AN ABSTRACT OF THE THESIS OF

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Abstract approved (Major professor)

The accumulation of capital is of prime importance for a large sector of farming in which farm family income is restricted by limited resources. The rate of accumulation by a particular farm depends on the allocation of net income between withdrawals and savings for investment in the farm. The close intermingling of the farm business and household provides the context in which the operator and his family make this allocation. In the competition between the firm and the household, farm family decisions are aided by a better understanding of their likely results.

Deciding whether to consume or save requires a comparison of the utility of present income with the utility of future income from "plowed back" savings, so the future income must be estimated. Assuming that income depends on total resources, the problem is that of predicting the periodic growth of resources and accompanying changes in income. The purpose of this study is to develop a method for projecting this growth by exploring the main variables involved.

These variables are determined from the equation: "annual addition to capital = annual net income-annual withdrawals". Living expenditures, income taxes and the social security levy were taken as the important components of withdrawals. The latter two can be calculated directly from net income, but the first must be estimated, as must net income.

Regression methods are used to estimate the variables and the following estimating equations are used:

$$N = bA + a$$

$$L = cN + \gamma S + d$$

where: N is usual net income,

L is usual living expenditures, and

S is household size in adult equivalents.

In the projection, total capital changes annually by the amount of the "plow-back" from the previous year. The effect of trends in prices of inputs, outputs and living expenditure items are incorporated in the model.

Assuming inter-firm and intra-firm relationships to be the same, cross-sectional data from a localized random sample of farms in Marion County, Oregon, were used to test the relationships between the variables. The regression coefficients were significant at the .01 level. The variable A accounted for 39 percent of the variability in N and the variables N and S accounted for 64 percent of the variability in L. Variations in type of farm and soil series had no significant effect on the relationship between usual net income and total input capital, although the useable soil series were too closely related to generalize beyond the strata represented.

Using two differing farms, selected from the sample for illustration purposes, several projections of capital accumulation were made, to demonstrate the use of the model and to note the effects of income taxes, family size, level of living, level of management, various credit arrangements, and unpaid family labor. The effect of adverse trends in prices of inputs and outputs is stressed. Specific application requires parameters derived from the subject farm or a homogeneous group of similar farms.

As a long run planning tool the method is flexible enough to incorporate planned withdrawals in any year, anticipated changes in unpaid labor, parameters and price trends, and planned capital replacements. Further exploration of its use is needed to refine the estimating procedures and to further test the relationships among variables with historical data and a wider variety of farm types and soil conditions.

PROJECTING CAPITAL ACCUMULATION FOR THE AGRICULTURAL FIRM-HOUSEHOLD

by

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These contributions in no way absolve the author from the full responsibility for the contents of this dissertation.

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CHAPTER I

INTRODUCTION

Background

A relatively recent development in agricultural extension is the "farm and home" approach to farm planning. This approach combines the economic planning of the farm business and the farm home into an integrated treatment. In the words of E. J. Nesius it "...is concerned primarily (a) with planning for the future, (b) with consideration of the family as a unit, and (c) with optimum use of the total resources controlled by the family" (55).

The Missouri Extension Service pioneered in this approach with their "Balanced Farming" program (55), which began about 1934 (10). Although several states at varying times adopted the approach, it was rather new, in general, until it attained national prominence as a consequence of the federal appropriation for extension work for 1953-54 (55). Today, extension workers throughout United States are thinking in terms of the expanded activity in farm and home management and of how they can help the families in their decision making (8, p. 94).

This comparatively new approach to agricultural extension has developed with the growing realization that managerial decisions in the farm business of production affect family living and, vice versa, family decisions regarding consumption and other family goals affect resource use in the farm business. Nesius points out that all family financial problems can be divided into two categories, (a) earning money (production) and (b) spending money (consumption), and that it is necessary to keep the two in balance (54, p. 20). Thus, because of the close intermingling of decisions concerning the farm business and the farm home, the "family farm" requires the combined application of production and consumption economics both in extension education and research. However, "the effect of farm and home development on research and instruction at the colleges seems to be limited. Very few states have oriented research projects specifically on farm and home development problems" (55). The present study will attempt to contribute somewhat to the filling of this gap.

Thus far the terms "farm" or "farm business" and "home" have been used. To give these concepts more precision, they will be designated as the "agricultural firm" or "the firm" and the "household". A firm is a combination of resources organized under one managerial head to produce one or more products with the view to maximizing profits. A household, for purposes of this study, is a group of people living together and making decisions respecting the allocation of their pooled income to various uses, to maximize group satisfaction (34, p. 28, 416-417). Using these definitions the farm, or the farm and home, will mean the "firm-household" in the remainder of this dissertation.

In many agricultural households there is a competition between the firm and the household for the use of income. On farms where resources are limited, relative to income goals, for example, farms that are in the early stages of accumulating resources and whose operators have young families, or other types of low income farms, this competition becomes important, and even critical. One study points out that "the degree to which business decisions and choices in the household are interrelated depends largely on the extent income or capital is limited" (37, p. 394).

