Financing Constraints and Investment in Agriculture

Tian-Jinn Pan, Neil R. Martin, Jr., and Gregory Traxler*

I. Introduction

Two years ago, the financial stress began to happen to the Farmers' Associations in Taiwan. During 1995-96, more than 30 Credit Divisions of Township Farmers' Association experienced severe withdrawals because of borrower delinquencies resulted from more lenient lending practices. The total amount of deposits in Taiwan Farmers' Associations dropped by NT$50 billion, thus resulted in the growth rate of deposits decreased from 20% to 2.39%. The total overdue to total loan ratio risen to 5% in about 20 percent of Credit Divisions. The growth rate of business earnings in Farmers' Associations was negative by 18% (Tsai, 1996). Anatomy of an American farm credit crisis in the 1980s may provide the experience of resolution and recovery in financial supervision and administration for Taiwan Farmers' Associations.

In the past, most farm capital formation has been financed from within the sector. Farmers have substantially increased external financing relative to internal financing since 1955 in the U.S. farm sector (Brake and Melichar, 1977). On December 31,

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*Authors are associate professor in the Department of Agribusiness Management at the National Pingtung University of Science and Technology in Taiwan, and professor and associate professor of agricultural economics, respectively, at the Auburn University in USA.

1992, outstanding farm business debt have risen steadily from $11 billion in 1950 to a historical peak of $194 billion in 1984, an almost eighteenfold increase at the peak (ERS/USDA, 1994). The peak-to-trough decline of debt during 1984-89 was $57 billion, nearly 30%. During the same period, observed growth in debt might show that farmers prefer debt financing to internal financing to finance investment in capital

assets, even when total farm cash flow is sufficient to cover all capital flow. Specifically, the time trend in market shares of farm loans held by lenders shifted significantly in 1973 (Pan, 1995).

Peoples *et al* (1992) asserted that increased farm borrowing was a consequence of the increased use of machinery and the resulting growth in farm size. Only slightly more aggressive lending practices permitted substantial farm expansion and investment. They also cited Cochrane's agricultural "treadmill" (1993) to describe how farmers have become more technically efficient through borrowing, investing, and expanding and how the 1950s and the 1960s farm business conditions eventually developed through the 1970s into a full-scale farm credit crisis in the 1980s.

Any attempt to explain the process of investing, borrowing, and expanding in the farm sector must consider the interdependent relationships between finance and investment (Tostlebe, 1957; Kuznets and Jenks, 1961). External financing is an important source of funds used to finance investment in farm capital assets. As long as farm enlargement continues, the upward trend in farm debt and in capital formation could be expected. More insight into the expansion and contraction in farm capital ***stock*** and movement in debt outstanding can be obtained by examining annual capital ***flow***. Emphasis will be focused on how the annual capital flow is financed internally through farm cash flow and externally from the change in farm debt, and on the effect of demand and supply in farm credit markets on farmers' move toward greater external financing.

Existing models of investment in agriculture fail to incorporate these financial

variables, such as leverage, costs of debt and equity capital, the rate of return on assets, savings rate, capital flow burden, etc., to examine the effects of farm capital flow and internal financing on the growth in debt financing. Thus, a structural model of financing constraints and investment will be built in which the effects of these interdependent financial variables on farm capital and credit will be jointly determined. The specific objectives of this study are to:

1. Investigate the relationships between farm capital flow, farm cash flow, and farm financing.
2. Examine the effects of changes in supply-side variables (the variables that characterize the determinants of farm credit supply for each lender group, such as bond rates, the values of collateral assets, loanable funds, etc.) on the change in farm financial structure.
3. Test a set of hypotheses concerning the effects of savings rate, capital flow burden, and lender policies on farmers' move toward greater external financing.
4. Discuss implications of the empirical results for the farm capital formation and credit policies.

II. Theoretical Model

A profit-maximizing firm must confront the mutually dependent problems of production, investment, and finance. Thus, the theory of the firm must be grounded in the interdependent theories of production, capital investment, and finance (Vickers, 1987). Turnovsky (1970) also argued that production activities can be maintained only when the firm raises a certain amount of required money capital. Thus, the firm has a "money capital requirements function" which relates the amount of money

required to the amount of factor usage.

As long as the relationship between production level and factor use are determined, the level of money capital requirement will be generated. Whatever level of production is chosen, it must be one that does not generate a money capital requirement greater than the money capital actually available to the firm. Since money capital is for most firms in most situations a scarce resource, the firm would not enjoy saturation with capital (Lange, 1936). In the presence of an operative money capital availability constraint, the firm has two sources to finance its investment in the factor use. The total money capital available is therefore a specified amount of equity capital and /or debt capital.

The firm is assumed to maximize its profit function subject to a production function and a money capital availability constraint. The firm's optimization decisions are then embodied into the task of selecting the optimal solution values of the factor inputs and the optimum amount of money capital employ, equity capital, and debt capital. This optimization procedure provides the simultaneous solutions of the firm's production, investment, and financing problems. In the long-run equilibrium, the optimization procedure implies that equity capital and debt capital will be employed to invest factors of production until the full marginal cost of debt equals the full marginal cost of equity, and both the full marginal cost are equal to the discount factor at which the net cash flow or marginal income streams generated from investment should be discounted for planning purposes.

Both the equity owners' reservation rate and the average rate of interest on the debt are dependent on the financing mix employed in the firm. They will be determined by the supply-demand conditions in the money capital market. This represents the impacts of the leverage characteristics of the firm's financial structure. The higher the debt-to-equity ratio, the greater will be the risk exposure of both the owner and creditors. If we assumed risk aversion on the supply side of the money

capital market, the higher risk induced by higher degrees of leverage will call forth higher required rates of the return on the invested money capital. Both the equity cost and the debt cost functions will be understood to be monotonically positive.

Under the assumption of perfect competition in markets for both factor and product, the demand for a factor, obtained by simultaneously solving the first-order optimization condition of the firm's Lagrangian function, is a function of its price, prices of other factors, product price, quantities of the fixed factors, and the stock of equity and debt capital employed in the firm. These factor demands are derived demands - derived from the underlying demand for the product, the production function, and the money capital requirement availability.

Put it another way, these factor demand functions are demands for the optimal or desired use of each factor, i.e., the desired stock of capital assets financed by equity capital and debt capital. But they say nothing about the actual stock of capital. There is no reason to expect that the desired stock always equals the actual stock in the case of fixed or durable assets. To the extend that the desired stock does not equal the actual, there will be investment to sustain and increase the regular operations. But investment adjustment takes time. It is reasonable to suppose that the rate at which adjustment takes place will depend on the amount difference between the desired level of stock and its actual level.

