the investment. There may be other benefits to borrowing in cases where debt financing is subsidized.

For example, Castle and Hoch argue that the inflation of the 1970's and the adjustment lag inherent in the Federal Land Bank's method of pricing loans at their average rather than marginal cost combined to create a subsidy to FLB borrowers that became capitalized into farmland values. The value of this subsidy, ex ante, would depend on expectations regarding the FLB's interest rate policy as well as the rate of inflation. Likewise, seller installment contracts for farmland usually offer a lower-than-market rate of interest which may be bid into the price of seller-financed tracts (Eberle and Fiske).

The second important assumption is that the investment in liquid assets detracts from the present value of the investment because it creates a tax liability instead of a tax shield. This assumption is based on the idea that the maintenance of liquidity is equivalent to "negative borrowing." Liquidity is necessary because of the mismatch in timing of cash inflows and outflows and because of the uncertainty surrounding expectations of the timing and level of those flows. These uncertainties are defined largely by the characteristics of the assets and liabilities held by the firm and by the types of enterprises the firm engages in. Firms whose operations generate more uniform cash flows or whose assets normally consist of a high proportion of liquid items such as marketable inventories would likely have less of a liquidity management problem. In addition, insurance or hedging programs may be used to modify the characteristics of expected cash flows to enhance liquidity.

Given the relevant characteristics of the firm (the level and variability of its cash flows), desired liquidity is provided by investment in liquid assets and by the maintenance of unused credit capacity. The latter source may have advantages in the sense that it is probably less disruptive to investment and production plans (although to the extent that assets vary with regard to their contribution to borrowing capacity, investment plans are affected). Whatever its source, liquidity is costly. Investment in liquid assets creates a tax liability rather than a tax shield. Similarly, unused credit capacity represents a foregone tax shield. Thus, from the standpoint of maximizing net worth, debt is desirable while liquidity is not.

The Objective Function

The objective is to maximize the current value of the net worth of the farm business. The buyer is assumed to have an opportunity to purchase farmland. His investment decision involves the price to bid on the farmland. His financing decision is how much debt to use in making the purchase. He also has a decision to make with regard to the level of liquidity he wishes to maintain. The farm business can further be assumed to have existing assets and liabilities which can enter the formulation as autonomous variables.

Investment decision:

The investment decision is formulated with the assumption of all-equity financing and no investment in liquid assets. It is assumed that the risk characteristics of the investment in farmland can be assessed independently of the risk characteristics of the firm's existing assets. It is also assumed that the farmland investment is not contingent on or competitive with any other investment the firm may make.

The approach to determining V_h^1, the value of investment h as of the beginning of period 1, is to capitalize expected net cash flows at the firm's after-tax equity cost of capital,

$$(1) \qquad V_h^1 = \sum_{t=1}^{n} \frac{C(t)}{(1+k_e)^t},$$

where: $C(t)$ = the expected after-tax cash flow from the farmland investment in t. All cash flows are assumed to occur at the beginning of the period.

k_e = the equity cost of capital for the farmland investment, assuming the base case of all-equity financing. The cost of capital for the farmland investment may be different from the cost of capital for an investment in machinery, for example.

In cases where farm income is taxed as individual rather than corporate income, the usual assumption of a constant marginal tax rate may be invalid. Given the larger number of brackets for individual versus corporate income, marginal tax rates for individual income may vary over the relevant range of expected income. The value of C(t) will therefore equal earnings before the interest and taxes minus the change in taxes arising from the investment. The change in taxes is the difference between the firm's total tax liability with the investment and its total tax liability without the investment. The total tax liability is a function of incremental income as well as the income tax rate structure (Musser). The after-tax equity capitalization rate would also have to be modified to reflect a non constant marginal tax rate.

The derivation of k_e presents additional problems. It is normally described in the agricultural economics literature as an opportunity cost but beyond that, little guidance is given on how to determine it. Barry and Collins suggest a method for deriving a hurdle rate for investment analysis by the proprietary firm that is based on the principles of CAPM.

Farmland bid price models often specify planning horizons, primarily as a way of accounting for the value of realized capital gains (Crowley, Lee and Rask). The equation above could be modified so that,

(2) $$V_h^1 = \sum_{t=1}^{n} \frac{C(t)}{(1+k_e)^t} + \frac{V(n)}{(1+s_e)^n}.$$

where:

V(n) = the expected market value of the land at the end of the planning horizon.

s_e = the rate used to discount the future selling price of the farmland.

