Farmland Price Behavior and Credit Allocation

Haim Shalit and Andrew Schmitz

A model of farmland accumulation analyzes the impact of credit allocation and the level of debt on farmland prices. The model stresses the importance of the real net wealth accumulated by the farming sector on the lending procedures for farmland purchases. It is shown that credit allocated on the basis of wealth not only increases farmland prices but also destabilizes them. The paper presents the model of individual accumulation to derive the farmland price equation whose dynamic properties are analyzed. A study of U.S. farmland data supports the theoretical results.

The recent cycling behavior of U.S. farmland values poses the problem of whether or not land prices can be forecasted and explained by rational economic models. The cycle of land prices has attracted the attention of research economists because the price behavior has not conformed to standard economic theory. Brake and Melichar, by surveying the studies prior to the 1970s, have shown the divergence in trends between net farm income and land price. Melichar, and then Reinsel and Reinsel, demonstrated that the earlier research was erroneous because net farm income did not measure land earnings. As an alternative, Melichar claimed that one should compare the real capital gain from farm assets with the current returns to these assets.[1]

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[1] According to Melichar, the current returns to assets are obtained by adding to operator's net farm income, the rental income of nonoperator landlord and the interest paid on farm debt "as the goal is a return to assets rather than equity." Since interest payments were subtracted to obtain net income, they are added to cancel the operation. In addition, imputed rent to operator dwelling is subtracted as farm production assets exclude operator's dwellings.

Recently, an empirical study by Pope *et al.* emphasized the difficulty of constructing econometric models of land values in the 1970s and the inappropriateness of models developed prior to that period to explain the rise in farmland prices in the 1970s. They suggested that further research was needed to account for the recent movements in farmland prices. This added considerable literature (Plaxico and Kletke; Barry; Boehlje; Chavas and Shumway to cite only a few) to the research being done by Castle and Hoch who demonstrated that, in addition to the capitalized value of rent, farm real estate prices involve important components corresponding to the capitalized value of capital *gains* and including changes in real debt. The impact of credit allocation on farmland values was studied by Shalit and Schmitz who developed a model of land accumulation to show how the level of debt is one of the main determinants of farmland prices.

The purpose of this paper is to extend the Shalit and Schmitz model of the land market in order to understand the present course of U.S. farmland prices. The original model explained how high farmland real prices can be sustained despite declining real net farm income. It emphasized credit allocation for land purchases

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by assuming that credit is rationed and allocated on the basis of accumulated net wealth. Thus, the farmer obtained the necessary loans in order to purchase additional land by offering his existing wealth as collateral. In the short-run, producers can bid up the price of land above the level which can be sustained by net farm income alone since loans are obtained against collateral from built-in equity in past acquisitions. This hypothesis was tested using 1949–78 national data.

The importance of credit in land purchases was emphasized in past studies,[2] but how credit allocated on the basis of real net wealth affects the dynamic behavior of land prices was insufficiently understood. The model presented here stresses the importance of the real net wealth accumulated by the farming sector on the lending procedures for farmland purchases.

The analysis shows that credit allocated on the basis of wealth both increases farmland prices and destabilizes them. Any policy attempting to deal with farmland values stabilization must regulate the allocation of credit to individual farmers. Often the opposite is done since, as land prices increase, farmers request and obtain more funds for land purchases. Loans are available since bankers expect farmland values to increase. On the other hand, if prices are expected to decrease, credit terms are strengthened, thus causing a fall in farmland values. We will analyze this behavior first by presenting the model of individual accumulation. Then we develop the farmland price equation and study its dynamic properties. We conclude the paper by analyzing U.S. farmland data to support the theoretical study.

[2] See Cotner *et al.* who reported that in Michigan over 40 percent of the farmers purchasing real estate used 100 percent credit. Many mortgaged part of their existing farms in order to avoid cash down payments.