By the partial adjustment model hypothesis, the addition to the desired capital stock in a given period and the corresponding money capital requirement are therefore derived from the demand for a desired stock of capital. That is the investment to be financed by net equity capital and net new debt capital. Since efficient markets for equity capital in the U.S. farm sector do not exist (Collins, 1985), the net equity capital must be replaced by the amount of internal financing from farm cash flow. Thus, in the investment behavior and financing choice in the Vickers amended neoclassical firm, the farm capital flow will be financed internally from cash

flow, and externally through increase in farm debt outstanding.

While the Vickers' model assumes that risk aversion on the supply side of the capital market will bid up the cost of debt and equity capital, the factors affecting the supply of capital available to borrowers are not modeled in detail. To address the availability of credit *per se* providing an additional influence on agricultural income and investment, Calomiris and others (1986) developed a model of links between credit markets and farm output based on the same assumptions as one that Vickers presented, but implicitly assumed that all investment was financed by debt.

Calomiris *et al* (1986) focused on three restrictions affecting credit availability: the role of collateral and projected cash flow for obtaining loans and changes in the value of collateral, agency problems limiting the ability of individual farmers to secure new external capital, and potential imperfections in farm credit markets limiting the number of loans a lender will make. These credit supply restrictions were shown to have depressed farm investment, and then resulted in aggregate reductions in output and income. Thus, they further limited farmers' ability to raise necessary operating funds as the values of collateral assets declined and farm cash flow shrank. Many farmers found themselves with land worth less than the amount of the mortgaged principal plus interest still to be repaid, default was the rational choice for these farmers. Then, increasing bank failures followed.

In contrast to the assumption of all investment to be financed externally made by Calomiris *et al*, the potential role of internal finance in the investment process was stressed in an internal net worth model developed by Hubbard and Kashyap (1992). They extended the neoclassical specification by maximizing the present discounted value of net cash flows from farm investment subject to capital accumulation, net cash flow, and a borrowing constraint. A firm's Euler equation for capital accumulation was derived to test the hypothesis of perfect capital markets in the standard neoclassical approach.

Financing and investment decisions are not in general independent because the effects of asymmetric information in capital markets have made costs of external finance inversely related to the level of internal finance. Thus, there is a direct channel for internal funds to affect investment. When borrowers' net worth improves, lenders become more willing to lend, and additional investment can be financed.

Integrating the neoclassical approach and its amended versions developed by Vickers, Hubbard and Kashyap, and Calomiris and others,, the structural model of financing constraints and investment may be expressed as follows:

$$I = f(P,q,K,R,r)$$
$$IF = g(\rho,r,T,M,E)$$
$$EF = h(r,\rho,T,M,D) \qquad (1)$$

where I is annual capital flow or investment; IF is annual internal financing; EF is annual external financing or demand for net new loan, P price of product, q vector of prices of capital assets, R return on capital stock, ρ return on equity capital, r real rate of interest, K stock of capital assets, E stock of equity capital, D stock of debt capital, M preference for internal financing, and T intensity of investment in capital assets.

In sum, both neoclassical approach and its amended approach demonstrated that a derived structural system which consists of demand for capital stock, debt capital, and equity capital can be obtained under certain assumptions. Flow models for capital flow, debt financing, and internal financing adjusting from actual stock to optimal level can also be derived using the partial adjustment hypothesis.

However, neither the neoclassical approach nor the amended approach focused on the analysis of effects of investment behavior and internal financing on debt financing. Only Calomiris *et al* (1986) have analyzed the effects of credit supply restrictions on farm output, but they focused on the negative aspects. Observations of farm credit market show that structural changes in supply side lead to changes in

market share of total farm debt held by each lender group. This gradual structural change in supply of farm credit since 1955 may appear as a demand shift (Pan, 1995).

Adding this structural change in supply side to the change in liquidity preferences of borrowers (M) and the intensity of investment (T) may be used to interpret why farmers with sufficient cash flow still move from internal financing to greater external financing, and eventually developed into a farm credit crisis in the 1980s. Thus, a model characterizing determinants of supply within a farm credit demand system will be developed to interpret shifts in farm credit demand and in financial structure caused by changes in supply-side variables.

The growth of farm debt since 1955 and the relative importance of different lenders in terms of their market share (Pan, 1995) suggested that farmers prefer debt financing to internal financing in their financial structure. Many types of financial institutions have emerged to provide the necessary linkages between suppliers and users of funds in financial markets. While historical data have shown that total cash flow for the farm sector has generally been greater than total capital flow, farmers still moved toward greater debt financing in their financial structure. Thus, the role of financial intermediation in the process of channeling farm credit between savers and farmers is important (Barry *et al*, 1988).

Information about loan quality in credit markets is often idiosyncratic to particular firm. This separation of agribusiness management from financing agents naturally creates asymmetric information (Myers and Majluf, 1984). Recent work (Stiglitz and Weiss, 1981; Greenwald, Stiglitz, and Weiss, 1984) showed that asymmetric information about a loan's quality can lead to credit rationing. Even if lenders do get good information, it may be costly for them to evaluate it as outsiders to the firm, especially for the information-intensive farm firm (Calomiris *et al*). A fundamental effect of asymmetric information on the functioning of the capital market that determines the level of investment is therefore the availability of credit,

not its cost. Thus, internal finance, existing interest commitments, ability to service debt from cash flow, and collateral of a farm firm play the signal role in the case of asymmetric valuations of expected returns between borrowers and lenders (Chan and Kanatas, 1985), especially in the case of farm loans (Peoples *et al*, 1992).

Farmers' collateral is composed largely of one specific asset - farmland. Fluctuations in the value of farmland are highly positively correlated with realizations of returns on farming and unrealized capital gains and losses (Melichar, 1979). With the positive relationship between the value of collateral stock and the supply of secured credit, the factors affecting the valuation of collateral assets determines how far the supply of secured credit shift. However, the distinction between a borrower's want and demand for credit depends not only on the rate of interest offered, but also on the borrower's collateral or equity (Azzi and Cox, 1976). Analysis in a model in which the proceeds of a loan are used to acquire a capital asset must involve study of the lender response to changes in borrower equity and collateral as well as the lender response to interest rate changes.

