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ACTUAL VERSUS POTENTIAL GROWTH OF A FARM FIRM: An Ex Post Analysis

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As agriculture adapts to the seventies, farm businesses are faced with several adjustment problems. Many farm firms must grow into a more viable economic unit or be forced to exit from farming. For some firms, growth will require gaining control over additional land resources, while for others, expansion will require a more intensive use of presently controlled resources.

The need for a greater understanding of farm firm growth has been well documented. Several studies have reported results from the application of various simulation and programming models to the problem [2, 6, 7]. The results derived from the application of a multiperiod linear programming model to a specific dairy farm situation are presented herein. The analysis of this farm was a part of a larger in-depth study of past financial and managerial performance on farms that had experienced expansion during the period 1964-1969 [4]. The resource situation and environment of this farm was considered to be representative of dairy farms in a nine county area of south central Kentucky. However, managerial capacity and use of intermediate credit probably exceeded the average.

THE PROBLEM

The ramifications of the adjustment process cannot be generalized into a few concise statements, but one of the more important factors is the ability to finance the expansion. Large increases in the use of external capital have occurred because of the inability of individual farm families to provide the needed capital from internal sources. In Kentucky, during the period, 1964-1969, non-real estate loans from institutional sources increased 68 percent while farm mortgage loans increased 60 percent [8, p. 21].

Intermediate-term credit is the type normally used for expansion of internal activities. Intermediate

credit is unique and presents problems for lending agencies not encountered with real estate credit or short term production credit (loans of one year or less duration). Real estate credit is secured by a fixed asset which has been appreciating annually, while short term credit is extended for a specific enterprise or purpose with specific payoff dates. But intermediate credit may be allocated to items which depreciate in market value (machinery), or to other items which are not marketable (buildings), or not even physically recoverable (land clearing).

Frequently, due to the nature of the investment, a period of time may elapse before returns achieve the level expected at the time the investment occurred. Also, as was the situation on the case farm, the lender may advance loans, observe expansion, and larger gross returns, yet the debt load is not reduced. In fact, it may continue to increase.

The specific objectives of this study were (1) to identify the problems associated with major organizational adjustments, (2) to determine what factors have the greatest impact on the speed and degree of success of major farm adjustments, and (3) to determine how variations in these factors affect the capital investment returns time lag.

PROCEDURE

The analysis for this paper was divided into two distinct but interrelated segments. These segments were (1) development of a multiperiod linear programming model and the application of the model to the case farm in order to determine an optimal growth pattern, and (2) introduction of lag-creating factors in the multiperiod model to analyze their effect on the optimal growth pattern.

For the purpose of this study, growth was defined

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as an increase in the size of the productive mechanism (acres of crops and/or animal herd size) of the farm business. Growth could occur through the acquisition of control over additional resources or by more intensive utilization of initially controlled resources. Growth could occur only through re-investment of internally generated funds and/or by external financing. A personal interview with the operator of the case farm did not reveal any plans for growth through merger or diversification into an unrelated business.

The interview revealed multiple family goals but a positive, dated farm business goal when expansion began, was also evident. The presence of the positive business goal led to the selection of a criterion function of maximization of net returns to the operator's labor, owned capital and management. The selection of this function was based on two factors. First, with a positive expansion goal in mind, maximization of net returns would provide the greatest amount of internal capital. Since borrowing capacity was limited, larger amounts of available internal capital should allow easier attainment of the stated farm business goal. Second, based on results of the interview, the enterprises considered in the model were those preferred by the operator. For example, the operator was interested only in dairying (i.e. he didn't want swine regardless of the profit potential). Therefore, it was felt that the operator was a profit maximizer within the constraints of his preferences.

APPLICATION OF THE MODEL

The framework of the model used in this study is similar to that employed by Martin [6] and Boehlje and White [2]. The multiperiod model extended over eight production periods with a productive period being defined as one year.

Basically, six operational restrictions consisting of land, labor, borrowing capacity, operating capital, overhead cost and equipment were included. Alternative production activities in the model included corn (grain and silage), hay, tobacco, dairy, soybeans, wheat and pasture. In addition, activities for purchasing land, debt servicing, buying equipment, dairy herd replacement, labor hiring and income transfer were included for each production period. Price changes, price trends and trends in technical coefficients were also included to reflect the actual environment as closely as possible. In all, 20 constraints and 21 activities were specified for each period resulting in a matrix of 160 rows and 168 columns for the eight year planning period.

THE CASE FARM ENVIRONMENT

The actual resource situation, enterprise organization and overhead costs for 1964 and 1969 are shown

in Table 1.

Assumptions made for the model approached reality as closely as possible. Unlimited seasonal labor was not available, therefore, an upper bound on hired labor was utilized. Labor cost in the model increased over the eight year period from \$1.00 to \$1.60 per hour. Sixty percent of total farm assets minus the amount necessary to secure the real estate mortgage was utilized as the borrowing capacity. Borrowing capacity in a specific period was not mutually exclusive of succeeding periods. For example, if \$1,000 was borrowed in period 1, \$1,000 was also removed from borrowing capacity in all succeeding periods until the \$1,000 or portions thereof were repaid. Repayment of intermediate term debt was required in five equal installments. Interest rates increased from 6 to 8.5 percent during the eight periods.