The Model of Land Accumulation

The model analyzes the behavior of an individual farmer in the land market to assess the derived demand function for farmland.[3] The farmer is viewed as both a producer and a consumer who maximizes his lifetime utility. To do so, he allocates the income generated from agricultural production between consumption and savings. Consumption enhances his utility but with his savings he purchases land that will increase his production[4] and, thus, his utility in the future. In addition to using savings, the farmer borrows funds to purchase land. He is not required to do so, but, as a rational individual he will borrow funds as long as farmland investment yields positive net present value implying that the internal rate of return is greater than or equal to the market rate of interest. We assume that credit is rationed such that borrowers cannot obtain unlimited funds at given interest rates and collateral must be offered by the borrowers to secure all loans.

Hence, to obtain funds for land purchases, the farmer offers his debt-free holdings of land as collateral. He will do so as long as land purchases yield a positive net present value of income or as long as he provides the necessary collateral to secure loans. Furthermore, we assume that land collateral serves only for the purpose of buying more land.

Formally, the model is presented as follows. The farmer maximizes his lifetime utility which is composed of his utility of

[3] The model was developed by Shalit and Schmitz. For a justification of the farmer's behavior and the method used in the maximization problem, see Blinder's essay.

[4] This assumption implies that for a given acre, profit is maximized with respect to all nonland inputs. Furthermore, it is assumed that people invest in that which they know best, and it is required that the returns on land are larger than the returns on any other prospect.

consumption during the planning period, U[C(t)], and his utility of bequest at the end of the planning period, V[W(T)]:

$$\int_0^T U[C(t)]e^{-rt}\,dt + V[W(T)]e^{-rT} \qquad (1)$$

where r is the market rate of interest used as discount rate, C(t) is the consumption level at t, T is the planning horizon, and W(T) is the net wealth at T.

The objective function is maximized by choosing a consumption pattern C(t) that satisfies the budget constraint. On the other hand, land is purchased with savings and with all the loans that can be obtained by mortgaging debt-free wealth. Thus, if $P^L(t)$ is the price of land, L(t) is the amount of land owned and D(t) the level of accumulated debt, a loan of size B(t) can be secured by offering the net wealth W(t) as collateral where net wealth is defined as

$$W(t) \equiv P^L(t)L(t) - D(t)$$

and

$$B(t) \equiv B[P^L(t)L(t) - D(t)], \qquad (2)$$

where $B(\cdot)$ is assumed to be a linear function of W(t). Net wealth changes as the result of land holdings changes ($\dot{L}$), land prices changes ($\dot{P}^L$), or debt changes ($\dot{D}$). Thus,

$$\dot{W}(t) = \dot{P}^L(t)L(t) + P^L(t)\dot{L}(t) - \dot{D}(t). \qquad (3)$$

For steady land prices at equilibrium, net wealth can only increase by the amount of savings since total wealth is already mortgaged for existing loans. When land prices increase, net wealth rises and the value of collateral that can be offered to secure additional loans increases. If land prices decrease, the farmer wanting to buy land must provide more savings to meet the cash down payment.

Since L(t) is the amount of land owned at time t, $\dot{L}(t)$ is the change in landholdings with time.[5] If $\dot{L}(t)$ is positive, land is bought by the farmer; if it is negative, the farmer sells part of his landholdings. Thus, if $\Pi[L(t)]$ is the maximal income obtained from the amount of land, L(t), the budget constraint is

$$C(t) + S(t) = \Pi[L(t)] - K(t) \qquad (4)$$

where S(t) is the savings and K(t) the current credit costs. These consist of payments toward interest and principal.[6] Thus, the land accumulation constraint which asserts that the quantity of land purchased or sold depends on the farmer's savings and the amount of loans he can secure by mortgaging his debt-free wealth becomes

$$\dot{L}(t) = \frac{1}{P^L(t)}\{\Pi\,[L(t)] - K(t) - C(t) + B[P^L(t)L(t) - D(t)]\}. \qquad (5)$$