Drawing from the literature on collateral, interest rate rigidity is always recognized as a rational move on the part of the lender to reduce default risk. In such credit markets, lenders incorporate non-price terms into loan contracts to sort loan requests by default risk. Non-price terms include collateral, transaction costs, and loan repayment terms. Thus, the demand and supply relationships can be shown as

$$EF^d = f(r, \rho, T, M, D) \tag{2}$$

$$EF^S = g(BR, LF, CO, AR) \tag{3}$$

where BR is the cost of funds paid by lenders, such as bond rate, LF is the loanable funds, CO is the value of collateral assets, and AR is the vector of alternative investment opportunities available to lenders. The other variables are the same as previous definitions.

This study presents a model of financing constraints and investment by allowing

total farm capital flow to be financed from farm cash flow and through change in debt. The proceeds of farm loans are assumed to be used to acquire capital assets. Internal financing, the difference between farm capital flows and net new farm loan, represents the proportion of cash flow allocated to finance investment. This analysis establishes the hypothesis that internal financing and capital flow will be significant determinants of the debt financing if asymmetric information in farm credit market is important for lenders to sort the request for farm loans, and the supply-side variables are, if any, not predetermined.

Emphasis is focused on the move toward greater external financing since 1955. A typical argument for this upward trend in farm debt rests mainly on additions to capital assets and increases in prices of capital assets and other inputs (Evans, 1972). An equally common argument, but for the capital investment, is that a consequence of the increased use of capital assets and the resulting growth in farm size is growth in farm borrowing (Peoples *et al*, 1992). If we recognize these two arguments to be justified, then the variables, farm capital flow and net new farm loan, are interdependent in this structural model for financing constraints and investment.

However, the amount of internal financing also depends on capital flow and net new farm loan. Since internal financing is the proportion of farm cash flow allocated to financing capital flow, and farm cash flow is determined by net farm cash income. Net cash income is generated from the return on capital investment. Therefore, internal financing is also a dependent variable in this analytical model.

Furthermore, debt financing is determined by the demand-and-supply conditions in the farm credit market characterized by the supply side and information asymmetries. Thus, the demand for farm loan must consider the lender response to changes in borrower collateral and the lender response to interest rate changes, and must be incorporated into the analytical model. The supply side in farm credit demand system is not assumed to be exogenous except for the extreme case such as

the credit offered by Farmers Home Administration (FmHA).

To derive factor demand functions, we have assumed perfect competition in markets for both factor and product. we may relax the assumption for farmland market to analyze the effect of farmland price behavior on financing new investment. Farmland values account for the most part of the values of collateral assets. Farmland prices play an important role in the real growth of farm capital flow and its external financing.

Integrating these considerations into a model of farm capital and credit, we have a system of equations consisting of capital flow equation, internal financing equation, debt financing equation, and farmland price equation. Since capital flow can be financed internally and externally,

$$I = IF + EF \tag{4}$$

and then

$$EF = I - IF \tag{5}$$

Thus, the simultaneous equation model takes the general form as follows:

$$\begin{aligned} I &= f(P, q, R^K, r, K) \\ q^L &= g(R^L, r^L, \rho^L, w, \pi, EF^L, CG) \\ IF &= h(\rho, r, T, M, E) \\ EF &= j(r, \rho, T, M, D) \\ EF &= I - IF \end{aligned} \tag{6}$$

where q^L is the farmland price, R^L the expected rental income to land, R^K the return on total farm capital assets, ρ^L the required rate of return on equity for farmland transfers, r^L the rate of interest charged on mortgage loans by lenders, w the financing mix for farmland transfers ,π the inflationary expectations, EF^L the amount of debt financing for farmland transfers, and CG the expected capital gains or losses for

holding land. The other variables have been defined above. Supply-side variables will be specified as instrumental variables imposed to the whole system of equations.

III. Specification of The Empirical Model

The theoretical model presented above demonstrated the interdependence between finance and investment. It is hypothesized that farmers' move toward greater external finance is affected by the level of farm capital flow, internal financing, and farm credit supply. The empirical model of factors that affects the level and source of financing of farm capital assets is specified as follows.

Farm Capital Flow Equation

In a subsector analysis such as our study, the gross farm investment (the farm capital flow) comprises land capital requirement associated with farm transfers, expenditures for machinery, buildings, and land improvements, changes in holdings of livestock, stored crops, and financial assets. In this study, emphasis is placed on understanding how farm capital flows and lender policies influence farmers' move toward greater debt financing. Departing from the neoclassical approaches, the specification and expected coefficient signs of the farm investment equation is given by

$$I_t = a_0 + a_1 P_t + a_2 q_t + a_3 q_t^L + a_4 q_t^M + a_5 R_t^K + a_6 r_t + a_7(\delta - \lambda)K_{t-1} \qquad (7)$$

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where I_t is annual total farm capital flow, i.e. gross farm capital expenditures for all capital assets, including land capital requirements associated with real estate transfers; P_t and q_t are prices of output and inputs, respectively; q_t^L is real estate price; q_t^M is machinery price; R_t^K is the rate of return on total farm assets; r_t is the rate of interest on farm loans; δ is the rate of depreciation, obtained by regressing current

replacement investment on the depreciable capital stocks at the beginning of the year (Klein and Goldberger, 1955); λ is the partial adjustment coefficient; and K_{t-1}, the stock of depreciable capital assets, measured at the beginning of the year.

The role of capital stock here is twofold: it has a positive effect on investment, measured by δ due to the larger replacement demand generated by a larger stock of capital, and a negative influence, measured by λ, owing to the damping effect of the existing stock of capital on the adjustment process. The net effect of the capital stock on investment is indeterminate, it depends upon whether δ is smaller or larger than λ. The sign of a_7 is used to test the hypothesis that annual machinery purchases have largely just served to replace depreciating capital stock.

Farmland Price Equation

After revising Alston's model, Feldstein's model, and Shalit-Schmitz model, and combining Melichar's model and the Reinsel-Reinsel model with Harris's model, we suggested another asset valuation model based on the standard growth stock valuation model. The price of farmland is formulated to be a function of current expected rental income, expected growth in income, real required rates of return on debt and equity, the financial mix used to purchase and hold asset, and inflationary expectations.

The general specification for the regression equations of farmland price is then specified as follows:

$$q_t^L = b_0 + b_1 R_t^L + b_t(w^D r^L)_t + b_3(w^E \rho^L)_t + b_4 \pi_t + b_5 EF_{t-1}^L + b_6 CG_t \qquad (8)$$

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where q_t^L is real price of farmland; R_t^L, current expected income to land; w^D and w^E, the proportion of respectively financed farmland transfers by debt and equity; r^L and ρ^L, the real rates of return on debt and equity for credit-financed transfers; EF^L_{t-1}, the lagged amount of external financing for credit-financed transfers; π_t, inflationary expectations; and CG_t, the current price level in real estate markets used as a proxy

for the expected capital gains/losses, because it appears as an indicative of expectations for both farmers and lenders (Melichar, 1979). The product of w^D and r^L represent the credit effect on farm real estate transfers.