Managerial ability was assumed adequate for successful growth to occur. Managerial performance, as reflected in production response such as crop yields and milk production per cow, was integrated in the coefficients used in the model. The dairy herd averaged 9,000 pounds per cow in 1964 and 9,698 in 1968. Initial herd size permitted internal expansion by ten cows in the second period. All additions thereafter were purchased.

Coefficients reflected the actual crop and livestock production and cost performance for production periods 1, 2 and 3. Coefficients for period 4 through 8 were computed as averages of the actual performance and were constant for the 5 year period. Additional investment in equipment became necessary when dairy herd size exceeded forty cows. Coefficients for equipment purchase were established such that total investment (including equipment on hand and new equipment) would approximate the total investment required for anticipated optimum herd size.

An overhead cost total was computed and withdrawn from the farm business during each production period. Basically, overhead costs included principal and interest payment on real estate controlled at the start of expansion, farm insurance, real estate taxes, depreciation and repairs for initial buildings and equipment and family consumption.

ANALYSIS OF THE GROWTH PROCESS

The primary solution resulting from the application of the model to this resource situation is shown in Table 2. Under the assumptions of the primary solution, the dairy herd expanded to 83 cows. Actual herd size was 73 cows in 1969 (Table 1). Most of the expansion occurred during the first four periods. Due to earlier borrowing, \$15,301 was the maximum

TABLE 1. ACTUAL RESOURCES, ENTERPRISE ORGANIZATION AND OVERHEAD COSTS, JANUARY 1964 AND JANUARY 1969

Item	Unit	1964	1969
Total land	Acres	201	201
Row cropland	Acres	138	138
Other cropland	Acres	42	42
Pastureland	Acres	21	21
Operator labor	Hours	3,052	3,052
Hired labor	Hours	^a	3,468 ^b
Borrowing capacity	Dollars	27,500 ^c	43,907 ^c
Operating capital on hand	Dollars	1,000	^a
Dairy cows	Animals	26	73
Dairy heifers	Animals	18	39 ^d
Equipment and buildings	Animals	40 ^c	80 ^c
Cropland organization			
Corn (grain)	Acres	30	83 ^e
Corn (silage)	Acres	5	17
Wheat	Acres	15	13
Hay	Acres	30	20
Tobacco	Acres	3.74	2.58
Soybeans	Acres	0	10
Pasture	Acres	117	120
Overhead costs			
Real estate payment	Dollars	1,525	1,425
Family consumption	Dollars	4,000 ^c	4,501 ^c
Real estate taxes	Dollars	150	328
Farm insurance	Dollars	300	300
Salaried labor	Dollars	0	3,200 ^c
Depreciation and repairs on buildings and equipment	Dollars	1,490 ^c	1,490 ^c
Outstanding operating debt	Dollars	17,045	34,548
Total real estate debt	Dollars	20,500	18,643

^aUnknown.

^bRepresents salaried labor. Other seasonal labor was also used.

^cCalculated or estimated by author.

^dHeifers and calves.

^eEighty-five acres cropland located at some distance from the main farm was rented in 1968. The operator, however, gave up the lease on this land in 1969.

TABLE 2. FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH, PRIMARY SOLUTION

Item		Production Period							
		1	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	84	92	69	88	88	64	86	88
Corn (sell)	Ac.	50	47	14	24	24	0	20	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	35	0	0	24	0	10
Wheat	Ac.	1	0	0	0	0	0	0	0
Hay	Ac.	32	36	28	31	31	31	32	16
Pasture	Ac.	46	69	64	79	79	79	80	83
Dairy	An.	26	46	64	79	79	79	80	83
Cows Purchased	An.	0	10	18	15	0	0	1	3
Heifers Purchased	An.	0	0	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,279	31,000	44,066	50,359	50,359	49,683	50,555	55,538
Operating Costs	Dol.	11,101	15,885	21,630	26,722	26,550	25,343	25,551	26,408
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	3,281	7,448	11,820	13,151	13,452	17,522	18,111	22,062
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol.	−719	3,328	7,577	8,781	8,951	12,886	13,336	17,144
Seasonal Labor (all)	Hrs.	606	1,129	0	71	71	76	95	193
Capital Expenditures	Dol.	0	6,131	17,357	15,688	0	0	1,026	3,432
Capital Borrowed in Period	Dol.	13,321	6,666	15,301	13,877	3,315	230	0	0
Debt Balance end of Period (all)	Dol.	38,253	41,549	52,148	58,262	51,040	36,661	28,283	21,239
Total Capital Borrowed	Dol.	52,710							
Criterion Function ^a	Dol.	71,851							

^aTotal net returns to owner's labor, owned capital and management for the entire eight-year period.

amount of capital available for borrowing in period 3.