Furthermore, the level of accumulated debt increases with the addition of a new loan and diminishes with each payment of principal when the farmer repays his loans. Thus, the debt function constraint becomes:

$$\dot{D}(t) = B[W(t)] - K(t) + rD(t). \qquad (6)$$

Equation (6) can be verified since credit costs, K(t), are the sum of payments on interest, rD(t), and payments on principal. When a loan, B[W(t)], is issued, the farmer repays it in equal installments, $\gamma(t)\cdot B[W(t)]$, where $\gamma(t)$ is the annuity of a \$1.00 loan granted at time t for the (T − t) period. Therefore, when a new loan is obtained, a new schedule of payments is issued for that loan. Credit costs K(t) are simply the sum of payments—principal and interest—from different loans that are paid at time t, and thus they increase each time the farmer takes a new loan:

$$\dot{K}(t) = \gamma(t)B[W(t)]. \qquad (7)$$

[5] A dot over a variable represents the time derivative: $\dot{x} \equiv dx/dt$.

[6] It is important to differentiate between flow variables such as income Π, credit costs K, consumption C, savings S, and loans B on one hand, and stock variables such as debt D and land L on the other.

The farmer's objective is to maximize lifetime utility subject to the land accumulation constraint (5) and the debt equation (6), and to credit costs equation (7). The solution is obtained by applying the maximum principle of optimal control given the initial conditions,[7] $L(0) = L_0$, $D(0) = D_0$, and $K(0) = K_0$. The control variable is the consumption level which, once optimal, fixes the other state variables such as the landholdings, the debt level, and the size of credit costs. For every state variable, there exists an implicit price variable which assesses its marginal value in terms of the objective function. Hence, for the land accumulation constraint, one defines λ as the implicit price of land; for the debt function constraint, the imputed value is μ which expresses the subjective costs of debt; for the credit costs constraint, η is the implicit price.

The solution to the farmer's maximization problem is a set of differential equations that are obtained from the first-order conditions of the optimal control problem as follows:[8] If $H(\cdot)$ is the Hamiltonian function, the optimal consumption plan is found by maximizing it with respect to C where

$$H(\cdot) = e^{-rt}\Big\{U(C) + \frac{\lambda}{P^L}[\Pi(L) - K - C + B(\cdot)] + \mu[B(\cdot) - K + rD] + \eta[\gamma B(\cdot)]\Big\}, \quad (8)$$

and λ, μ, η are the dual variables associated with the dynamic constraints (5), (6) and (7). From the first-order conditions that hold for every t,

$$U'(C) = \frac{\lambda}{P^L}, \quad (9)$$

$$\dot{\lambda} = \lambda\left(r - \frac{\Pi_L}{P^L} - B_W\right) - B_W P^L[\mu + \eta\gamma(t)], \quad (10)$$

$$\dot{\mu} = B_W\left[\frac{\lambda}{P^L} + \mu + \eta\gamma(t)\right], \quad (11)$$

$$\dot{\eta} = \frac{\gamma}{P^L} + \mu + \eta\gamma(t), \quad (12)$$

where

$$B_W \equiv \frac{\partial B(\cdot)}{\partial W}, \quad \Pi_L \equiv \frac{\partial \Pi}{\partial L}.$$

Since equation (9) holds for every t, the dynamic equation of consumption is derived by differentiating (9) with respect to time to obtain

$$\dot{\lambda} = P^L\left(U''\dot{C} + U'\frac{\dot{P}^L}{P^L}\right)$$

and from (9), (10) and (11), it follows that

$$\dot{\lambda} = U'P^L\left(r - \frac{\Pi_L}{P^L}\right) - \dot{\mu}P^L.$$

Hence, the differential equation of consumption is

$$\frac{\dot{C}}{C} = \frac{\Pi_L/P^L + \dot{P}^L/P^L - r}{\sigma(C)} + \frac{\dot{\mu}}{U'(C)\sigma(C)} \quad (13)$$

where

$\sigma(C) = -U''(C)/U'(C)C$ = the elasticity of marginal utility of consumption,

Π_L = the marginal net income of land,

$\dot{P}^L/P^L$ = the rate of change of land prices,

and

$\dot{\mu}$ = the rate of change of the implicit price of debt.