Internal Financing Equation

Total farm capital flow is financed with a combination of internal and external funds. The distribution of total capital flow between internal and debt financing depends mainly on savings rate, capital flow burden, the cost and availability of these two source of funds, and collateral constraints. Other economic and financial variables also have effects on these two source of funds.

The portion of farm cash flow allocated to finance capital flow is referred to as internal financing. Because the availability of internal financing is determined by the farm cash flow, its components should be identified and defined carefully. Farm cash flow in this study is defined to be the cash flow available to finance farm capital flow internally. Thus, it is the sum of net cash income (including off-farm income), net change in other financial assets, net rent paid to non-operator landlords, capital expenditures, and the downpayment for credit-financed real estate transfers. The last item represents the amount that farmers must pay down when additional farmland is purchased from the sellers who leave the farm sector or who are non-farm heirs.

The farm sector return on investment relative to that in non-farm sectors, measured as the ratio of the rate of return on farm equity to the yields on U.S Treasury Bonds, is expected to affect internal financing. The higher yields are outside the farm sector, the less willing farmers will be to finance capital purchases internally. The preference for internal financing can be measured as the "savings rate" for farm sector, i.e., the amount of internal financing as a percentage of cash flow. Further, the intensity of investment, measured as the capital flow burden (total capital flow as percent of cash flow), should have a positive effect on internal financing.

Because debt financing is the alternative source of funds for financing investment, its cost has a positive effect on the amount of internal financing. The level of internal funds, measured as the net cash income, has a positive effect on internal financing. Thus, the equation of internal financing can be specified as

$$IF_t = c_0 + c_1 RY_t + c_2 r_t + c_3 SR_t + c_4 CFB_t + c_5 NCI_t \qquad (9)$$

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where RY_t represents the relative return on investment between farm sector and non-farm sector; r_t, the cost of debt capital, measured as the weighted average rates of interest charged on total farm loans; SR_t and CFB_t, savings rate and capital flow burden, respectively; and NCI_t, net cash income.

External Financing Equation

The market for farm credit could be studied from at least three perspectives: the stock of debt outstanding, the annual gross flow of loans, and the net flow of loans closed less repayments. Each would be modeled differently. Hesser and Schuh (1963, 1962) used the annual gross flow of farm mortgage loans in a study of the farm mortgage credit market. The net flow concept was employed by Lins (1972) to analyze the sources and uses of funds in the farm sector. Robison and Love (1979) used the concept of new loans in a study of changes in farm mortgage loan market shares held by Federal Land Bank (FLB) and life insurance companies (LIC). Boyette and White (1987) used net flows to account for refinancing of existing farm real estate debt. Due to the lack of complete data for new money loans and loan repayments, efforts here will be focused on the demand for net new farm loans, i.e., the net changes in farm debt.

Farm sector debt, as reported by USDA, is classified for each lender by long term real estate debt and shorter term non-real estate debt. Real estate debt includes loans

and mortgages held by the Farm Credit System (FCS) through Farm Credit Banks and Agricultural Credit Associations and FLB associations, the USDA's FmHA, LIC, commercial banks (CB), individuals and others (IO), and the Commodity Credit Corporation (CCC) for loans on storage and dry facilities. Non-real estate debt includes loans held by the FCS (through Production Credit and Agricultural Credit Associations), FmHA, CBs, and IOs.

The determinants of net changes in farm debt can be grouped into two broad categories: those affecting the demand for credit by farmers, and those affecting the supply of credit available to farmers. Potential determinants on the demand side are cost of credit and services provided by each lender group, availability of internal financing, current or expected future returns on capital investment, savings rate, and capital flow burden.

Thus, the general specification for regression equation of farm loans demanded by farmers is given by

$$EF_t = d_0 + d_1 r_t + d_2 \rho_t + d_3 SR_t + d_4 CFB_t + d_5 NCI_t \qquad (10)$$

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where r_t is weighted average rate of interest charged on total farm loans; ρ_t, required rate of return on farm equity; SR_t and CFB_t have been defined as in the internal financing equation; NCI_t, the net cash income. The expected impacts of interest rates, savings rate, and net cash income on the credit demand are negative; but those of capital flow burden and the rates of return on farm equity are positive.

Data Description

The annual time-series data used in this study are secondary data for the U.S. farm sector from 1950 to 1992. They are used to create the variables appearing in the simultaneous equations model of investment activity in U.S. agriculture. The predetermined variables can be subdivided into exogenous and lagged endogenous

variables. The values of exogenous variables are completely determined outside the system under consideration, whereas the values of lagged endogenous variables are represented by the past values of the endogenous variables of the model.

For convenience to contrast endogenous variables with predetermined variables, the simultaneous equations model presented above is reproduced as follows:

$$I_t = a_0 + a_1 P_t + a_2 q_t + a_3 q_t^L + a_4 q_t^M + a_5 R_t^K + a_6 r_t + a_7(\delta - \lambda)K_{t-1}$$

$$q_t^L = b_0 + b_1 R_t^L + b_2(w^D r^L)_t + b_3(w^E \rho^L)_t + b_4 \pi_t + b_5 EF_{t-1}^L + b_6 CG_t$$

$$IF_t = c_0 + c_1 RY_t + c_2 r_t + c_3 SR_t + c_4 CFB_t + c_5 NCI_t$$

$$EF_t = d_0 + d_1 r_t + d_2 \rho_t + d_3 SR_t + d_4 CFB_t + d_5 NCI_t$$

$$EF_t = I_t - EF_t \qquad (11)$$

Each equation is fitted in linear form to the time series data from 1950 to 1992. The interdependent relationships of variables across each equation within the structural system can be shown as Figure 1. Data are obtained from *Economic Indicators of the Farm Sector: National Financial Summary, 1992* and other USDA's publications listed in references.

Estimation Procedures

The estimation procedure for the simultaneous equations model of financing constraints and investment is aimed at testing a set of hypotheses for investigating the farmers' move toward greater debt financing. Rapid growth in farm loan demands and the observed decline in internal financing might be ascribed to a higher rate of real capital formation. We perform two tests: one to see if preferences for farm finance have changed from internal financing to debt financing; another to see if growth in farm capital flow has contributed to change in farmer preference for internal financing, i.e., farmers may indeed have moved toward greater debt financing for investment in capital assets.