In the absence of changing expectations about the level of C(t), the value of V(n) evaluated at t=n would be,

(3) $$V(n) = \sum_{t=n+1}^{m} \frac{C(t)}{(1+k_e)^t}.$$

where m represents a point in time beyond n. Combining equations (2) and (3), equation (1) can be rewritten as

(4) $$V_h^1 = \sum_{t=1}^{m} \frac{C(t)}{(1+k_e)^t}.$$

As m approaches infinity, the equation becomes $V_h^1 = C/k_e$, the expression for a perpetuity.

This implies that any capital gains received at time n would be equal to the present value of the foregone cash flows over the period n to m. The same result would hold if C(t) were assumed at t=0 to be growing at a constant annual rate.

Under some conditions it may make sense to use equation (2) rather than the equation for a perpetuity. Crowley considered a special case in which farmland had potential alternative uses. In that situation, expected rental income reflected agricultural use while terminal value reflected the land's value in its alternative use. Lee and Rask's bid price model incorporates the situation in which land price rises with the rate of inflation while annual rent increases at a different rate. Both cases reflect underlying imperfections in the farmland market. But they also imply an additional element in the formulation of an ex ante bid price: namely, the optimal holding period for the asset.

Assuming that capital gains expectations are related to expectations of increased cash returns, the value of anticipated capital gains can be captured in a growth model. With anticipated growth, the value of a perpetuity at t=0 is

$$(5) \qquad V_h^1 = \frac{C_o\,(1+g)}{(k_e\;-g)}$$

where k_e equals the discount rate and g the expected per period growth rate in cash returns and $k_e>g$. Equation (5) implies the existence of capital gains in that $V_h^2 > V_h^1$ and $V_h^3 > V_h^2$, etc.

Also implied is a contingent tax liability on the capital gains. Thus, the value of the asset at t=0, given the assumption that it will be sold at t=n is,

$$(6) \qquad V_h^1 = \frac{C_o(1+g)}{(k_e-g)} \left[\frac{C_o(1+g)^n}{(k_e-g)} - V_h^1\right]\left[\frac{t_c}{(1+k_e)^n}\right]$$

where the term to the right of the minus sign represents the present value of the capital gains tax, payable at the rate t_c and due at time t=n when the asset is sold. As n grows large, the present value of the tax liability approaches zero.

As long as the incidence of capital gains is related to expectations of increasing net after-tax cash returns, there seems little reason to impose a time horizon on the investment decision. The farmland market may experience occasional shocks wherein the rate of change in farmland values differs from the rate of change in the current returns. But these shocks represent periods of disequilibrium in the market.

Debt financing decision:

The impact of debt financing on the net worth of the farm business has been identified as the tax shield on debt that results from the tax deductibility of interest payments. The impact is illustrated by computing the net present value of a loan to a borrower.

Assume that the borrower receives \$100 at t=0 with the obligation to repay the \$100 plus 10 percent interest at t=1. The borrower's tax bracket is assumed to be 30 percent. The net present value of the loan is:

$$NPV(D) = \$100 - \frac{\$100\ (1+.10(1-.30))}{(1+.10)}$$

$$NPV(D) = \$100 - \ \$97.27$$

$$NPV(D) = \$2.73$$

The net present value of the loan is the present value of tax shield provided by the interest expense. The interest rate on the loan rather than the firm's equity cost of capital is used to discount the payment of principal and interest because that rate represents the market's (creditor's) assessment of the riskiness of the cash flows necessary to service the debt. There may be other reasons for wanting to borrow, such as subsidized interest rates, and these reasons could be incorporated in NPV(D).

Assuming that the farm business will have taxable income in each period and that the marginal tax rate, τ, is known, the present value per dollar of debt outstanding in period t, computed at the start of period 1, can be expressed as:

$$(7) \qquad D_t^1 = \frac{\tau r}{(1+r)^t}\ .$$

Farm businesses limit their use of debt financing despite its advantages. The limit may reflect external or internal credit rationing either of which can be reflected in a constraint equation. Or, the limit may be implied in the objective function itself with the addition of a cost function which would increase with the amount of debt used.