Equation (13) determines the optimal path of consumption over time. Together with equations (5) and (6), we are able to establish the optimal landholdings and debt size. Equation (13) represents the general case of land price behavior in a dynamic framework with credit restrictions such as credit rationing. This can be

[7] For the economic interpretation of optimal control models, see Dorfman and the survey by Zilberman. The solution of the problem is presented entirely in the paper by Shalit and Schmitz.

[8] From now on, we omit the time variable t whenever it is unambiguous.

easily verified since if no individual land accumulation takes place ($\dot{L} = 0$), if consumption remains constant over time ($\dot{C} = 0$), and if no credit restrictions are imposed ($\dot{\mu} = 0$), the standard land valuation theorem including capital gains is obtained as

$$r = \frac{\Pi_L}{P^L} + \frac{\dot{P}^L}{P^L} \quad \text{or} \quad P^L = \frac{\Pi_L + \dot{P}^L}{r}. \tag{14}$$

In equation (13), the implicit price of debt μ appears as an indication of the farmer's subjective ability to sustain debt. This value is negative since an increase in debt limits the farmer's future ability to borrow funds by reducing net wealth. $\dot{\mu}$ expresses mainly the rate at which a unit of debt appreciates in utility terms. At the beginning of the planning period, μ is positive since increasing debt is beneficial enabling the farmer to accumulate land at a faster rate. However, as time passes, μ decreases and becomes negative since the burden of debt reduces net wealth and limits the ability to obtain future credit. This leads to the conclusion that $\dot{\mu}$ becomes negative with time. On the basis of equation (13), it can be stated that credit allocated on the basis of wealth forces the farmer to postpone consumption. In addition, from equation (5) this implies that larger holdings of land will be maintained.

We have shown that once credit is introduced into the system, the farmer tends to accumulate land at a faster rate by increasing the share of income allocated to savings. This enables him to accumulate debt-free wealth that will serve as leverage for obtaining credit in the future. As time goes on and consumption increases, land accumulation continues to increase because of the credit effect. Furthermore, if the farmer perceives that land prices tend to rise, he will purchase more land. This behavior of the utility-maximizing farmer as described above serves us to examine the impact of credit rationing and land accumulation on farmland values.

The Farmland Price Equation

In an economy where the physical supply of land is fixed and finite,[9] the aggregate excess demand for farmland is the sum of the derived demands by the potential buyers and sellers. The equilibrium price of farmland is the price at which the market clears, i.e., no more transactions take place. In our model, it is assumed that all farmers have a similar discount rate, a similar time horizon, and are endowed with a similar initial amount of land, L_0, and debt level D_0. However, it is assumed that they differ in terms of their economic age a, whose distribution is given by h(a) such that

$$\int_0^T h(a)\, da = N(t), \tag{15}$$

where N(t) is the number of farmers at time t. This differentiation according to economic age is essential since the consumption level, the demand for farmland, and the level of debt are time- and thus age-dependent.

The total land is distributed among the farmers of different ages as follows:

$$\int_0^T L(a)h(a)\, da = \bar{L}, \tag{16}$$

where L(a) is the amount of farmland held by a farmer of age a at time t and $\bar{L}$ is the total amount of land in the economy. Equation (16) holds for every t since total land is fixed and finite. Therefore, by differentiating (16) with respect to t and assuming h(a) uniform, one obtains

$$\int_0^T \dot{L}h(a)\, da = 0 \quad \text{for all t.} \tag{17}$$

Since each farmer's behavior is optimal, one substitutes $\dot{L}(a)$ with equation (5)

[9] A referee proposed an alternative assumption of farmland being created from nonfarmland at a high enough price. In that case, the supply and demand for farmland will also incorporate; for example, woodland and its reservation price will be established by the same model.