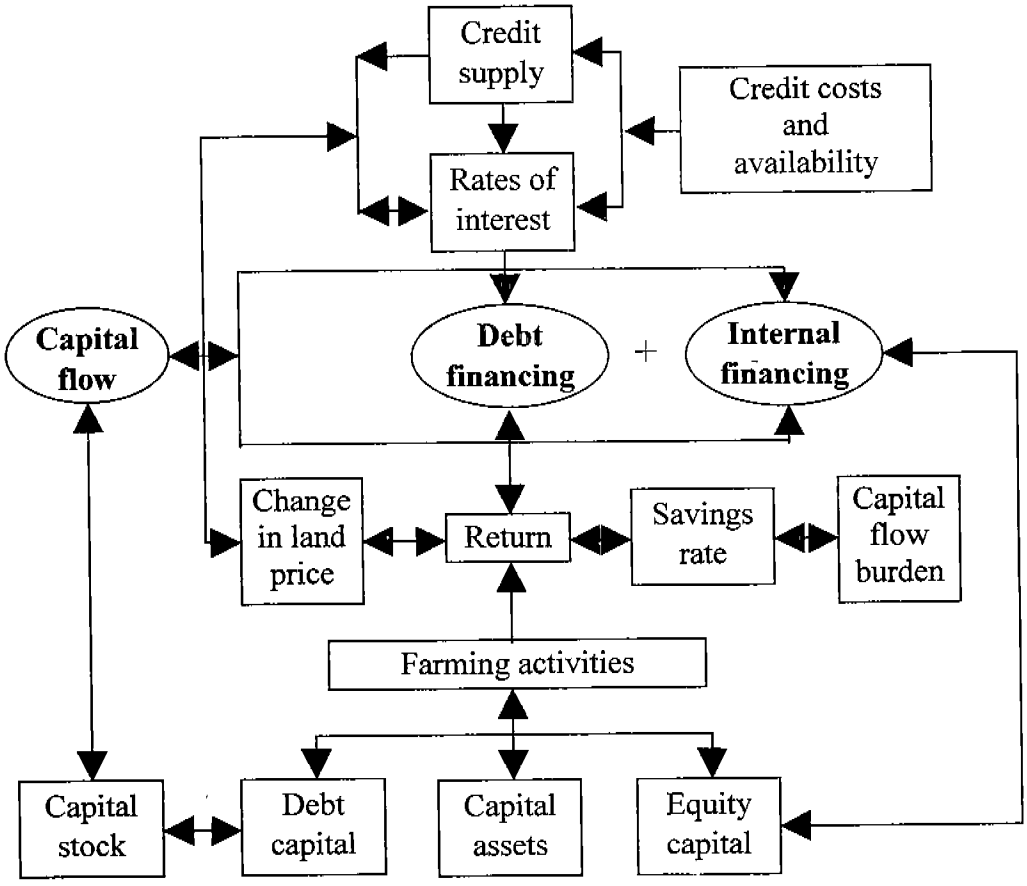

Figure 1 Flow Chart for a Model of Farm Capital and Credit.

Many reasons have been used to explain the change in farm finance. But more lenient lending practices such as lower cost financing, the congressional mandate to FCS, seller financing of farmland, and FCS adjustable loan rates, have deserved much recognition (Peoples *et al*, 1992). The combination of rising general inflation, rising land prices and lenient lending practices was irresistible to some farmers and their lenders. All of these factors have been incorporated into the empirical model.

An econometric approach is used to test for the one-time shift in farm finance.

Total funds used for investment are the sum of debt financing and internal financing. The level of total capital flow to debt financing and internal financing is also used to test for a change in preference for farm finance. The post-1973 intercept dummy and the post-1973 multiplicative variable are included in the capital flow equation, internal financing equation, and debt financing equation, respectively. The choice of one-time shifts in demand is based on the time trend in market shares of farm loans held by each lender group. Total farm loans shifted significantly in 1973 (Pan, 1995). Both the post-1973 intercept dummy and the post-1973 multiplicative variable indicate a one-time shift in the slope and intercept of the demand for finance.

If both the intercept dummy and the multiplicative variable are significant in the capital flow equation, indicating a one-time shift in capital flow, but are not significant in either of the financing equations. Then the change in capital financing mix is causing the apparent shift in capital flow. Alternatively, if a corresponding structural change occurs in one or both of financing equations, then the apparent shift in capital flow is caused by the change in capital financing mix and there is a real change in preference for farm finance.

As the dummy variable approach shows, both the statistically significant intercept dummy and multiplicative slope indicate that the regressions for the two period are different in slope and intercept. The test of the stability of the entire regression can be made by the usual F test of the overall significance of the estimated post-1973 regression (Gujarati, p. 448).

The effect of real capital formation on internal and external financing is indicated by the coefficients of capital flow burden in both financing equations. If the coefficients are significant in both equations, then the higher rate of real capital formation has contributed to farm finance. The effect of farmland price on farm finance is incorporated into the instrumental variables in a lagged form. Lender response to changes in farmer collateral and to interest rate changes have a substantial

influence on farm finance. For insights into the effects of changes in supply-side variables on farm finance for new investment, *2SLS* estimates from each equation are compared with *OLS* estimates to determine whether changes in supply-side variables explain much of the apparent early 1970s shift in farm finance.

IV. Empirical Results

Statistical estimation showed that each model in the system of financing constraints and investment equations fitted well. The results of *2SLS* estimation, with instrumental variables characterizing determinants of credit supply, are reported to examine the effect of changes in supply-side variables and finance for investment on the growth of debt in the U.S. farm sector. Estimated results for the system of equations are reported in Table 1.

Farm Investment Behavior

The coefficients in the capital flow model are reasonable in signs and magnitudes. The effect of prices paid by farmers for production items is larger than that of prices received by farmers. The effects of real estate and machinery prices on capital flow are positive and highly significant. Purchases of new machinery and real estate transfers are the two major components of capital flow, accounting for four-fifths of the total capital flow. Our findings are similar to those of Evans (1972) and Melichar (1973).

The upward trends in annual capital flow required for real estate transfers and in machinery purchases reflect a similar trend in the value of real estate and machinery stock (Melichar, 1973; Brake and Melichar, 1977). Evans attributed measured additions to capital assets, and therefore, to the increase in farm debt outstanding to increases in land and machinery prices.