Liquidity decision:

The impact of investment in liquid assets on the net worth of the firm measured by the net present value of the liquid asset. Assume that the liquid asset is a one-year, riskless, security that yields 8 percent per period. The investor pays \$100 at t=0 for the security and receives \$108 before taxes, at t=1. Given a tax rate of 30 percent, the net present value of the investment is:

$$NPV(L) = -\$100 + \frac{\$100(1+.08(1-.30))}{(1+.08)}$$

$$NPV(L) = -\$100 + \$97.78$$

$$NPV(L) = -\$2.22$$

This is the net present value of the tax liability created by the investment in the liquid asset. Under normal conditions, the return on the riskless, liquid asset would be less than the interest rate on debt. Thus, NPV(L) would be smaller in absolute value than NPV(D). Furthermore, the cash flow from the investment in the liquid asset is evaluated at the riskless rate of return rather than the farm business's cost of capital because, by definition, the riskless security is not in the same risk class as the farm business. The present value per dollar of investment in liquid assets can be expressed as:

$$(8) \qquad L_t^1 = \frac{\tau i}{(1+i)^t}.$$

where τ is the marginal tax rate and i the riskless rate of return.

The firm may wish to hold its liquidity in the form of unused debt capacity or it may hold a combination of liquid assets and unused debt capacity. The opportunity cost of unused debt capacity represents the foregone tax shield on debt. In the example given above, liquid assets would be a cheaper form of liquidity than unused borrowing capacity.

Putting the three elements together, the objective function is to find the investment, the debt level, and the level of investment in liquid assets that maximizes the value of the firm's net worth, NW, evaluated at the beginning of t=1:

$$(9) \qquad NW^1 = \sum_{h=0}^{N} X_h V_h^1 + \sum_{t=0}^{T} Y_t D_t^1 + \sum_{t=0}^{T} Z_t L_t^1.$$

The Constraints

The farm business faces important constraints in achieving its objective. One of the requirements for a feasible investment and financing plan is that cash sources and uses be equal.

Furthermore, the firm is constrained in its debt decision by a limit on debt capacity. Finally, the firm is constrained to maintain a particular level of liquidity.

Sources and uses of cash:

In each period, cash sources must equal cash uses. Sources include net after-tax cash flow from investment projects and net additions to debt (a net reduction in debt principal constitutes a use of funds). Uses include investment in liquid assets (net disinvestment in any period is a source of funds) and cash withdrawals by the owner.

The constraint can be written as follows for any period t,

$$(10) \quad \sum_{h=0}^{N} X_h C_h(t) + Y_t d_t(t) + Y_{t-1} d_{t-1}(t) - Z_t + (1+(1-\tau)i)Z_{t-1} - W_t$$

where $d_t(t)$ represents the cash flow impact in period t of a dollar of debt incurred in t and $d_{t-1}(t)$ represents the cash flow impact in period t of a dollar of debt incurred in period t-1. The value of $d_{t-1}(t)$ would reflect principal repayment as well as after-tax interest expense. Cash withdrawals by the owner of the firm are represented by W_t.

Debt capacity:

Debt capacity is defined in terms of the risk of insolvency perceived by the buyer from the use of financial leverage rather than a specific lender-imposed limit on debt use. This is not to suggest that institutional constraints on debt use are not relevant to farmer's decisions. Indeed, one of the uses of the approach outlined in this paper is to determine how relevant they are and under what conditions.

Empirical studies have failed to find a reasonably consistent and significant relationship between mortgage credit availability and prices at the micro level (Herr, Thompson and Kaiser). One hypothesis is that these terms are not binding in the land purchase decision. The model suggested in this paper presents a conceptual framework for assessing that hypothesis. Insolvency is defined as the situation in which the market value of the firm's assets is less than the book value of its debt obligations. Given that market value is uncertain, debt in each period will be limited to a fraction of total asset value. That fraction depends on the volatility of asset value and on the buyer's maximum acceptable probability of becoming insolvent.

Assume that the maximum acceptable probability of insolvency is equal to ϵ, then debt capacity in period t, K_t, can be expressed as

$$\text{prob}(TA_t \le K_t) = \epsilon$$

Where the TA_t represents total assets. If TA_t is assumed to be normally distributed then

$$K_t = E(TA_t) - F \epsilon (TA_t)$$

where F is the inverse of the cumulative probability function of the standard normal distribution.