where consumption, debt, and credit costs are optimal following (6) and (13). The equilibrium price of land is determined by P^L which, for every time t, solves that equation:

$$\frac{1}{P^L}\int_0^T \{\Pi[L(a)] - K(a) - C(a,P^L) + B[P^L L(a) - D(a,P^L)]h(a)\}\, da = 0 \quad (18)$$

where K(a) is the level of accumulated credit costs at age a, $C(a,P^L)$ is the solution to the differential equation (13) and $D(a,P^L)$ is the level of accumulated debt at age a. Equation (18) is the fundamental farmland price equation. It is implicit in P^L since both consumption and debt are dependent on the price of farmland. To obtain the latter, one must solve the set of simultaneous dynamic equations composed of (6), (13), and (18). This task cannot be achieved analytically. However, the simultaneity does not prevent us from analyzing the dynamic determinants of farmland price changes. Since we are dealing with the entire agricultural sector, we express the implicit pricing equation in terms of aggregate variables such as

$\bar{C}(P^L) = \int_0^T C(a,P^L)h(a)\, da$, the aggregate level of consumption,

$\bar{D}(P^L) = \int_0^T D(a,P^L)h(a)\, da$, the aggregate level of debt,

$\bar{\Pi}(\bar{L}) = \int_0^T \Pi[L(a)]h(a)\, da$, the net income of the agricultural sector, and

$\bar{K} = \int_0^T K(a)h(a)\, da$, the level of accumulated credit costs of the agricultural sector.

Furthermore, by assuming that $B(\cdot)$ is a linear function of net wealth such that $B(\cdot) \equiv B_W P^L L - B_W D$, where B_W is a scalar, we obtain equation (18) as:

$$\pi - k - c(\cdot) + B_W P^L - B_W\, d(\cdot) = 0, \quad (19)$$

where $\pi = \bar{\Pi}/\bar{L}$ is the net income per acre, c is the consumption per acre, d is the debt per acre, and k the amount of credit costs per acre. This is the fundamental equation for estimating the price of farmland from aggregate data which was done in a previous work as

$$P^L = \frac{1}{B_W}[c(\cdot) - (\pi - k)] + d(\cdot) \quad (20)$$

where $c(\cdot)$ is the solution of a differential equation similar to (13) and $d(\cdot)$ is the solution of (6). The estimates show the great impact of increasing debt per acre on land values. Our purpose is to use these equations to evaluate the dynamic behavior of land prices that results from the present credit policies.

The Dynamic Behavior of Farmland Prices

We analyze the effects of individual land and debt accumulation on farmland values. The main issue is whether credit granted on the basis of accumulated wealth destabilizes land prices. To test this hypothesis, we isolate the dynamic determinants of farmland price changes. This is done by differentiating the implicit price equation (19) with respect to time. Since that equation represents an equilibrium condition that holds for every t, the equation derivative is always equal to zero. This yields the following result:

$$\dot{\pi} - \dot{K} - \dot{c} + B_W \dot{P}^L - B_W \dot{d} = 0 \quad (21)$$

where $\dot{\pi} = \partial\pi/\partial t$ is the change of income per acre per unit of time. From equation (13), we establish the change rate in aggregate consumption per acre as

$$\frac{\dot{c}}{c} = \frac{\frac{\pi_L}{P^L} + \frac{\dot{P}^L}{P^L} - r + \dot{m}}{\sigma(C)} \quad (22)$$

where $\dot{m} = \dot{\mu}/U'(C)$ is the implicit evaluation of debt for the agricultural sector.

Similarly, the change in aggregate debt per acre is derived from (6) as

$$\dot{d} = \frac{1}{\bar{L}}\int_0^T [B_W P^L L - B_W D$$

$$- \bar{K} + rD]h(a)\,da \tag{23}$$

or

$$\dot{d} = \frac{1}{\bar{L}}[B_w P^L \bar{L} - B_w \bar{D} - \bar{K} + r\bar{D}]$$
$$= B_w P^L - B_w d - k + rd.$$