The negative effect of depreciable capital assets on capital flow implies that the adjustment coefficient of capital stock is greater than the economic rate of

Table 1 *2SLS* Estimates of the Model for Financing Constraints and Investment

RHS Variables	Equations: Capital flow	Farmland price	Internal financing	External financing
P	1.138*			
	(0.315)			
q	−3.373*			
	(0.678)			
q^L	1.270*	2.045*		
	(0.189)	(0.415)		
q^K	1.999*			
	(0.486)			
K_{t-1}	−0.527*			
	(0.150)			
R^K	2.393*			
	(0.289)			
r	−1.066		0.337*	−0.426
	(0.553)		(0.166)	(0.352)
R^L		16.357*		
		(2.075)		
Ω^L		0.661		
		(5.557)		
ρ^R		−5.562		
		(6.975)		
π		21.167*		
		(7.345)		
EF^L_{t-1}		25.287*		
		(4.515)		
RY			−0.034	
			(0.062)	
SR			0.666*	−0.513*
			(0.039)	(0.072)
CFS			0.239*	0.580*
			(0.048)	(0.074)
NCI			0.353*	−0.152
			(0.038)	(0.104)
ρ				0.709*
				(0.115)
$INTRCPT$	113.110*	−219.280*	−24.993*	7.556
	(23.650)	(64.770)	(2.662)	(5.938)
R^2	0.838	0.956	0.973	0.852
$D\text{-}W$	2.38	1.98	2.47	2.57

Right-hand-side variables have been defined previously; $\Omega^L=w^D*r^L$, $\rho^R=w^E*\rho^L$; *D-W*: Durbin-Watson.

depreciation, which was estimated to be 0.2007. In this study, by regressing annual replacement investment on annual values of depreciable capital stock at the beginning of the year gives

$$\text{Replacement investment} \quad \underset{(1.204)}{-12.174} + \underset{(0.0083)}{0.20071} K_{t-1},$$

the adjustment coefficient, 0.7281, is obtained by adding the depreciation rate to the estimated coefficient of depreciable capital stock (K_{t-1}). The economic rate of depreciation only accounted for about 27 percent of the adjustment coefficient. Thus, our finding does not agree with those of Melichar (1973) and Evans (1972), who found that large annual purchases of new machinery have served primarily to replace worn-out or obsolete machinery and equipment, based on a comparison of USDA expenditure and depreciation-allowance data.

Capital theory suggests that the rate of return on capital stock is an important factor in capital investment. Our estimated result of the rate of return on total capital assets, including from current income and from real capital gains/losses, coincides with capital theory, because it has a significant positive effect on total farm capital flow during the past forty years to 1992.

The variables in the capital flow model which employs supply side instruments in general have more significant effect on farm capital flow than the corresponding estimates in the model which does not account for the supply side (Appendix). This comparison shows that including supply side instruments alters measured farm finance and investment behavior.

Farmland price Behavior

The farmland price model shows that neither component of the discount rate, Ω^I and ρ^R, is significant, and the credit effect (Ω^I) has the wrong sing. Harris's model

suggests that the discount rate has a negative effect on land price. Thus, the effects of these two variables, the real required rates of return on debt and equity (r^L and ρ^L) associated with the corresponding financing mix used to purchase and hold land (W^D and W^E), on the growth in real land price are indecisive.

The amount of debt financing for real estate transfers, measured as the beginning values of the year, has a significantly positive effect on the growth in real land prices. This result is similar to that of Shalit and Schmitz (1984), who found that credit-financed farmland transfers made a substantial contribution to the growth in real farmland prices.

Our finding of a highly positive effect of rental income on real farmland prices agrees with that of Alston, that is, most of the real growth in U.S. farmland prices can be accounted for by real growth in rental income to farmland during the study years to 1992. The finding of a positive effect of increased inflation on real farmland prices agrees with Feldstein's hypothesis (1980), but are opposite to that of Alston (1986), who found that the inflation effect on farmland prices is significantly negative but empirically relatively small given the other parameter magnitudes.

Another factor which has had a positive effect on real land prices is the current price level in the real estate market. This variable is used as a proxy for expected capital gains for holding farmland based on an argument popular in real estate markets, that is, the present rate of current return (rental income) and thus the present level of land prices in the real estate market appears implicitly as an indicator of expectations for farmland buyers and sellers (Melichar, 1979, 1986).

Comparing the estimates from the farmland price model estimated with supply-side variables with the estimates without the supply side shows that supply-side instruments increase the magnitudes of the coefficients for expected rental income and price levels of real estate, but reduce the magnitudes of the other variables. This comparison indicates that lenders have the same expectations as land buyers about the

level of land prices in their mortgage loan decisions (Peoples *et al*, 1992; Thomson and Kaiser, 1985) but are less concerned about interest rates and the amount of mortgage loans.

Farmland is the most creditworthy form of collateral in mortgage loan markets; when the values of the collateral increases, lenders either make larger loan offers at any given interest rate or lower the interest rate on loans (Harris, 1979). The supply of credit to a borrower is an increasing function of the amount of collateral or equity offered by the borrower (Azzi and Cox, 1976). This finding reflects that lender response to changes in borrower collateral as well as lender response to interest rate changes have a fair effect on real growth in land prices.

Internal Financing Model

Results in column 3 of Table 1 represent the estimates from the internal financing model. All variables in this model have the expected signs and reasonable magnitudes. The coefficient of relative yields to alternative off-farm investment is negative, indicating that greater yields on off-farm investment will decrease the amount of internal financing for farm investment. The positive coefficient of interest rates indicates farmers will increase the amount of internal financing for capital investment relative to debt financing when the rate of interest charged by lenders is going up.

Both coefficients of capital flow burden and net cash income are highly significant and positive, indicating that a higher degree of intensity in farm investment and higher levels of net cash income have larger effects on internal financing. The indicator of farmer preference for internal financing, the savings rate, has the expected impact on the amount of internal financing, that is, the amount of internal financing will increase relative to debt financing if farmers prefer the internal source of funds to external source of funds used to finance farm capital flow.

Comparing estimates with supply-side instruments to those without the supply

side also shows that lender policies have amplified the magnitudes of the intercept, capital flow burden, and interest rate, but reduce those of savings rate and net cash income. Therefore, changes in supply-side variables have the real effect on internal financing.

For more insight into the change in demand for internal financing, a post-1973 dummy and a corresponding multiplicative term for savings rate are included in the internal financing model. The results of the test for a one-time shift in demand for internal financing are reported in Table 2. The negative post-1973 dummy is significant, indicating a one-time shift in internal financing after 1973. The shift in demand for internal financing is also confirmed by the F value [F=190.32, $F_{.05}(2, 35)=3.28$]. But the positive effect of the post-1973 savings rate on internal financing is small - only increase by 3 percent (from .646 to .664) in magnitude because of the severe 1980s farm credit crisis.

