# FINANCIAL CONTROL AND VARIABLE AMORTIZATION UNDER UNCERTAINTY: AN APPLICATION TO TEXAS RICE FARMS

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Variability in commodity prices and yields, together with greater financial obligations for highly leveraged farms, have added much uncertainty about farmers' debt servicing capacity (Barry and Fraser; Hanson and Thompson). As a result, financial responses must come more to the forefront in farmers' risk management, through emphasis on fuller development and application of the financial control process; and development of specific financial programs and instruments for dealing with random variations in debt servicing capacity (Baker; Lee). An example of the second response is the variable amortization payment plan VAPP suggested by Baker and tested empirically by Stone for use in farm mortgage lending.

This paper applies the financial control process to the case of business risks experienced over time by Texas rice farms. The concepts of variable amortization and loan insurance are contrasted with fixed payment schemes in terms of their effects on a model farm's performance measures, and on its capacity to meet intermediate and long-term debt obligations. Responses of VAPP plans to different specifications on farmers' credit limits, participation in government programs, length of horizon, and capital purchases and sales also are considered. The analytical method uses recursive linear programming in a simulation mode to implement the control process so that different indicators of farm performance can be evaluated.

## FINANCIAL CONTROL AND VARIABLE AMORTIZATION

The VAPP is a flexible repayment system in which farm borrowers can make loan payments in amounts that fluctuate with variations in crop yields, prices, and farm income. The payment specification is stipulated so that farmers pay, on average, according to their ability. Thus, debt servicing is based on an index that is computed for each period of production and marketing in the following way

$$(1)\quad I_t = \sum_{i=1}^{N} \frac{(Y_i)\,(PR_{i_t})\,(Q_{i_t})}{(Y_i)\,[E(PR_{i_t})]\,[E(Q_{i_t})]}$$

where $I_t$ is the debt servicing index in time period t; i is the farm enterprise; $Y_i$ is the proportion of total income derived from enterprise i; $PR_{i_t}$ is the actual price of commodity i in period t; $Q_{i_t}$ is the actual production of commodity i in period t; $E(PR_{i_t})$ is the expected price for commodity i in period t; and $E(Q_{i_t})$ is the expected production of commodity i in period t.

This debt servicing index is based on the ratio of actual income to expected income during the respective periods. A farmer's expected net income is determined by a budgeting procedure that subtracts expected farming expenses, taxes, and family consumption from expected gross income. The resulting measure of disposable net income is the maximum amount of funds that are available to service loans.

The farmer's required payment on intermediate and long-term debt then is computed by the following formula

$$(2)\quad P = \sum_{i=1}^{m} IT_i(I_t) + \sum_{j=1}^{n} L_j(I_t)$$

where P is the actual payment; IT and $L_j$ are the scheduled payments for intermediate and long term debt, respectively; $I_t$ is the debt servicing index for year t; and m and n are the numbers of intermediate and long term payments per year.

In "good" years, when application of the index results in a required payment higher than the scheduled payment, the difference is deposited in a reserve account. In "poor" years, when application of the index results in a required payment lower than the scheduled payment, the funds come both from the farmer's current earnings and from the reserve account. In years when the reserve account is insufficient to meet the required payment, the deficit funds are provided from an insurance policy paid for by the borrower.

The debt servicing index developed here is applied both to intermediate and long-term loans. It is initiated with a zero balance, and interest earned on the reserve account is paid annually to the borrower. The insurance policy is required as a contingent source of liquidity if the reserve account is depleted to zero. Hence, insurance plays an important role, especially in early years of the loan contract when the debt reserve is ac-

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cumulating, and in years of very low farm income. Terms of the insurance policy were based on the Average Annual Loss-Cost method, one of several used by the U.S. Federal Crop Insurance Program.[1]

Thus, except for short-term loans, all other loan payments are subject to the financial control process. Without the variable amortization plans, the short-term lender generally bears the brunt of variations in farmers' income, by carrying over loans, deferring payments, or advancing additional loan funds to meet the borrowers' fixed payment obligations for intermediate and long-term debts. The payment plan suggested here shifts this risk-bearing function to the intermediate and long-term lenders.