This competition may not be important for larger farms where business affairs and domestic affairs are conducted separately, as with many non-farm businesses, that is, the members of the household are not informed of the business affairs nor consulted in decisions about the firm, but are concerned only with consumption decisions on the income "brought home" by the operator. One California farm management specialist has estimated that a "sizeable portion" of commercial farms are of this type, which may be so in California[a]. However, there is a large number of farms, in the United States and in Oregon, for which resources are limited[b], relative to income goals, and which require more capital, particularly in regions where farm labor is scarce or relatively costly, as it is in Oregon, and the income of each farm firm depends largely on the assets controlled by the operator.

a. Reed, A. Doyle, Farm Management Extension Economist, Department of Agricultural Economics, University of California. Davis. Personal interview (1958).

b. Of the commercial farms in Oregon with sales of farm products valued at $1,200 and over, in 1959, 53 per cent had sales of less than $10,000. For United States as a whole, the proportion is 65 per cent (78, p. 613). Sales of $10,000 would provide roughly $3,000-$3,500 net income for living and for capital accumulation. At current levels of living, competition between household expenditures and farm investments could reasonably be expected when the net income is less than $3,500.

Frequently, under conditions of low assets and low incomes, the competition of the farm household with the firm is strong for any net income available for "plowing back" or accumulating capital. The rural home is fast becoming a modern home. Rural electrification, one of the most important events to affect the living patterns of rural people in the last hundred years, the automobile and improved highways, and other relatively recent developments, have created new rural living modes or standards that result in expenditures for living at the sacrifice of capital accumulation that is greatly needed on many farms. Because of these new demands by the household, additional motivation is necessary to induce saving for accumulating capital.

When extension workers approach the problems of farm financial management from the "farm and home" viewpoint[a] they are in fact assuming that the family is the decision-making unit[b] (72) and that "...there is a general retreat of benevolent paternalism as a prevailing type of family leadership" (54, p. 17). If this assumption is correct, it is another source of intensification of the firm-household competition, and another reason for additional motivation for the necessary accumulation of capital.

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a. Heady has observed that, within agriculture, the responsibility for capital accumulation falls more nearly upon the households than is true for many other major industries. Corporate methods of financing do not exist to any important extent in agriculture (32, p.9).

b. One interesting finding of a study made recently in Ontario, Canada was that in two-thirds of the families, decisions on whether the next purchase of desired equipment will be farm equipment or home equipment are made jointly by the operater and his wife (1, p. 3).

The Purpose of the Study

Where farm businesses are in the stage of growth wherein they need to accumulate capital to increase income, self-control is required in current consumption to leave a portion of income for accumulation. Such self-control usually requires high motivation[a]. The purpose of this study is to provide a means for assisting in this motivation.

It is assumed that a plan showing the future path of capital accumulation on a given farm, its effect on income and the effect of consumption on this accumulation, can assist a farm family in exercising self-control in current consumption by affording a clearer concept of the consequences of the decisions of the family. Also, such a plan could enable the operator to see more clearly the effect on capital planning of other uses that compete for residual income, for example, liquid reserves held back for risk, life insurance premiums, and others.

The intention of this study is to provide this motivating and planning "tool" by examining the major factors involved in the capital accumulation of the firm-household and, as a result of this investigation, develop a method for estimating this accumulation for longer

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a. Compare the following quotation: "...there is no mechanistic relationship between size of incomes and savings. However high incomes may be, saving is always a matter of choice, dictated by human purposes and valuations, between present and future uses of income. For this reason, the existence of goals for which savings are needed, combined with enough faith in one's ability to achieve these goals, to translate desires into purposeful action to achieve them, is necessary for savings to occur" (38, p. 4).

periods and with greater accuracy than chance guessing or rough budgeting provides. An integral part of the estimation of capital accumulation will be the estimating of the income associated with the accumulated capital.

Importance

In addition to providing a tool for motivation to accumulate, capital planning, with some estimate of the rate of accumulation and its effect on income, is useful in several other ways. A farm operator and his wife, with a growing family, who are getting started in farming, very likely have some long run goals, such as education for the children, comfortable housing, vacation trips, a good car, well bred stock, an attractive set of farm buildings and machinery and perhaps several other amenities. It is assumed that in many cases newer farmers, and even more experienced farmers, do not relate present resources and the rate at which they may grow, to the future income required to achieve long run goals. With a knowledge of the probable future growth of his assets, a farmer would be better able to estimate the possibility of attaining goals, how fast they could be attained, the additional resources he needed or the increase that may be required in the rate of accumulation to reach the goals. Also, if the necessary resources cannot be obtained, he may want to change to an alternative enterprise or occupation that would provide the necessary income. The family may want to modify their goals or they may want to "trust to luck" and concentrate on short run planning. In any case, capital planning can help them to make such decisions more intelligently.

The benefits of estimates of capital accumulation in credit planning, both to farm operators and to credit agencies, are fairly obvious. For instance, effects of living costs on accumulation and therefore repayment ability, and on the rate of growth in income, constitute information that is vital for repayment scheduling as well as for deciding on loan size and uses to be made of loans. Also, when loans have long repayment periods, the changes that may occur in living costs over the period must be taken into account. Estimating the path of capital accumulation could help greatly in answering the question of whether to use a "pay-as-you-go" plan or credit, to achieve goals more rapidly.

The importance of capital accumulation within agriculture has been noted by several writers. For example, Tostlebe (71, p. 19) has noted: "To a remarkable degree, farmers have financed the increase in farm capital with their own incomes and savings". He sees the need for a greater emphasis on the study of internal financing of agriculture rather than the study of external sources. According to Spitze (65,p.1): "One of the most important financial problem of farmers rests with the acquisition and management of capital. By capital we mean past production saved from consumption and used to increase future production". Staniforth and Day (66), in speaking of farm and home development, point out that "development is primarily a capital accumulation problem. The process of growth and expansion of the farm business usually consist of plowing the returns from limited investment funds back into further investment to accumulate a stock of working capital".