By substituting $B_w P^L - B_w d - k$ from equation (19), we obtain

$$\dot{d} = c - \pi + rd. \tag{24}$$

The substitution of equations (22) and (24) in (21) yields the result

$$\dot{\pi} - \dot{k} - \left\{\frac{\pi_L}{P^L} + \frac{\dot{P}^L}{P^L} - r + \dot{m}\right\}\frac{c}{\sigma(C)} + B_w\dot{P}^L - B_w c + B_w\pi - B_w rd = 0,$$

which, in turn, expresses the rate of change of land prices as

$$\frac{\dot{P}^L}{P^L} = \frac{\left[\dot{\pi} - \dot{k} - \frac{c}{\sigma(C)}\left(\frac{\pi_L}{P^L} - r + \dot{m}\right) + B_W(\pi - c - rd)\right]}{\frac{c}{\sigma(C)} - B_W P^L}. \tag{25}$$

Following our theory of individual land and debt accumulation, the rate of change of land prices over time depends on the rate of change of net income per acre, consumption, debt, and the rate of change of the subjective evaluation of debt. We will isolate and analyze these effects by considering first the behavior of land prices when no credit restrictions are imposed in agriculture. In that case, $B_W = 0$, $\dot{m} = 0$, $d = 0$, and $k = 0$. And the rate of change of farmland prices becomes:

$$\frac{\dot{P}^L}{P^L} = r - \frac{\pi_L}{P^L} + \frac{\dot{\pi}}{c}\sigma(C). \tag{26}$$

First, consider a growing agriculture sector ($\dot{\pi} > 0$). In that case, land price changes will increase as income per acre grows. Furthermore, $\dot{P}^L/P^L$ increases when the interest rate exceeds the marginal return on land per dollar spent on that land. Hence, if $r = \pi_L/P^L$ (a standard condition), land prices will increase with growing income ($\dot{\pi}$) due to technological changes or changes in terms of trade.

If, on the other hand, one assumes a steady state economy where income per acre does not increase over time ($\dot{\pi} = 0$), one obtains the known standard valuation condition expressed by equation (14) stating that the rate of interest must be equal to the marginal rate of return on land. This rate of return is composed of two elements: the first one expresses the marginal income per unit value of land, the second one is the rate of capital gains $\dot{P}^L/P^L$. Hence, *only* in a *steady-state agricultural sector without credit restrictions,* the price of land will behave as

$$P^L = \frac{\pi_L + \dot{P}^L}{r}, \tag{27}$$

which conforms to standard economic theory.

Let us now analyze the behavior of land prices in an economy where credit is rationed and allocated on the basis of net wealth. First of all, one observes that the denominator of equation (25) is smaller than the one in equation (26) implying that any land price change will be accentuated over time once credit is allocated according to net wealth. We anticipate, at least in the short-run, an amplification of the land price cycle, i.e., when land prices increase, they rise fast and when they decline, they fall rapidly. This effect is indeed similar to the multiplier effect of banking reserves and is as much volatile since credit is allocated on the basis of net wealth.

The analysis of the numerator of equation (25) consists of the following elements. First, the effects of interest rate, marginal income, and income growth are identical to those in equation (26). Second, the introduction of credit restrictions in the model emphasizes the ability of the agricultural sector in borrowing funds by offering its net savings as collateral. This is expressed by $B_W \cdot (\pi - c - rd)$. As the net savings increases ($\pi - c - rd \geq 0$), so

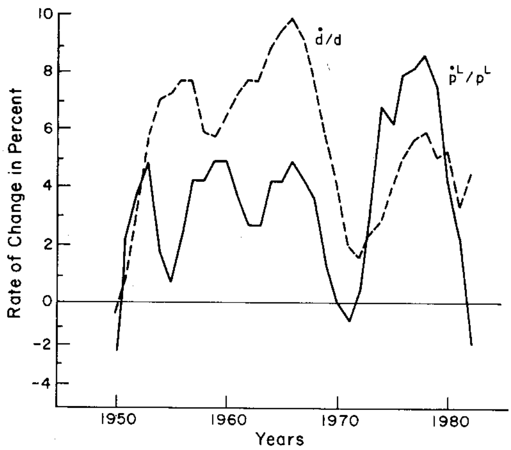

Figure 1. The Rate of Change of Farmland Prices ($\dot{p}^L/p^L$) and the Rate of Change of Farm Real Estate Debt per Acre ($\dot{d}/d$) (3 Year Moving Average, 1950–82).