## ANALYTICAL DESIGN

The analytical design uses a case farm approach to evaluate financial performance under three payment plans for two different "model" scenarios that characterize the farmer's decision environment. The three repayment plans are: Plan I, Fixed Interest and Fixed Amortization (FI & FA); Plan II, Variable Interest and Fixed Amortization (VI & FA); and Plan III, Variable Interest and Variable Amortization (VAPP). Only Plan III includes maintenance and use of the debt reserve account and the insurance plan. Other liquidity-providing specifications in the control process include borrowing from a short-term credit reserve to supplement deficits in annual cash flows, and sales of land in 50-acre tracts. These two liquidity responses are available under all three repayment plans. However, they are initiated in Plan III only after funds available from the debt reserve and insurance program are depleted. Moreover, their response is such that disinvestment of farmland occurs after the short-term credit reserve is depleted.

The case farm is representative of rice farms in the Upper Gulf Coast area of Texas. Its production and marketing characteristics were specified with data obtained from the U.S. Department of Agriculture (USDA, 1977), and from other secondary sources. The farmer was assumed to have originally inherited 50 acres of farmland, and then to have accumulated enough capital over the years to start farming. He now rents additional farmland, with share rent payable at the end of each production year. He owns farm machinery worth \$90,000, but has a \$40,000 note to be repaid over 5 years.

Acquisition of farmland and machinery are specified as investment alternatives that contribute to firm growth. As indicated above, disinvestment of farmland is allowed as a risk response of last resort. At the beginning of the simulation period, land purchases occur in each of the model scenarios (120 acres in Model I and 80 acres in Model II). Following these initial purchases, purchases or sales are allowed only in 50-acre units, depending on the availability of necessary cash and credit. Purchases of land occur at the land's current market value; however, proceeds from land sales are reduced to 90 percent of current values to reflect a discount experienced under forced liquidation.

Crop yields, prices, and interest rates are considered random variables, described in terms of estimated probability distributions, which are assumed to be normal. Means and standard deviations of the probability distributions are based on historical time series of actual observations on values of these variables.[2] The time period 1950–77 was used to estimate parameters for the yield distribution, while the period 1970–77 was used for the price distributions. The expected value of the yield distribution for rice is based on a yield trend regressed over time. The 1977 average price of rice is assumed to be the expected price for future years. Long-term interest rates are also considered random variables. Interest rates on Federal Land Bank loans over the 1958–77 time period are used to derive stochastic rates for future years (USDA, 1978). Rates on non-real-estate loans are set 1 percent below the long-term rates.

As indicated above, the case farm's financial performance for the various repayment plans was evaluated under two different "model scenarios" in order to determine the effectiveness of the VAPP under different characteristics of the farm's decision environment. Hence, the models are not designed for comparing their respective performances; rather, they indicate the effectiveness of the VAPP (Plan III) relative to the other repayment plans (Plans I and II) for the various environmental characteristics. Model I includes: (1) a maximum debt-to-equity ratio of three for real estate debt; (2) absence of government programs providing deficiency payments; and (3) a 20-year horizon. Model II includes: (1) a maximum debt-to-equity ratio of two; (2) presence of government programs providing deficiency payments; and (3) a 10-year horizon. In both models, the maximum debt-to-equity ratio is two for non-real-estate debt, and a 15 percent down payment is required on purchases of farmland.

Preliminary analysis had indicated significant income-stabilizing effects provided by deficiency payments from government programs, and resulting reduction in benefits associated with the VAPP relative to other repayment plans. Thus, a lower debt-to-equity ratio for real estate debt was

[1] A complete description of insurance premium determination may be found in Rahman.

[2] Estimated means ($\bar{X}$) and standard deviations ($\sigma$) for yield, price, and interest rate are: (1) yield is $\bar{X} = 3739.5$, $\sigma = 887.42$; (2) price is $\bar{X} = \$9.910$, $\sigma = 3.594$; and (3) interest rate is $\bar{X} = 6.8305$, $\sigma = 0.4999$.

specified in Model II to subject the firm to more stringent credit rationing. Trial runs after the tenth year showed little change in performance of the three loan plans. Therefore, to conserve research resources, the length of horizon in Model II is confined to 10 years.