The key importance of capital accumulation within each agricultural firm-household complex and of understanding and predicting the process, is widely recognized by agricultural economists and farm management extension workers.

The Problem

The specific problem at which this study is directed is how to project the path of capital accumulation and the income flow associated with this capital. When a farm operator and his family attempt to plan the future production and consumption which they can expect, given present resources, they are immediately involved in estimating the income flow and the resource base required for the income. For a farm-firm the main factor, aside from management, that limits the income is physical capital, including land, so that the amount of initial capital and the ensuing rate of capital accumulation are critical in determining the size of income (30, p. 8)[a]. At the same time, income, given the amount consumed, is critical in determining the rate of capital accumulation. Any farm and home planner, farmer or otherwise, must consider initial resources and rate of accumulation, regardless of his efficiency in organizing given sets of resources. Increasing his efficiency may increase income but may not be as effective as accumulating capital.

Many studies have been done on the amount of capital needed, say by beginning farmers, to provide a specified level of income, usually some "minimum level". Several bulletins have also been written on how

a. Also, for the importance of capital to income and to the adoption of technical information compare (35).

to acquire capital to start farming. This study is concerned not with these but with the rate of capital accumulation that occurs after starting farming, or after a certain level of assets has been establised.

Given the capital assets on a particular farm, it is impossible to plan the rate of future capital accumulation and related income with certainty because a knowledge of all influences affecting the rate is not available. This makes it necessary to do the next best thing, that is, to estimate them. The accuracy of such an estimation depends upon the extent to which the influences are understood. On some basis, planning and estimating of future income (and capital accumulation) are done continually, in some fashion, by most farm operators and their families. Often they are assisted by extension workers, loaning agents and others. Usually the planning on a particular farm is based on average yields and average prices for selected time periods, current cost structures and current living expenditures, with the idea in mind that the future incomes estimated must be equal to or above a certain minimum. Although it varies, the planning horizon is usually short (17, p. 136) and (48), relatively, because of the lack of understanding of relationships involved and the effect of uncertainty on these relationships. Many are satisfied with the relative certainty of a short horizon and "trust to luck" for the longer run outcome (54, p. 26). The objective in this study is to provide some degree of refinement to the estimating procedure that will take into account the important influences on capital accumulation and will extend the planning horizon.

There is a need for a method or a model to show the compatibility of future goals with present assets and which would also enable consideration of such influences as the amount "plowed back" into the business each year, the effect of credit in attaining or falling short of goals and the effect of household expenditures on the whole process.

Specifically, this study will investigate the effect, on the rate of capital accumulation and associated income flows, of the consumption and investment decisions of the farm operator and his family in the allocation of net income.

Scope and Method

Scope

The primary concern of this study is the growth of assets. The "life-cycle" of the firm-household may be divided according to stages of capital accumulation or depletion. The growth wherein capital is being accumulated, continues to the "mature" stage. During this growth stage the marginal-value-product/price ratio of capital exceeds that of the operator's management and labor and he strives toward an optimum by obtaining more capital. During the "mature" stage capital is neither accumulated nor depleted. In this stage capital and the labor and management inputs of the operator and his family are at an optimum level in that their marginal-value-product/price ratios are equated. The family obtains living requirement from current income. Some saving for retirement or future consumption may occur but it is not "plowed back" into the firm to increase its capital. In other words the net income and physical capital remain stable[a]. The

a. Except for fluctuation in price level.

retirement phase is reached when net income from the firm declines and capital must be depleted to maintain expenditures. Here the marginal value productivity of the labor and management of the operator and his family decline, relative to that of capital, and capital becomes underemployed in that more resources could be used with it.

Without getting into a further discussion of these definitions, they are sufficient to indicate that this study is restricted to the growth stage. It is applicable to those farm operators and families who need to increase their assets in order to increase their incomes[a]. This restriction will approximately define the length of run to which the method will apply.

A further restriction will be placed on the scope of the study, in that it will be confined to capital accumulation generated within the farm firm, that is to say, from income deriving from the agricultural operations involving the resources controlled by the farm operator and his family.

The farm planning that is implied herein, in projecting capital accumulation, will not be concerned with the dynamic adjustment of resources to find the least cost or highest profit combinations, per se, but will take the following approach: Given these, what is the effect of the firm-household's allocation of annual income on the growth of, and income from, the business? The focus of this study is on the financial aspects of the firm-household's planning.

a. Every farmer plans but not every farmer plans to increase his net income. Some who are less likely to do so are subsistence farmers, high income farmers and retiring farmers.

Method

A prediction equation or model will be developed to project the capital accumulation and associated income. The equation will be based on the logic or theory of what occurs in the process of capital accumulation by the agricultural firm-household. Empirical tests will be applied to certain components of the model but lack of data prevents an empirical test of the model for explaining capital accumulation on an intra-firm basis.

Frequently the data available are inadequate for complete positive proof of a theory, but this does not negate the usefulness of an attempt to develop theoretical models as solutions to problems. Most research in farm management and many other disciplines is aimed at discovering or isolating generalized principles that enable prediction. Even with known production coefficients and prices, it is impossible to predict exact outcomes for each farm because many things can interfere during the period covered by the projection. But from experience it is possible to develop standards or guides and methods of thinking for applying them, that enable useful predictions. Farm operators must make decisions continually. Many of these decisions must be based on theory that has not been empirically tested, at least adequately. But the theory itself is usually based on assumptions that are derived from experience, so that it is not entirely devoid of an empirical basis. It is useful to develop hypotheses to isolate variables, which in itself is a considerable aid in decision making, and to provide guides for obtaining the data required for adequate testing (13, p. 10)[a].