The variance of TA_t is equal to the variance of the net worth of the firm. The variance of the net worth, in turn, is equal to the variance of the net present value of the portfolio of assets that makes up the firm.

Therefore,

$$\sigma^2(V_p^t) = \sum_{h=0}^{N} \sum_{h'=0}^{N} X_h X_{h'} (\text{Cov}(V_h^t V_{h'}^t))$$

where V_p^t is the net present value of the portfolio of investments that defines the firm and $\text{Cov}(V_h^t\ V_{h'}^t)$ is the covariance between the hth and h'th asset's net present values. This expression is nonlinear in the X's. But, a linear approximation can be derived where γ_t is the correlation coefficient between V_h^t and V_p^t. Thus,

$$\sigma(TA_t) = \sum_{h=0}^{N} X_h \gamma_{ht} \sigma(V_h^t).$$

This approximation is reasonable if the value of the proposed farmland investment is highly correlated with the value of the firm's existing asset portfolio or if the proposed investment is small relative to existing assets.

Debt capacity in period t can thus be expressed as

$$K_t = E(TA_t) - F(\sum_{h=0}^{N} X_h \gamma_h \sigma(V_h^t)) \tag{11}$$

and the limit on borrowing is given by

(12) $$Y_t + U_t = K_t$$

where U_t represents unused borrowing capacity in period t.

Liquid reserve:

Although the cash sources and uses constraint requires that expected sources equal expected uses in each period, uncertainty with regard to the availability of cash may induce the buyer to maintain a liquid reserve as a safeguard. The liquid reserve constraint is imposed to assure that the firm remains liquid as it undertakes new capital investments.

Liquidity can be of particular concern in the case of the farmland investment. While the strong capital gains component of farmland value may enhance the firm's solvency position, the low current return may deplete its liquidity. Solvency and liquidity are related to the extent that unused borrowing capacity serves as a source of liquidity. In this model, the liquid reserve may consist of both liquid assets and unused credit.

Thus,

(13) $$LR_t = Z_t + U_t$$

where LR_t is the liquid reserve.

The size of the desired liquid reserve will depend on the volatility of cash requirements for the portfolio of investment projects held by the firm as well as by the decision maker's maximum acceptable probability of being unable to meet cash requirements. Thus, the size of the liquid reserve will reflect the cash flow characteristics of the major enterprises pursued by the farm. Variability is assumed to be confined to the net cash flow from the firm's investment projects (i.e., the C_h (t)'s). This ignores the uncertainty created by variable rate loans.

Defining the maximum acceptable probability in period t as β_t, then

$$prob(CR_t \leq CS_t + LR_t) \geq 1-\beta_t$$

where CR_t = cumulative cash requirements for the firm's investments up to period t. CR is a random variable where σ^2 $(CR_t) = \sigma^2$ $(C_p^t\ (t))$, $C_p(t)$ being the net after-tax cash flow accruing the firm's portfolio of investments.

CS_t = cumulative cash flows from financing up to period t.

All of the elements in CR_t and CS_t are found in equation (10), the sources and uses constraint. Following Myers and Pogue, the constraint is calculated on a cumulative basis. The reasons for doing this are first; it allows a consideration of the statistical relationship between cash flows in different periods, and second; it avoids counting the liquidity reserve in one period against the liquidity needs in another.

From the probability statement given above

$$CS_t + LR_t - E(CR_t) \geq F \sigma (CR_t)$$

where F is the inverse of the cumulative probability distribution of the standard normal distribution evaluated at $1-\beta_t$ (assuming that cumulative investment cash flows to period t are distributed normally).

The value for $\sigma (CR_t)$ is derived in a manner similar to the derivation of $\sigma(TA_t)$. Specifically, defining cumulative cash flows for periods 1 through t for project h as $C_{ch}(t)$, and the correlation coefficient between CR_t and $C_{ch}(t)$ as γ_{ht}, the expression for the liquid reserve is

$$(14) \quad Z_t + U_t > F \sum_{h=0}^{N} X_h \gamma_{ht} \sigma(C_{ch}(t))$$

Summary:

The objective function maximizes the net worth of the firm subject to constraints on sources and uses of funds, debt capacity and the desired liquid reserve. The impact on net worth of an investment in farmland will be influenced by the financing choice (i.e., the debt-equity combination used to finance the acquisition). The financing choice in turn depends on the wealth and earnings characteristics of farmland and the statistical interdependencies of these characteristics with the wealth and earnings characteristics of the firm's existing asset portfolio.