## VARIABLE AMORTIZATION AND FINANCIAL PERFORMANCE

Effects of the three payment plans on the case farm's financial performance are shown in Tables 1 and 2 for Model I, and in Tables 3 and 4 for Model II. Tables 1 and 3 show means, standard deviations, and coefficients of variation over the model horizon for four performance measures: end-of-year net worth; annual debt-to-equity ratio; net income before debt servicing; and net cash flow before consumption. Tables 2 and 4 show annual flows of funds associated with the debt reserve and insurance policy for Plan III.

The results of Model I clearly show the superiority of Plan III (VAPP) over the other two loan plans. The VAPP achieved a higher average net worth over the horizon primarily because of the asset values of the debt reserve and the interest that it generates. The average annual debt-to-equity ratio was the lowest and most stable for the VAPP. Moreover, while net income was strongly erratic due to the variability in yields and prices, the VAPP contributed to achieving higher, more stable levels of net income before and after debt servicing than did the other plans. The larger figures for average net income were primarily the result of the operation of a large farm unit, brought about in turn by the greater financial capacity provided by the VAPP. Moreover, the interest received from the debt reserve also contributed to the higher net income.

Like net income before debt servicing, net cash flow before consumption experienced much variation from year to year, including 7 years of negative net cash flow for Plans I and II and 5 years of negative cash flow for Plan III during the 20-year period. Plan I showed a higher average for net cash flow than other plans largely because of the fixed nature of interest rates for Plan I and the contributions to the debt reserve in Plan III. However, the coefficient of variation for net cash flow under Plan III was lower than under Plans I and II, thus showing the moderating effects of the VAPP on the fluctuations of net cash flow.

On average, the farm borrowed more short-term credit under Plan III to operate a farm unit that grew to a larger average size over the hori-

**TABLE 1.** Performance Measures of the Case Farm for Alternative Payment Plans, Model I.

| Performance Measure | Plan I: FI & FA | Plan II: VI & FA | Plan III: VAPP |
|---|---|---|---|
| End-of-Year Net Worth, | | | |
| Mean | $265,651 | $244,997 | $303,297 |
| Standard deviation | $125,125 | $109,960 | $137,806 |
| Coefficient of variation | .471 | .449 | .454 |
| Annual Debt-to-Equity Ratio | | | |
| Mean | 1.263 | 1.337 | 1.221 |
| Standard deviation | .685 | .744 | .535 |
| Coefficient of variation | .543 | .557 | .474 |
| Net Income Before Debt Servicing | | | |
| Mean | $ 19,864 | $ 15,529 | $ 27,948 |
| Standard deviation | $ 84,773 | $ 78,688 | $ 82,301 |
| Coefficient of variation | 4.268 | 5.067 | 2,945 |
| Net Cash Flow Before Consumption | | | |
| Mean | $ 48,032 | $ 29,274 | $ 43,818 |
| Standard deviation | $106,936 | $ 93,699 | $ 83,328 |
| Coefficient of variation | 2.226 | 3.201 | 1.901 |