In the theory chapter of this thesis certain hypotheses will be developed to which empirical tests may be applied. The testing of the complete equation or model requires historical data on the growth of firm-households. Data of this kind are difficult to obtain and are not available for this thesis. Such a test remains for the future and suggestions concerning this will be made in the concluding chapter.

A theoretical model for successfully projecting real economic phenomena must be based on premises that are based on facts and usually[b] must describe or simulate correctly the economic processes that will occur over the projection period. Complete empirical testing of the model requires both verification of the validity of the basic assumption and determination of how well the model describes real processes. When theories err in attempting to explain real phenomena, they frequently err in the basic assumptions and thus, the empirical testing of assumptions is vital to the usefulness of the model. Therefore, although the projections made by the model developed in this thesis of necessity will not be tested empirically, an important contribution can be made by testing basic assumptions, and this is

a. Day (17, p. 143) points out that "...a particular model is a judicious compromise between the conceptual understanding of an economic process and the possibility of representing and testing this conceptual understanding with real data."

b. It is true that certain phenomena are not logically connected, causally, but their variations are closely enough associated that the behavior of one can be used to predict the behavior of another. However, the discovery of such association of variability depends upon an empirical accident and cannot be achieved by a process of causal logic.

possible from available data. Appropriate statistical methods will be used.

Source of Data

The empirical tests will utilize data that were obtained for another study (41) that was not designed specifically for the thesis. The data were obtained in a one-call survey of a sample of farms, that were randomly selected, in the Mount Angel-Woodburn area of Marion County, Oregon. Information on the farm business of each farm for the crop year of 1957 was obtained. Among other things the data contain information on farm capital, income, expenses, and living costs, all of which will be used for this study.

Procedure

The remainder of this dissertation will proceed as follows:

(1) The theoretical projecting model will be developed.

(2) This will be followed by a review of writings appearing in the literature, that are relevant to the present study.

(3) Empirical testing of hypotheses derived from the critical assumptions on which the model is based, will be presented next.

(4) Some useful applications of the projecting equations in the financial planning of the firm-household will then be illustrated.

(5) Some of the author's conclusions regarding the study will be stated and the study summarized.

CHAPTER II

THEORETICAL ANALYSIS OF THE PROCESS OF CAPITAL ACCUMULATION WITHIN THE FIRM-HOUSEHOLD

Introduction

The primary reason for the existence and activities of the majority of farms seemingly is to produce income for the operator and his family. Most of the family goals require income to permit their achievement. The size of the annual income obtained from a farm business depends to a great extent on the amounts of productive resources controlled by the operator and his family and entering the production process. No matter how efficient the operator is, he requires adequate resources for an adequate income. These resources include those with which the operator starts farming and those he accumulates thereafter. The rate at which he increases his income, given his organizing ability, depends upon the rate at which he accumulates resources. Since the operator's management and labor resource, in the form of himself and his family, is more or less fixed, the chief resource which he needs to accumulate is capital.

Resources are usually made up of those that are owned and those that are financed by a source outside the business. The resources used in farming can be classified into the labor and management of the operator and his family, all other labor, land and buildings, capital equipment, livestock and funds with which to meet current operating expenses. The last category includes funds to provide a minimum living while awaiting the income from the production process. All of these but the first one constitute "capital" in the sense of investment in a business that produce a return and investment that has alternative opportunities. It is this capital that is accumulated as the firm grows[a].

It is recognized that the aggregate quantity of resources entering the production process is not the only influence on income. The quality of these resources is important as well as the operator's choice of enterprises, the production functions of these enterprises and the efficiency of resource combination involved in the process. Quality is taken into account, theoretically, in the market evaluation, which provides the common measure (unit value) necessary for aggregating to determine the total resource quantity.

For any individual farm firm, the choices of ways to combine various types of resources are usually limited to a relatively few alternatives by the physical and economic environment, as well as the managerial characteristics of the operator. Once the general enterprise combination has been embarked upon, the choices are even fewer. Thus, for a particular farm with given management, the aggregate quantity of resources as measured in units of value, is by far the main controller of income at any given stage of growth of that firm.

After the beginning of farming operations, the capital accumulated thereafter must come from the income obtained by the operator

a. One form of capital has been omitted here because of the difficulty in measuring its productivity. It is the education of management and labor, sometimes spoken of as "intellectual investment".

and his family. This income may come from the business, from non-farm employment and investments by the operator or family members or from gifts. Another source of income is from capital gains resulting from a rise in prices of capital assets[a]. This study is limited, however, to that income obtained from the farm business, because most farms interested in accumulating capital normally either do not have access to the other sources of income or this type of income becomes available fortuitously.

The rate at which capital accumulates in the business therefore depends upon the amount of the income and the proportion of the income that is withheld from consumption, that is, saved. Since most farms do their accounting in annual terms, it is more convenient and practical for purposes of this study to use annual income, consumption and saving.

Some savings may be withheld (from re-investment) for liquid reserves against uncertainty[b]. Such reserves constitute accumulated capital but they may not contribute much to the future output of the farm and therefore to future accumulation of capital.

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a. For capital gains to be converted to income, liquidation of the assets must occur.

b. Here uncertainty consists of those unforeseen events, involving costs to the business, which are unpredictable and thus cannot be insured, actuarially. Risk consists of insureable future events that have a known probability of occurring (34, p. 440, 443). Reserves, that is, insurance against risk constitute a cost of production, are taken out of income annually and are not available for capital accumulation.