does the credit allocation as shown by B_W. This parameter governs the policy of credit allocation out of net wealth. It is the key factor in credit rationing. As bankers and government loan officers expect land values to increase, they appreciate more favorably the farmer's existing assets and propose larger loans on existing savings, i.e., B_W increases. This amplifies the rate of change of land prices. If, on the other hand, bankers expect land prices to decline, they offer smaller loans on the same collateral values, i.e., B_W declines causing a fall in future farmland prices. This cycling behavior—which seems to be accelerating since fueled by the bankers'

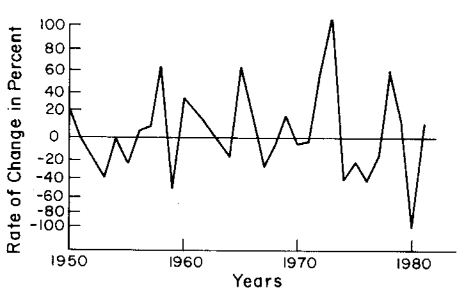

Figure 2. Rate of Change of Residual Income to Real Estate Equity per Acre, 1950–81.

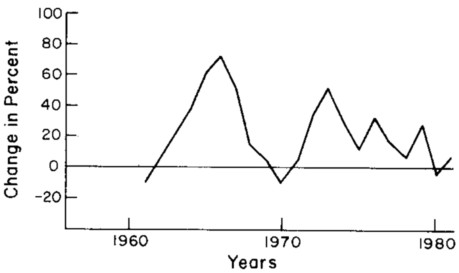

Figure 3. Banker's Expectations on Farmland Prices Changes, 1961–81.

expectation process—is, however, restrained by two additional elements that decelerate the rate of change of prices. The first is the rate of change of credit costs, $\dot{k}$, which increases with debt and reduces net income. The other one is the rate of change of the debt subjective evaluation, $\dot{m}$, which increases when debt accumulation becomes a burden for the farmer. As debt increases, the rate of growth of land prices is slowed down by these factors.

Credit allocated according to net wealth triggers, in the short-run, a self-generating inflation of land prices. This process is amplified by bankers' expectations of the farmer's assets. As debts accumulate, the burden of credit costs stabilizes the price of land. As the debt level continues to increase, so does its subjective evaluation; the numerator of condition (25) becomes negative and the price of land starts to fall. As P^L declines, less credit is distributed by the bankers, the debt level decreases, and the reversal process is restrained since credit costs are being reduced. We have described a nondivergent cycling process of farmland prices that is fueled by the way credit is allocated. We will justify empirically that analysis.

Estimating Land Price Changes in the United States

The empirical analysis consists of explaining the rate of change of land prices as expressed by equation (25). The relationship between $\dot{P}^L/P^L$ and the other variables is estimated for U.S. agriculture by using annual data for the period, 1961–81.

In Figures 1 and 2, we present the cyclical behavior of the main variables of the model for the 1950–81 period. In Figure 1, the moving average (3 years mean) of the farmland price change and the real debt per acre change is plotted. The price of farmland is measured by the value per acre deflated by the consumer price index. Debt per acre is obtained from the balance sheet of the farm sector and adjusted for inflation. Total net income is obtained from the series compiled by Hottel and Evans. The series consists of residual income to real estate equity obtained by deducting computed returns to labor, management, and dwellings from the operator's total net farm income. This series is then deflated by the consumer price index (1967 = 100). The data on farm real estate debt, total land, and the interest rate are provided by Agricultural Statistics of the U.S. Department of Agriculture. To evaluate credit rationing and its effects on land price changes, we used the expectation data surveyed by the Federal Reserve Bank of Chicago. The survey reports land value and credit condition expectations of a sample of member and non-member banks of the Federal Reserve System. As of 1973, the total survey sample consists of responses of over 1,000 banks or about 40 percent of all banks in the seventh district of the Federal Reserve System. As a variable explaining credit rationing, we used the percentage of banks expecting the trend of market value of farmland during the current quarter to be up less the percentage of banks expecting the trend of farmland value to be down. The annual average data of expectation of farmland market value is depicted in Figure 3.