**TABLE 2.** Insurance and Debt Reserve Flows for Model I

| Year | Amortized Payment Due[a] | Indexed Payment | Insurance Payment | Payments From Debt Reserve | Payments to Debt Reserve | Debt Reserve Balance |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| 1 | 21,768 | 15,309 | 6,459 | | -- | 0 |
| 2 | 22,481 | 22,481 | -- | | -- | |
| 3 | 22,157 | 44,901 | -- | | 22,744 | 22,744 |
| 4 | 41,289 | 33,142 | -- | 8,147 | -- | 14,597 |
| 5 | 43,151 | 25,510 | 3,044 | 14,597 | -- | 0 |
| 6 | 34,936 | 32,302 | 2,634 | -- | -- | 0 |
| 7 | 33,101 | 32,519 | 582 | -- | -- | 0 |
| 8 | 32,320 | 19,369 | 12,951 | -- | -- | 0 |
| 9 | 25,905 | 39,300 | -- | | 13,395 | 13,395 |
| 10 | 27,225 | 32,752 | -- | -- | 5,527 | 18,922 |
| 11 | 40,427 | 62,812 | -- | -- | 22,385 | 41,307 |
| 12 | 51,424 | 86,629 | -- | -- | 35,205 | 76,512 |
| 13 | 59,608 | 94,092 | -- | -- | 34,484 | 110,996 |
| 14 | 86,415 | 77,014 | -- | 9,401 | -- | 101,595 |
| 15 | 85,469 | 69,675 | -- | 15,794 | -- | 85,801 |
| 16 | 69,134 | 65,643 | -- | 3,491 | -- | 82,310 |
| 17 | 61,007 | 56,864 | -- | 4,143 | -- | 78,167 |
| 18 | 62,637 | 37,006 | -- | 25,631 | -- | 52,536 |
| 19 | 49,733 | 74,088 | -- | -- | 24,355 | 76,891 |
| 20 | 49,164 | 54,287 | -- | -- | 5,123 | 82,014 |

[a] Annual insurance premium is 6.48% of this amount.

**TABLE 3.** Performance Measures of the Case Farm for Alternative Payment Plans, Model II.

| Performance Measures | Plan I: FI & FA | Plan II: VI & FA | Plan III: VAPP |
|---|---|---|---|
| End-of-Year Net Worth, | | | |
| Mean | $236,993 | $233,958 | $245,866 |
| Standard deviation | $ 75,896 | $ 75,078 | $ 77,699 |
| Coefficient of variation | .320 | .321 | .316 |
| Annual Debt-to-Equity Ratio | | | |
| Mean | .670 | .685 | .647 |
| Standard deviation | .244 | .244 | .218 |
| Coefficient of variation | .365 | .356 | .337 |
| Net Income Before Debt Servicing | | | |
| Mean | $ 32,307 | $ 33,493 | $ 38,289 |
| Standard deviation | $ 60,862 | $ 62,911 | $ 71,269 |
| Coefficient of variation | 1.884 | 1.878 | 1.861 |
| Net Cash Flow Before Consumption | | | |
| Mean | $ 46,885 | $ 44,315 | $ 52,041 |
| Standard deviation | $ 64,162 | $ 64,037 | $ 59,485 |
| Coefficient of variation | 1.368 | 1.445 | 1.143 |

zon than under other plans. The farm borrowed from its credit reserve in 7 different years under Plan I, 8 years for Plan II, and 6 years for Plan III. Moreover, deficits in cash flow that exceeded credit reserves and the VAPP capacity, forced the farm to sell a total of 200 acres in 4 different years under all loan plans. Since the farm purchased a total of 320 acres (including 120 acres at the start of the horizon) under each plan, the net acreage gain was 120 acres. Because the land purchases occurred earlier and sales later under Plan III, its average farm size was larger than those of the other plans.

VAPP transactions in Table 2 indicate payments occurring from the debt reserve, insurance, or both in 11 years of the horizon for Model I. Shortfalls in meeting scheduled obligations on intermediate and long-term debt were met entirely by insurance proceeds in years 1 and 5 through 7 because the debt reserve balance reached zero in those years. Payments into the debt reserve occurred in 8 years, resulting in a balance ranging from zero to $110,996 and an ending balance of $82,014.

Results for Model II show substantially less variability in performance measures for all repayment plans, largely because of the effects of deficiency payments from government programs and of more restrictive limits on real estate credit that constrained farm growth. Hence, the availability of liquid funds from government programs reduces the need for variable amortization schemes. Nonetheless, performance measures under Plan III still show higher and more stable values for net worth, net income before debt servicing, and net cash flow before consumption. The mean value for leverage also is lower under Plan III, with a slightly lower coefficient of variation.

The frequency of negative values for net income and net cash flow was low in Model II, and borrowings from the short-term credit reserve occurred in 3 years under Plan I, 4 years under Plan II, and 2 years under Plan III. A total of 130 acres was purchased in two different years under all three loan plans. No land was sold. As in Model I, the average total land cropped was greatest under Plan III.