In addition to expenses, capital maintenance, consumption, capital accumulation and reserves, the income of the firm-household may be allocated to one other recipient which is the Bureau of Internal Revenue. Other forms of taxation are accounted for in operating expenses and consumption but income tax is taken from net income, and the amount paid depends upon the size of the net income. It has a more overt effect on capital accumulation than do other taxes and therefore it will be considered explicitly in this study.

It is apparent that all of these uses necessarily compete for the income obtained by the firm-household. Operating expenses and capital maintenance have first claim because they must be met to realize any income on a sustained basis. The remaining four uses compete for the net income after expenses and depreciation have been covered. This competition continually requires decisions by the farm operator and his family and, as was pointed out in the introduction, there is a much greater mingling of these decisions for a farm business than occurs in non-farm businesses, because of the close association between the farm firm and the farm household. Decisions are likely to be more rational if the results can be estimated.

Firm-Household Choices

The only theoretical analysis of the choices in reinvesting or spending of income in the context of the agricultural firm-household was contributed by Heady in 1952 (34, p. 416-438) and (33,

p. 1129-1132) although he had outlined the basic idea earlier (32). He analyzed the major factors in the competition for net income in terms of alternative opportunities and choice indicators. The analysis was not applied empirically at that time and no model for projecting capital accumulation was developed[a]. The analysis will be presented briefly here, because it clarifies some of the major variables involved in the choice process facing the firm-household and it is somewhat related to the predicting model developed later in this chapter.

The analysis concerns farm family decisions on the disposition of a residual annual income available to them after all payments have been made from gross income[b]. For expository purposes, this net income will be taken to be that income about which the operator and his family have to make only one decision, namely, how much to spend currently on consumption and how much to re-invest for future consumption (of the investment), that is to say, how much capital to accumulate[c]. These alternative opportunities for disposing of the income are represented by an opportunity surface, depicted in Figure 1 by a map of curves concave to the origin. The Y-axis represents the current annual net income and the X-axis represents the discounted future

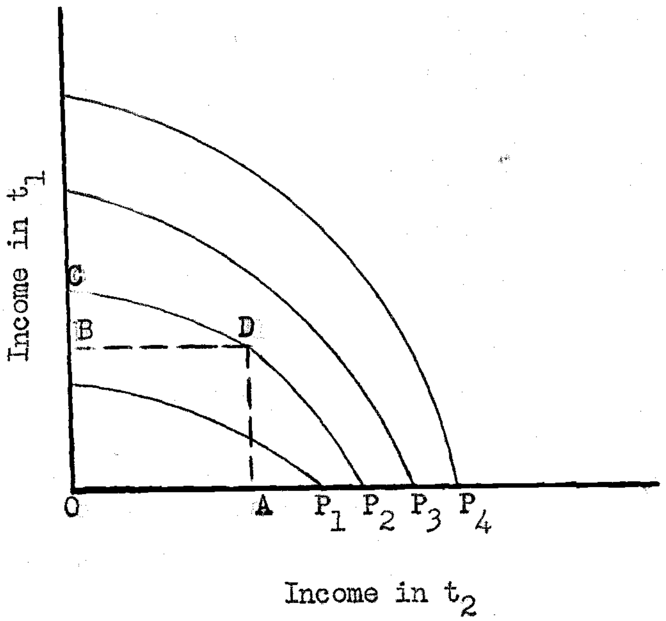
a. In 1959 Loftsgard and Heady described a dynamic programming model, for farm planning, that applies this theory to some extent (45).

b. This net income will be defined precisely in the empirical chapter following.

c. For the present, reserves and income tax will be assumed not to exist.

income derived from investing current income. Each curve is the locus of the combinations of current consumption and investment in the future, for the annual net income represented by that curve. Curve P_2 represents a higher income than curve P_1, curve P_3 higher than Curve P_2, and so forth. For curve P_2 the distance OC represents the total income currently available for consumption and saving. The point D on the curve CP_2 represents one of the alternative combinations depicted by the curve. The quantity AD is the portion of the annual income currently consumed while the quantity BC is the remaining part of the annual income, current consumption of which is foregone and which is invested for future returns. BD is the discounted future income expected from the investment of BC.

Figure 1



The slope of the curves, at any particular point, has significant meaning. If the slope is less than 45 degrees it indicates that it pays to invest, that is \$1.00 of current income invested will return more than \$1.00 of discounted future income. Similarly, a slope of more than 45 degrees indicates that it does not pay to invest[a]. Where the rate of profit is i, the slope is (1+i). The return to investment will depend upon the forms of capital and the production process in which the investment is made. The length of the period necessary for the chosen capital to begin providing a return affects the rate of discounting and thus the discounted income alternative.