Debt Financing Model

The estimates from the debt financing model for U.S. farm sector as a whole show that the coefficients of the savings rate, capital flow burden, and the rate of return on farm equity are reasonable in signs and magnitude, and highly significant. The savings rate is negative, indicating greater preference for internal financing will decrease the demand for farm loans offered by all lenders. In contrast to the savings rate, the effect of capital flow burden on debt financing suggests that higher intensity of investment in capital assets will increase the amount of debt financing.

Like the savings rate, the effect of net cash income on debt financing is negative but not significant. The rate of return on equity capital is positive, where it is large and highly significant, contrary to the rate of interest charged by all lenders on farm loans. This estimated results for these two variables indicate that the return on equity capital deserved more concern by farmers in their financing decisions for investment

than the costs of external funds did. Thus, the total farm loan demands showed a smaller-own-price elasticity.

The debt financing model also provides evidence on real changes in farmer preference for financing by including a post-1973 dummy and a corresponding multiplicative variable for savings rate. The significant dummy shows an outward shift in the quantity demanded for farm loans and indicates that the amount of debt financing still increased after 1973, during the farm credit crisis of 1981-87. The significant post-1973 savings rate shows a 35 percent increase in the magnitude of the negative effect for savings rate on debt financing after 1973. It is easy to imagine an increase in farmer preference for internal financing after 1973, since total farm capital flow was primarily financed internally during the 1980s credit crisis. The significant computed F=35.06 also confirms this shift in demand for debt financing.

Comparing *2SLS* estimates from both the internal financing model and the debt financing model, which account for the supply-side variables, with *OLS* estimates which do not account for the supply side, indicates that changes in supply-side variables have reduced the magnitude of net cash income (Table 2) by 5 percent in the internal financing model and by 15 percent in the debt financing model. But the positive effect of capital flow burden on internal and external financing increased by 20 percent and 2 percent, respectively, in these two models, indicating the increase in the intensity of farm investment continued after 1973.

Further, the changes in savings rates have also been altered by the inclusion of supply-side instruments. In the internal financing model, the percentage change in savings rate after 1973 declined from 20 percent in the estimates without the supply side to 3 percent in the estimates with the supply side, indicating the farmer preference for internal financing declined by 85 percent. In the debt financing model, the same percentage change in savings rate fell from 44 percent to 35 percent, i.e.,

Table 2 Changes in Farm Financial Structure

	Equations			
	Internal financing		Debt financing	
RHS Variables	with instruments	without instruments	with instruments	without instruments
RY	−0.047	−0.002		
	(0.064)	(0.030)		
r	0.347	0.136	−0.230	−0.256
	(0.176)	(0.152)	(0.339)	(0.373)
ρ			0.777*	0.767*
			(0.109)	(0.118)
SR	0.646*	0.615*	−0.476*	−0.444*
	(0.068)	(0.045)	(0.070)	(0.075)
SR^{73}	0.018	0.124*	−0.170*	−0.196*
	(0.084)	(0.052)	(0.084)	(0.091)
CFB	0.248*	0.206*	0.528*	0.516*
	(0.050)	(0.033)	(0.071)	(0.078)
NCI	0.357*	0.366*	−0.138	−0.162
	(0.038)	(0.035)	(0.095)	(0.101)
DM^{73}	−0.070	−3.001	7.449*	8.090*
	(2.420)	(1.616)	(2.896)	(3.176)
INTRCPT	−25.146*	−22.742*	5.709	6.775
	(3.040)	(2.405)	(5.499)	(5.947)
R^2	0.974	0.980	0.875	0.876
D-W	2.44	2.20	2.68	2.58

Structural Change in Capital Flow Model

K_{t-1}	K^{73}_{t-1}	DM^{73}	*INTRCPT*
−0.848*	0.591*	−95.793*	156.670*
(0.251)	(0.261)	(38.000)	(42.090)

Right-hand variables have been defined previously; figures in parentheses are standard errors; *: indicates significant at a 0.05 level; DM^{73}: a dummy variable equal to 1 in all post-1973 years and 0 elsewhere; SR^{73}, K^{73}_{t-1}: variables which are the product of the dummy and the savings rate, and the lagged capital stock, respectively; *D-W*: Durbin-Watson.

almost 20percent. Our findings suggest that changes in supply-side variables have altered farmers financing behavior.

Changes in Farm Financial Structure

A test for changes in farm financial structure is presented here. The level of total farm capital flow is the sum of the amount of internal financing and debt financing. Both one-time shift variables, the intercept dummy and the multiplicative variable for the lagged depreciable capital stock in the capital flow equation, have an unexpected sign after 1973, contrary to the sign prior to 1973, indicating a downward one-time shift in demand for investment in farm capital assets. The F-test result [F=20.86 for $DM^{73}=K^{73}_{t-1}=0$ simultaneously, and $F_{.05}(2, 33)=3.25$] also confirms this shift in farm capital flow after 1973. The positive coefficient of the post-1973 depreciable capital stock indicates that the partial adjustment coefficient declined and was less than the economic rate of depreciation after 1973. This decline in the adjustment coefficient is also reflected in the negative post-1973 intercept dummy.

Checking the corresponding intercept dummy and the post-1973 savings rate in the debt financing and internal financing models indicates that a corresponding structural change occurs in both of the capital financing equations. Both the intercept dummy and the post-1973 savings rate are significant in debt financing equation, and positive for intercept dummy and negative for savings rate, indicating debt financing shifted upward after 1973, contrary to a downward shift in internal financing.

Combining the tests for a one-time shift in the capital flow, internal financing, and debt financing equations, both the intercept dummy and the interaction term are significant in the total farm capital flow equation, indicating a one-time shift in demand for farm investment, but are also significant in debt financing equation. Therefore, the change in capital financing mix, both of the debt financing and internal financing, is causing the apparent downward shift in capital flow after 1973, and there

is a real change in farmer preference for finance, That is, change in farm capital flow is explained by the changes in the capital financing mix and by a real change in preference for farm finance. Financial structure in the U.S. farm sector has significantly changed since 1973 due to farmers prefer debt financing to internal financing.

Evidence presented above suggests that the move toward greater debt financing had two aspects, and that the shift in the savings rate deserves as much recognition and study as the shift in the capital flow burden. The shift in the savings rate also had two aspects, the exogenous decline in preference for internal financing, due to exogenous growth in consumption and/or off-farm investment and the endogenous increase in farm credit demand and supply caused by the increase in capital flow burden, i.e., the intensity of investment in farm capital assets.