VAPP transactions in Table 4 indicate that payments occur from the debt reserve, insurance, or both in 5 years of the 10-year horizon. Shortfalls in meeting scheduled obligations on intermediate and long-term debt were met entirely or in part by insurance proceeds in four different years because the debt reserve balance reached zero in those years. Payments into the debt reserve occurred in four years, resulting in a balance ranging from zero to $18,704, and an ending balance of $14,098. Magnitudes of transactions and balances involving the debt reserve were lower in Model II due to the availability of the deficiency payments and the more binding credit limits that constrained firm growth.

**TABLE 4.** Insurance and Debt Reserve Flows for Model II.

| Year | Amortized Payment Due [a] | Indexed Payment | Insurance Payment | Payments From Debt Reserve | Payments to Debt Reserve | Debt Reserve Balance |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| 1 | 17,940 | 13,934 | 4,006 | -- | -- | 0 |
| 2 | 18,461 | 18,461 | -- | -- | -- | 0 |
| 3 | 18,221 | 36,925 | -- | -- | 18,704 | 18,704 |
| 4 | 44,199 | 34,749 | -- | 9,450 | -- | 9,254 |
| 5 | 44,964 | 32,204 | 3,506 | 9,254 | -- | 0 |
| 6 | 36,090 | 33,369 | 2,721 | -- | -- | 0 |
| 7 | 34,823 | 40,384 | -- | -- | 6,011 | 6,011 |
| 8 | 34,310 | 25,101 | 3,198 | 6,011 | -- | 0 |
| 9 | 15,144 | 22,975 | -- | -- | 7,831 | 7,831 |
| 10 | 15,908 | 22,175 | -- | -- | 6,267 | 14,098 |

[a] Annual insurance premium is 6.48% of this amount.

## IMPLICATIONS

The variable amortization approach offers a formal method of holding reserves for liquidity purposes that may reduce financial uncertainties both for lenders and borrowers, and may enhance efficiencies in risk bearing. The simulation results show its potential for stabilizing various measures of a farm's financial performance, and perhaps contributing to higher rates of economic growth. Moreover, the variable amortization approach clearly becomes relevant in an environment where liquidity provided by government programs is not readily available. The lenders' risk is reduced under variable amortization by assurance that scheduled amortization will occur each year and by the possibility of early debt retirement from growth of the debt reserve. The borrower should experience a stronger credit response from his lenders because of greater stability in cash flows, and he will have a more secure basis for meeting debt obligations.

If lenders adopt variable amortization plans, they should consider the plans as an option for all borrowers. For high-risk borrowers with low equities and marginal income potential, the variable amortization plans could be mandatory. If, as indicated here, the VAPP reduces lending risks, then lenders could respond by allowing higher leverage, long maturities, or lower interest rates.

Alternatives arise in specifying initiation of the debt reserve and disposition of its interest earnings. The debt reserve began here with a zero balance. However, borrowers could make initial deposits into the reserve account, or a portion of the loan could be allocated to the debt reserve so as to resemble a compensating balance. Interest earnings on the debt reserve were paid annually to the borrower. Lenders could also offer borrowers the option of retaining earnings in the debt reserve. The reserve balance then would grow faster, but would provide less cash flow to the borrower.

The loan insurance policy protected the borrower and lender by supplementing loan payments in years of low income, when the debt reserve was depleted. If insurance companies were willing to participate, a feasible payment scheme should be possible after careful study. Having the debt reserve initiated by withholding part of the loan as a reserve balance may make the insurance plan more functional.

Many rice farmers in the Coastal Prairie area of Texas raise cattle on pasture and produce soybeans along with rice. Including these activities would make the simulation analysis more realistic, but more complex too. However, the design of and likely responses to the financial control process would be the same. Except for deficiency payments in Model II, the study did not consider any other provisions of government programs for rice. The feasibility of frequent purchases and sales of farmland is also a control response that requires careful consideration. Nonetheless, partial liquidations of assets is a last-resort method of generating liquidity that may not seriously disrupt business performance and that warrants treatment in the analysis. Finally, this study demonstrates variable amortization under only one set of stochastic conditions. Additional analyses might usefully explore the effects of variable amortization under different sets of stochastic events.

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