The firm's desired liquid reserve is a function of the level and variability of the cumulative cash flows produced by its asset portfolio. The additional liquid reserve needed in the case of a farmland investment depends on the statistical properties of the cash flows derived from it and as well as its statistical interdependencies with cash flows produced by the existing asset portfolio. The liquid reserve is composed of liquid assets and unused debt capacity. Thus, departures of actual debt in any period from debt capacity in that period will have an effect on the level of liquid asset investment necessary to maintain the desired liquid reserve. Unused debt capacity will reduce the need for investment in liquid assets while "overused" debt capacity will increase the need.

A Numerical Illustration

This illustration of the conceptual model focuses on the purchase of farmland in the Cornbelt. The buyer is assumed to begin with a cash balance and no other assets or liabilities. The data used in estimating parameters comes from various USDA sources.

A five-period time horizon is imposed for the sake of convenience. The solution is sensitive to time horizon but that relationship is not of interest here. The base-case present value of the farmland is derived from equation (6). Cash flows are represented by net rents which are gross rents minus per acre real estate taxes. The value of g, the expected growth rate in net rents was derived from a weighted average of lagged values which assigns heavier weights to more recent observations (Vantreese, Reed, and Skees).

A proxy for the variance in farmland value was calculated from historical data on average farmland values in representative Cornbelt states. The variance for total asset value per farm and the correlation coefficient were also calculated although they were not used in this analysis.

Likewise, proxies for the variance in cumulative cash flows from farmland and from total farm operations were calculated from historical data on net cash rents and annual cash flow per farm. The correlation coefficient between these two was assumed to be highly positive. The cash rent data series reflects factor payments determined in light of expected costs and revenues. The cash income series, on the other hand, reflects actual cash expenses and receipts. The correlation between the two series would not reflect the actual experience of owners who worked the land themselves. Table 1 summarizes these and other parameter values.

Given the initial conditions and parameter values the value of the objective function was $763.05. This value can be interpreted as the present value of the investment in farmland. It is the sum of the present value of the investment if it were all-equity financed ($736.00) plus the financial side effects from debt financing ($29.68) and investment in liquid assets (-$2.63). The side effect of debt financing can be further defined as the product of the present value of the tax shield on a dollar of debt and the change in debt capacity due to the acquisition of the farmland. The financial side effect of the investment in liquid assets is the product of the present value of the tax liability incurred from a dollar of investment in liquid assets and the change in the liquid reserve due to the acquisition of the asset.

If the buyer were willing to pay up to the full present value for the acre of farmland, he could afford a price of $763.05. At prevailing market prices of more than $763.05 the net present value of the investment if all-equity financed is negative. But the investment provides the opportunity to borrow, an opportunity which itself is valuable. The investment requires that the buyer maintain liquid assets which detracts from net worth, but on balance the investment is profitable.

Initial equity is assumed to be fixed and new equity is assumed not to be available in future periods. At the optimal solution, $299 in initial equity is required to purchase a full acre. If initial equity is limited to $200 and $100, respectively, the value of the objective function falls to $750.46 and $743.23, respectively. The constraint on initial equity reduces the level of the investment and in doing so, also reduces the amount that can be borrowed.

Sensitivity analysis:

Several parameters were changed to assess the impact on the basic solution. The changes and resulting objective function values are shown in Table 2.

The effect of a reduction in the variability in farmland value is to increase the value of the objective function. For one thing, the equity capitalization rate should fall, thereby raising the base-case net present value. For another, the debt capacity of the investment should increase in recognition of the willingness of the buyer to borrow more to finance an asset with a more stable value. The change in the value of the objective function, $8.29, reflects only the present value of the additional debt financing. An increase in the variability in farmland values will lower the value of the objective function. The base-case present value should fall in response to a higher capitalization rate and the debt capacity of the investment is less. In this