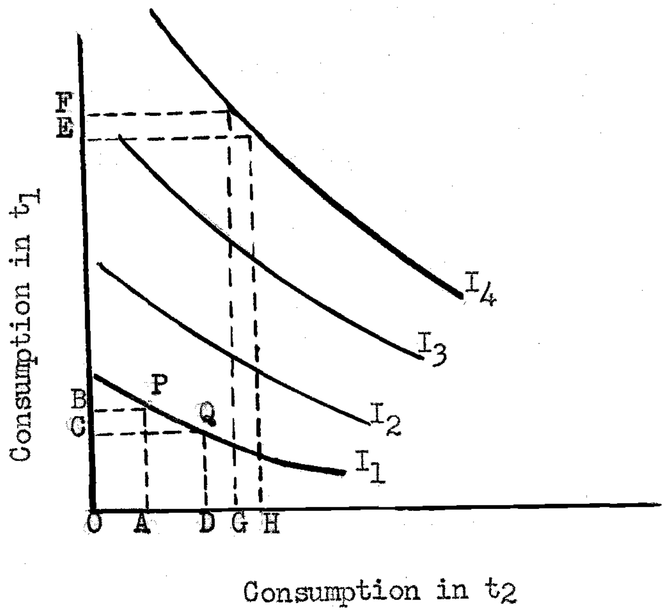
Concavity to the origin represents diminishing productivity of capital resources for a particular time period. The small curvature and shallow slope of the lowest income curve depicts high productivity of any income re-invested. As the income level rises the increased curvature of the curves depicts the tendency of income invested back into the firm to encounter diminishing returns sooner, relative to the proportion of current income "plowed back", because of the larger amounts of capital associated with the larger incomes.

To determine the optimum allocation to investment or consumption of current income, choice indicators are required. In making the decision, the farm operator and his family must balance the utility of the discounted future returns from investment of current savings against the utility of current income spent on consumption. The

a. Either case assumes that one dollar of discounted income has the same utility for the goods and services it will provide in the future as the utility available from one dollar of current income.

utility comparison is a subjective process that is difficult to measure but the alternatives may be depicted by indifferences curves such as those shown in Figure 2. These curves show the combination of

Figure 2



current and future incomes for consumption, at any particular income (consumption) level, among which (combinations) the choosers are indifferent. At different points on a single curve the farm family maintains the same level of utility with different combinations of present and future consumption and each curve is the locus of all of these points, at the income level indicated by the curve. For example, at the income level of curve I_1, there is no difference in utility between the combination at point P (with OB of current consumption and OA of future consumption) and the one at Q (with OC of current consumption and OD of future consumption). Thus, AD of future income consumed provides the same utility as BC of current income consumed. If r is the rate at which future consumption substitutes for current consumption then the slope of the curve at any point is (1+r). The convexity of the curves toward the origin indicates that a different discount (or premium) is placed on each increment of saving, that is, the marginal rate of substitution of consumption in one period for consumption in the other diminishes for any particular indifference curve. At the highest income level, represented by the steepest curve I_4, it requires less future consumption to substitute for current consumption[a], that is, the utility of present income is less, relative to the utility of future income, for higher than for lower levels. In other words, a family on a higher curve is willing to give up more current consumption for future consumption than on a lower curve[b]. The propensity to consume declines with higher incomes[c]. These indifference curves provide the choice indicators of the operator and his family for the optimum positions on the opportunity curves shown in Figure 1[d].

$i = 1, 2, 3$

saying $MRS^{I_4}_{E_1,E_2} < MRS^{I_i}_{E_i,E_i}$ for any point on horizontal axis

---

a. BC = EF and it can be seen that AD is greater than GH.

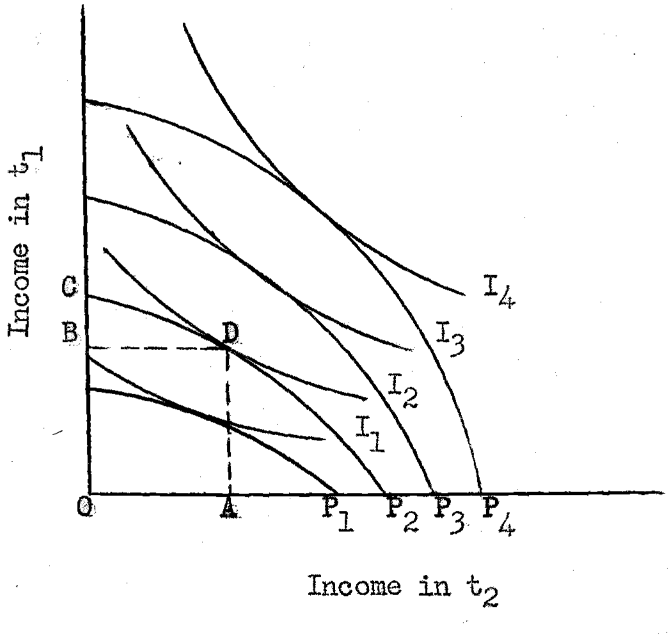
b. It must be remembered that future income and consumption thereof can only be obtained by foregoing current consumption, that is, by saving and investing the savings.

c. This was partially substantiated in 1950 by a survey in Iowa (34, p. 425). A significant conclusion regarding the effect of income level on propensity to save is that, even though optimum positions may be attained, the disparity in capital accumulation and incomes, between high and low income farms, may become greater over time.

d. Heady has listed several reasons why current consumption may have a high value relative to future consumption and, several reasons, on the other hand, why a high value may be placed on future consumption (savings or investment) (34, p. 426).

The application of the farm family's utility decisions or indifference pattern to its consumption investment opportunities is depicted in Figure 3 superimposing the indifference map in Figure 2 on the map in Figure 1. The optimum combinations of income to be currently consumed and income to be re-invested for the future[a], occurs at the points of tangency between the opportunity curves and the indifference curves. At these points the marginal rate of transformation of current income into future income (discounted)[b] is equal to the marginal rate of substitution of the consumption of current

Figure 3



a. If this income is "plowed back" into the farm business, capital is accumulated.
b. That is, the marginal rate of substitution of future income for current income in the transformation process.

income for the consumption of future income. On curve CP_2 (Figure 3) the operator and his family, that is, the household, would consume AD and invest the remaining portion, BC, of the current annual net income, to obtain BD in the future[a].