Debt balance, including real estate indebtedness, represents the total amount outstanding at the end of each period. Therefore, a debt of \$21,239 was outstanding at the end of the eighth period. Actual indebtedness in 1969 was \$53,191.

Net returns after family consumption increased from a minus \$719 to \$17,144 in period 8. This

represented the amount of internal funds available for debt retirement or reinvestment in the business. Since there is no leakage of income in the model, these funds were utilized for these purposes.

Family consumption increased at the rate of 3 percent per year to reflect increases in the cost of living. Income data for period 8 were slightly overstated because there was no transfer requirement for feed crops. Therefore, the model converted this

acreage to cash crops which resulted in an abnormally high gross income for period 8.

The logical extension of the analysis considered alternatives to the primary solution to ascertain their effect on the growth process and to demonstrate the result when lags were introduced.

Table 3 shows a summary of total net returns, total borrowing, debt balance and dairy herd size for all alternatives. There is a range of \$74,043 in total net returns, \$82,915 in total capital borrowed, \$48,999 in debt balance and a range in ending dairy herd size of 32 cows.

Alternative 1 used the same resource situation as the primary solution but the initial intermediate debt of \$17,045 was removed from the model. This alternative, while perhaps not too realistic, provided the largest total net returns and had the lowest ending debt balance for eight periods.

The impact of withdrawals from the farm business for family consumption is demonstrated by the

results from alternatives 2 and 3. The assumptions underlying these two alternatives were the same as those for the primary solution. Consumption for alternatives 2 and 3 was the base amount (shown in Table 2) plus the percentage of net returns shown in Table 3. The effect on required borrowing, net returns, and optimum dairy herd size is shown. It is apparent that if family consumption greatly exceeds that estimated at the time of loan extension, repayment and debt reduction may not meet the planned schedule.

Alternative 4 assumed a lag in expansion of the dairy herd. All other solutions assumed that the herd could expand by adding a dairy cow with annual milk production at the herd average. Alternative 4 assumed that only heifers could be purchased and that milk production would begin the year following purchase. Initial annual production per heifer was assumed to be .95 of the per cow average. Production in following years was assumed to equal herd average. This lag resulted in \$10,773 less net returns and \$7,858 additional borrowing, when compared to the primary solution. Obviously production lags could be much longer.

TABLE 3. SUMMARY OF SELECTED FINANCIAL AND BUSINESS INDICATORS FOR ALL ALTERNATIVES

Alternatives ^a	Total Net Returns	Total Borrowing	Ending Debt Balance	Dairy Herd Size
	----- Dollars -----			Animals
Primary Solution	71,851	52,710	21,239	83
Alternative 1—No initial intermediate debt load	104,034	35,419	17,000	89
Alternative 2—Family con- sumes 25 percent of annual net returns	53,719	91,552	44,544	75
Alternative 3—Family con- sumes 50 percent of annual net returns	29,991	118,334	65,999	57
Alternative 4—Dairy ex- pansion by heifer purchase only	61,078	60,568	23,843	77
Alternative 5—Upper bounds on dairy herd expansion	62,557	45,313	25,319	80

^aAll data is at the end of the eighth period.

Alternative 5 investigated the possibility of operator imposed bounds on dairy herd expansion during the initial four production periods. The relevant comparison is with the primary solution where no upper bounds on herd size were assumed. The slower expansion resulted in a reduction in net returns, an increase in ending debt but the total amount borrowed also decreased from the amount required for the primary solution. In effect, alternative 5 demonstrated the result of lower borrowing limits which might be self imposed.

Of the alternatives considered on this farm, family consumption had the largest impact on total net returns. The withdrawal of funds for consumption from the business not only removed internal funds from potential reinvestment but required increased borrowing and its accompanying service charges. Although family consumption was selected as the obvious example for draining off capital funds, other requirements for funds outside the business would affect the growth pattern in essentially the same manner.

Results from the alternative solutions indicated that, once the decision is made to expand, the most profitable procedure is that of larger initial borrowing and rapid expansion of the dairy enterprise. The rapid expansion resulted in a larger stream of net returns over a longer period of time. However, the model results were free of imperfect knowledge which is not

true under actual conditions. Rapid expansion also required that the maximum borrowing capacity be used in at least one of the early periods. Many operators prefer to "keep a little back" and not borrow to the maximum limit. If lower, self-imposed borrowing limits were placed on the model, optimal expansion would be less rapid.

Expansion of the land resource was not as profitable as expansion of the dairy herd. This implied that, in situations where resources are being underutilized, as was the case on this farm in period 1, the most profitable alternative is to grow by a more intensive use of existing land resources rather than add to them. However, the use of a different criterion function might result in a different implication.

Of importance to the lending agency was the fact that actual annual borrowing was increased while the primary solution indicated that, under optimum conditions, annual borrowing would be zero in periods 7 and 8. This indicated that there was a leakage of income from the business that was affecting the operator's ability to meet financial obligations. The inability to anticipate the duration and amount of investment-return lags and the apparent failure of the operator to control family consumption appeared to be the primary causes. Improved financial planning prior to loan extension should aid understanding by both lender and farmer.

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