Table 1. Parameter Values for Numerical Illustration

1. Base case net present value	
net cash rent	$ 94.00
expected growth rate in net cash rent	0.026
equity capitalization rate	0.13
marginal tax rate	0.20
2. Determinants of debt capacity	
interest rate on debt	0.12
variance in farmland values	0.149
variance in total asset value	0.203
correlation coefficient	0.8
maximum acceptable probability of insolvency	0.001
3. Determinants of liquid reserve	
risk-free rate of return	0.07
variance in cumulative project cash flows	
1 period	0.161
2 periods	0.103
3 periods	0.084
4 periods	0.081
5 periods	0.079
variance in cumulative cash flows	
1 period	0.771
2 periods	0.364
3 periods	0.252
4 periods	0.163
5 periods	0.108
correlation coefficient	0.90
maximum acceptable probability of cash shortage	0.001

case, reflecting only the loss of debt capacity, the value of the objective function fell by $8.57.

When the variability in cumulative cash flows is lessened, the value of the objective function rises. The size of the desired liquid reserve falls, thereby reducing the required investment in liquid assets. As the variability in cumulative cash flows rises, the value of the objective function falls to reflect a larger required investment in liquid assets.

Table 2. Sensitivity Analysis

Parameter Name	Parameter Value	Value of the Objective Function
Variance in farmland value	0.10	$771.34
	0.20	754.48
Variance in cumulative project cash flow		
1 period	0.100	
2 periods	0.064	
3 periods	0.052	
4 periods	0.050	
5 periods	0.048	764.04
1 period	0.200	
2 periods	0.128	
3 periods	0.104	
4 periods	0.100	
5 periods	0.098	762.40
Expected growth rate in net cash rent	0.0	595.94
	0.05	1,001.47

Changes in the expected growth rate in cash rents have a profound impact on the value of the objective function. The effects of these changes are comprehensive. The base-case net present value is directly affected as are the debt capacity and liquid reserve constraints.

Given expectations of no growth in cash rents (and by implication no capital gains), the base-case present value becomes $576. Assuming that borrowing takes place at the optimal level, (i.e., borrowing capacity is a percentage of calculated present value), the contribution of debt financing is $22.46.

If cash rents are expected to grow by 5 percent per period, the value of the objective function rises to $1,001.47. Reflecting the growth in cash flow, the base-case present value rises to $964 per acre. The growth in cash flow implies capital gains so that the debt capacity of the investment also rises. The expected increase in cash flows also raises the size of the desired liquid reserve.

Debt capacity and institutional constraints:

The optimal level of debt each period does not conform to a traditional mortgage amortization schedule. Land is a nondepreciating asset which, conceptually, supports permanent debt. When land values are rising, unrealized capital gains support even more debt. Most farmland buyers cannot issue bonds to finance their land ownership but other opportunities exist for converting debt capacity into borrowing. These opportunities range from refinancing the land itself to stretching out or refinancing non real estate debt with the aid of equity acquired in land.

However, uncertainty may exist with respect to the availability of these opportunities in the future (Barry, Baker, and Sanint). The debt decision could be specified in more detail to reflect the degree of uncertainty associated with each type of borrowing opportunity. For example, total debt in any period might consist of a first mortgage, a secondary mortgage and secured non real estate debt. Each of these sources may have different interest rates and each may be subject to a different capacity restraint.

If the model were constrained so that debt in each period had to equal the remaining balance of the mortgage, then unused debt capacity would likely be negative (or overused) in the early periods and positive in the later periods. Unused debt capacity is a source of liquidity and therefore reduces the need for investment in liquid assets. Overused debt capacity implies illiquidity and in terms of this model would require further investment in liquid assets to maintain the desired liquid reserve. The shadow price on debt would normally be greater in absolute value than the shadow price on liquid assets so that forcing the amortization schedule into the solution would usually have an impact on the value of the objective function.

Concluding Comments

The model of the farmland purchase decision presented in this paper has much in common with earlier efforts. It assumes that current asset values are influenced by expectations of future values (Lee and Rask). It states that expected capital gains, even though unrealized through the sale of the land, influence future borrowing capacity and thereby affect current value (Plaxico and Kletke). It states, too, that more stable asset values (which may be due to more stable earnings) induce greater debt capacity (Boehlje and Griffin).

In addition, the model suggests a building block approach to the determination of net present value that disaggregates the value of the farmland investment into separate components reflecting financing choice and liquidity demands. This approach is potentially useful to both managers and researchers in understanding investment and financing interactions.

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