To apply this analysis to the problem of projecting capital accumulation for the firm-household, it would be necessary to assume that BC is re-invested in the farm business. Also required would be (1) a knowledge of the functional relationship between BC and the future returns, BD, in order to estimate BD, (2) knowledge of the rate at which the farm family discounts the future income stream, (3) knowledge of the indifference map of the farm family, depicting the functional relationship between the present utility of the consumption of current income and the present utility of consuming income in the future. All three requirements must be related to specified time periods in the future and are thus subject to uncertainty. Each of the three presents a difficult problem. It is quite apparent that the competition between consumption and capital accumulation involves a complicated series of decisions that must be made on the part of each farm operator and his family.

The indifference pattern depicted in Figure 2 must be supplied subjectively by the farm operator and his family and no method is available for its empirical quantitative measurement. Thus the points of tangency in Figure 3 cannot be designated exactly. However, when a farm family makes a decision to invest rather than consume a part of

a. See (34, p. 425-425) for further explanation of these diagrams.

its income, by (1) estimating the income from the investment, (2) discounting the income to the present and (3) making the choice by comparison, it is, in effect, locating its decision at a point of tangency depicted in Figure 3, *if* for re-investment it foregoes from consumption the maximum amount compatible with its subjective consuming goals and invests it to bring the highest rate of return. A model will be developed, in the next section, to project capital accumulation based on some of these choice considerations. The model will recognise them implicitly without explicitly developing time-transformation or time-indifference curves.

An Approach from the Viewpoint of Savings[a]

The analysis will begin with a given annual net income from a farm for which resources are organized or combined at the optimum combination of all except management, for which there is excess capacity. This assumes that the management problem of the optimum combination of other inputs has been solved. The annual net income will be defined again as the residual income available for consumption and saving or investment back into the firm after allowing for operating expenses (which include insurance against risk) and capital maintenance (depreciation) and adjusting for net inventory changes and farm perquisites (income in kind).

This net income is allocated to one or all of consumption (including gifts, charity, etc.), savings and income tax. Savings, in

a. Savings are defined here as income not consumed.

turn, may be allocated to investment in the business and/or resources against uncertainty. All of the net income is accounted for by these items so that any one item can be determined if the others are known. Thus, for any income period, the amount "plowed back" into the business will be the net income minus the portions consumed, paid out for income tax and withheld for reserves. If no outside income, from such sources as gifts and non-farm employment, enters the firm, the capital that is accumulated will depend entirely upon these items.

Each component, of course, is subject to many influences. The problem is to isolate the important things that influence these components and incorporate them, along with the components themselves, into a time series showing the rate of capital accumulation per period.

The most important component in the annual capital accumulation is annual net income, It depends on several important influences, which must be taken into consideration when making any projection of capital accumulation: (1) the total quantity of resources entering the production process, (2) the organization or combination of these resources, (3) their quality, (4) the weather and other natural factors, (5) the prices of products and input factors and forces influencing these prices.

The next important component is the amount of annual income consumed, that is, withdrawn from production permanently by expenditures or family living. It is influenced by such things as size of family, size of annual income, family spending habits and needs.

Of the other two components, reserves against uncertainty depend upon the non-liquid reserves owned by the farmer, the credit available to him, his attitude and that of his family toward uncertainty, and perhaps others. Income tax is influenced by the tax rate and net income.

Simplifying Assumptions

In order to simplify the discussion for the present, reserves and income tax will be neglected and the most important variables from the other two components will be abstracted. The current value of the total amount of inputs, except operator's management and labor, entering the production process, will be used as the main factor influencing net income. The quality of inputs will be presumed to be accounted for in their value by virtue of pure competition in factor markets, which competition results in the inclusion of an evaluation of quality in their prices. The combination of resources may be taken as "given", for a given type of farm, that is, the relative proportions of resource inputs that determine the type of farm and are expressed by the type of farm, will be assumed to be stable, allowing only for an increase in scale. This assumes that the operator has unused management capacity so that management can increase in proportion to other inputs. The effects of natural hazards and changing price on income will be assumed constant for the present. The simplification of using current value of total inputs as the main factor influencing income permits the use of the ratio of net income to total inputs to estimate the net income for a given firm when total inputs are known.

To simplify the estimation of expenditures on consumption, the influence of family size and spending habits will be held constant and net income will be used as the main influence. This enables the use of the ratio of consumption expenditures to net income to estimate expenditure when net income is known.

Simplified Estimate of Capital Accumulation

Thus, to estimate the income of a farm for a given year, the following equation may be used:

$$N = k_N A \qquad (1)$$

where N is net income (as defined) in dollars,

A is the value of total inputs and

k_N is the ratio of net income to value of total inputs.

To estimate the amount of this income that would be consumed, given the ratio of consumption expenditures to net income

$$L = k_L N \qquad (2)$$

where L is living costs (consumption expenditures),

N is net income and

k_L is the ratio of consumption expenditures to net income.

Then

$$L = k_L N = k_L k_N A \qquad (3)$$

Neglecting the proportion of net income going to income taxes and reserves,

$$P = N - L \qquad (4)$$

where P is the amount of net income available for re-investment ("plowed back").