V. Summary and Conclusions

The primary goal of this study is to apply the theory of finance and investment to farm credit and capital. The ultimate aim of this paper is to demonstrate how the savings rate and capital flow burden can be modeled in a financing demand system to link farm finance and investment behavior, and to investigate the effect of these two variables on farmers' move toward greater debt financing for capital flow.

Some significant economic and financial elements such as prices of output and inputs, existing capital stocks, the rates of return on capital stock , and the rates of interest display a continuing effect on farm investment. To finance farm capital flow, farmers were forced to adjust to changes in the savings rate, capital flow burden, net cash income, the rate of return on equity capital, lender response to change in farmer collateral, and lender response to changes in costs and availability of farm credit.

The savings rate and capital flow burden entered the financing demand function as percentage parameters. The savings rate is viewed as indicating farmer preference

for internal financing. The higher the farmer preference for internal financing, the greater the savings rate.

This study has measured the intensity of investment in capital assets using the capital flow burden, which affects financing by changing the share of capital flow that can be financed from cash flow. The interdependent relationship between farm finance and investment behavior is, therefore, linked through the capital flow burden.

Several conclusions drawn from the empirical results are listed as follows:

1. The effect of capital flow on farm finance is transmitted through the change in the capital flow burden.
2. Lender response to the change in borrower collateral and supply-side variables characterizing determinants of farm credit supply have altered farm finance and investment behavior.
3. There is an apparent shift in U.S. farm financial structure after 1973 caused by the change in the financing mix and the change in farmer preference for finance. These findings confirm that farmers' move toward greater external financing is due to the shift in the savings rate and the shift in the capital flow burden under more lenient lending practices.
4. The move toward greater debt financing by farmers had two aspects: the shift in the savings rate and the shift in the capital flow burden. The shift in the savings rate also had two aspects, that is, the exogenous decline in preference for internal financing, which may be due to the exogenous growth in consumption and/or off-farm investment, and an endogenous growth in farm credit caused by the increases in capital flow burden.

Limitations of the Study and Future Research

Explanation of the causes of the increase in farm debt since 1955 and the full-scale credit crisis in the 1980s is an important area of study. However, our empirical

study is the first to test the structural change in farm finance, in particular, the change in preference for external finance sources. The major contribution of this study is its attempt to link farm finance and investment based on the fundamental identity - farm capital flow can only be financed through a combination of internal cash flow and external change in debt. This linkage, through the savings rate and capital flow burden variables, allows lender response to the changes in supply-side variables and lender response to the change in farmer collateral to be incorporated into the econometric model. This study provides insight into the factors that contribute to the move toward greater use of debt to finance investment in farm capital assets.

Empirical results can be expected to be different in magnitudes and influential directions among different states and production areas. Unfortunately, available data prohibit this study from proceeding further in those areas. Empirical analysis of interregional differences in farm finance and investment behavior is needed to support the conclusions drawn by the sector level analysis presented in this study.

The assumption of an exogenous decline in preference for internal financing caused by the growth in consumption and/or off-farm investment is awaiting an empirical test to support the conclusions presented here. Divergence in the use of farm cash flow for consumption and off-farm investment may play an important role in explaining interregional differences in the change in preference for farm finance.

Finally, farmers' move toward debt financing for their capital investment and the lenient lending practices also contributed to the financial stress in Taiwan Farmers' Associations during 1995-96. Thus, the findings in this study provide a future research direction for the credit policies and lending practices of the Credit Division in Taiwan Farmers' Associations.

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Appendix

Table 1 *OLS* Estimates of the Model for Financing Constraints and Investment

RHS Variables	Equations			
	Capital flow	Farmland price	Internal financing	Debt financing
p	1.250*			
	(0.310)			
q	−3.373*			
	(0.666)			
q^L	1.891*	1.821*		
	(0.192)	(0.427)		
q^K	1.997*			
	(0.484)			
K_{t-1}	−0.468*			
	(0.158)			
R^K	2.110*			
	(0.261)			
r	−0.924		0.208	−0.490
	(0.596)		(0.154)	(0.377)
R^L		14.343*		
		(2.115)		
Ω^L		1.619		
		(5.903)		
ρ^R		−2.324		
		(6.963)		
π		24.830*		
		(7.524)		
EF^L_{t-1}		27.735*		
		(4.768)		
RY			0.014	
			(0.031)	
SR			0.691*	−0.486*
			(0.036)	(0.075)
CFS			0.178*	0.570*
			(0.034)	(0.079)
NCI			0.372*	−0.179
			(0.036)	(0.107)
ρ				0.696*
				(0.121)
$INTRCPT$	103.700*	−127.040*	−24.106*	8.893
	(24.570)	(67.250)	(2.316)	(6.243)
R^2	0.844	0.957	0.977	0.853
$D\text{-}W$	2.42	1.89	2.71	2.49

Used to compare with Table 1; $\Omega^L = w^D * r^L$; $\rho^R = w^E * \rho^L$.

金融限制下之農業資本投資

潘添進, Neil R. Martin, Jr.,

*and Gregory Traxler**

摘　　要

本文旨在探討農業部門之生產、投資、與融資間的相互依存關係，並估測影響農業資本投資、農地價格、內部融資、與外部融資的重要因子，據以說明美國農業金融結構變動的原因，並且因而導致 1980 年代之農業信用危機。根據美國農業部門 1950-92 年之間的時間數列資料，並依二階最小平方法(*2SLS*)測定聯立方程式的結果發現，43 年以來的資本投資資金來源，有內部融資遞減、而外來資金(舉債融資)卻遞增的趨勢；這種農業金融結構變動是因爲資本融資組合變動與農民融資偏好變動所造成；另外，寬鬆的農業信用供給變動，也是促成農民偏好轉向舉債融資的主要原因之一。農民偏好舉債融資的金融風險頗高，因爲農民舉債多寡決定於抵押品(尤其是農地)價值的高低，而農地價格則與農產品價格成正向變動關係，當農產品價格大幅下跌，導致農地價格下滑到其所隱含的價值低於其舉債金額時，債權人爲保護其自身利益，祇有要求農民提前償債。在農產品價格及農地價格相繼滑落的雙重壓力下，農民無力償債的結果，祇好訴諸破產，農業信用危機於焉發生。

關鍵詞：農業金融、資本投資、農業信用市場、金融結構

* 作者分別為國立屏東科技大學農企業管理系副教授、美國奧本大學農業經濟與鄉村社會學系教授與副教授。