The theoretical model shows that land price changes as a function of income changes and debt changes. If we assume that land is sold at the season after income is generated, we will have a land price change as a function of lagged income changes and present debt. We have from equation (25)

$$\frac{\dot{P}^L}{P^L} = f(\pi_{t-1}, \dot{d}_t, r_t, d_t, B_{Wt}) \qquad (28)$$

where

π_{t-1} = the lagged income per acre

$\dot{d}_t$ = the debt per acre change ($d_t - d_{t-1}$),

r_t = the real interest rate,

and

B_{Wt} = the credit effect.

As a proxy for B_{Wt}, we use the Federal Reserve Bank of Chicago expectation survey data. The equation is estimated in a log-linear form as follows:

$$\log\left[\frac{P_t^L}{P_{t-1}^L}\right] = \alpha_0 + \alpha_1 \log(\pi_{t-1}) + \alpha_2 \log(d_t) + \alpha_3 \log(B_{Wt}) + \alpha_4 \dot{d}_t + \alpha_5 r_t. \qquad (29)$$

The regression results are reported in Table 1.

Although we obtained a low fit, the results are quite satisfactory for that size of sample. Since we deal with rates of change in land prices, we have small coefficients and, thus, low elasticities. The level of debt enters the equation under two components: the first expressing the impact of the rate of debt change on land values which is positive and second one showing the impact of debt burden (log d_t) which is negative.[10] Hence, we remark that debt changes accelerate the change in farmland values but as the absolute level of debt increases, prices tend to slow their acceleration since debt servicing decreases net income and becomes a burden for the farmer.

The proxy variable for B_{Wt} is not statis-

[10] The two debt variables are not highly collinear (correlation coefficient = 0.547).

TABLE 1. Regression Results of the Land Price Changes Equation—1961–81.

	Constant	$Log(\Pi_{t-1})$	$log(d_t)$	$log(B_{Wt})$	$\dot{d}_t$	r_t	R^2	D.W.
1.								
Coefficient	0.091	0.051	−0.039	0.033	0.023	−0.01	.66	2.08
Standard Error	0.11	0.015	0.03	0.03	0.01	0.007		
t Ratio	0.81	3.48	1.45	0.89	1.60	1.47		
2.								
Coefficient	0.07	0.055	−0.037	—	0.031	−0.01	.65	2.29
Standard Error	0.11	0.014	0.027	—	0.01	0.007		
t Ratio	0.69	3.85	1.39		2.78	1.45		

tically significant although its coefficient of correlation with land prices changes is 0.50. The measure is not precise since it does *not* account for the strength of expectation, its magnitude, and the relative importance of the banks. Thus, in the second regression, we omit B_{Wt} and obtain quite similar results. The need for a better variable estimating credit rationing behavior in agricultural capital markets is primordial to obtain a valid understanding of land price dynamic behavior. In general, we see that a lagged income increase, debt changes, and increasing expectation accelerate land price changes. On the other hand, debt burden and interest rates are depressing the rate of land price increases.

Concluding Remarks

The analysis has shown the impact of credit granted on the basis of net wealth on land prices. The accumulation of farm real estate debt accelerates the rate of increase of farmland values up to the level where the amount of debt burdens the farmer and forces him to sell some land. Then, prices fall and credit terms are strengthened to reduce debt size. This cycling behavior of the real estate debt is, in fact, destabilizing farmland values. Given the rate of land value appreciation in the 1970s, it was hard to foresee that the price of land could decline. However, credit allocation—which in the short-run helped to increase farmland values—has, in fact, depressed them because of the burden of accumulated debt. Land prices are likely to rise because of uncertainty due to general inflation but also because accumulated debt has been relatively reduced. However, we must regard farmland price behavior in a cycling way with booms which, as Breimyer remarked, eventually bust.

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