Substituting:

$$P = k_N A - k_L k_N A = k_N A\ (1-k_L) \qquad (5)$$

Assuming k_N and k_L to be given, the following is a framework for tracing the path of capital accumulation:

Table 1. Theoretical process of capital accumulation for an agricultural firm-household[a]

Year	Total capital at beginning of year	N	L	P
1	A	N_1	L_1	P_1
2	$A + P_1$	N_2	L_2	P_2
3	$A + P_1 + P_2$	N_3	L_3	P_3
4	$A + P_1 + P_2 + P_3$	N_4	L_4	P_4
5	$A + P_1 + P_2 + P_3 + P_4$	N_5	L_5	P_5
⋮	⋮	⋮	⋮	⋮
n	$A + P_1 + P_2 + \ldots + P_{n-1}$	N_n	L_n	P_n

a. A is total input capital at the beginning of the period, N is net income, L represents living expenditures and P is "plow-back", that is, the portion of net income that is invested back into the business.

From this table a basic equation may be derived[a], under the assumptions, to calculate total accumulated capital TC at the beginning of any particular year i:

$$TC_i = A\left[1 + k_N\ \ (1-k_L)\right]^{i-1} \qquad (6)$$

a. See Appendix A1 for the derivation of this equation.

where i is any particular year. From this the following are obtainable:

$$N_i = k_N \; TC_i \qquad (7)$$

$$L_i = k_L \; k_N \; TC_i \text{ , and} \qquad (8)$$

$$P_i = k_N \; (1-k_L) \; TC_i \qquad (9)$$

<u>Assumptions</u>

Equation 6 is based on several assumptions:

1. That all of the net income not consumed (N-L) is invested back into the business; and that this investment is all productive and not made partly for psychic benefits, such as an oversized tractor bought to keep up with the neighbors;
2. That k_N remains constant as total capital increases;
3. That k_L remains constant with the increases in income;
4. That variations in total capital account for variations in net income, or are highly correlated with other factors that do accunt for variations in net income;
5. That variations in net income account for variations in living cost or are highly correlated with other factors that do account for variations in living costs.

All of these assumptions provide hypotheses for empirical testing. The best statistical testing of Equation 6, as an hypothesis for explaining the path of capital accumulation, requires historical data on individual farms. This frequently is impossible to obtain. However, the equation may be tested by logical examination and statistical testing of its component parts. The importance of A, k_N and k_L may be readily seen, and these are the components or parameters on which this study will concentrate the empirical testing. Assumptions 3 - 5 will be tested empirically but, due to lack of suitable data, Assumption 1 will not; nevertheless it will be considered when the effects of reserves and income tax are discussed.

Choice Alternatives

The preceding analysis assumes that the choice has been made as to how much of net income to invest back into the business. The ratio k_L expresses the result of the choice of the farm operator and his family between the net income consumed and that returned to the business in the form of capital.

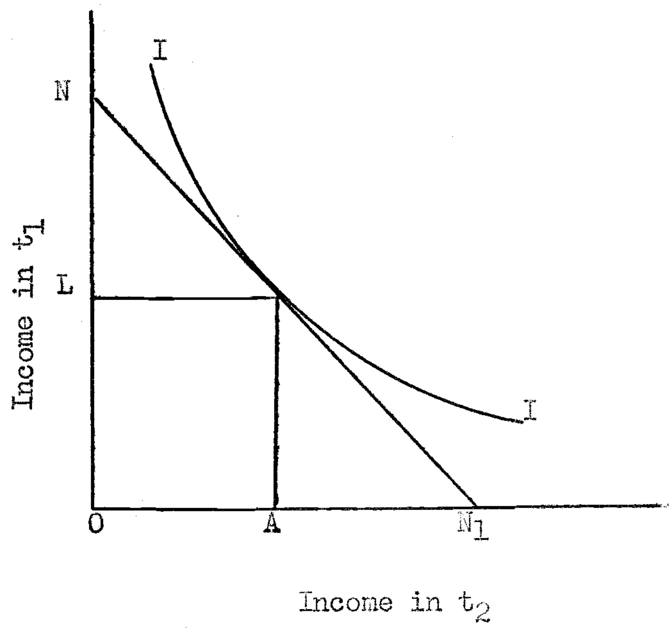
To make this choice, the operator and his family must compare the present utility derived from consuming present income, with the present utility of future income arising from returning to the business the foregone present income. This future income is the sum total of the income stream produced by the investment, discounted to a present value, mainly because of the time preference of the farm family. The actual utility comparison is subjective and, as yet, unmeasurable.

Future income from P_1 would vary according to the decision of the farm family on three alternatives: (a) leaving the original "plow-back", P_1, intact and consuming all net income derived therefrom each year; (b) investing all of the net income from P_1 back into the business each year to accumulate income to be used at some future point of time, in which case the expenditure on living, that is current at the time of decision, could not be exceeded; (c) consuming part of the net income from P_1 and plowing back the residual each year. The last alternative is the most likely to occur, since P_1 and its net income usually would not be earmarked but would be integrated with the total input capital and the net income of the farm business. The formulas for present values of the income streams available under each of these alternatives are given in Appendix A9. For the planning decisions of the farm family the importance of the estimates of future net income and living costs and the importance of the discount rate used by the family, may be readily seen from these formulas. Methods for providing these estimates and identifying the discount rate are worthy objects of research.

Relationship to the Heady Analysis

Utilizing Figure 4, the foregoing analysis of capital accumulation from the viewpoint of savings invested back into the farm can be related to Heady's opportunity curve - indifference curve analysis, outlined at the beginning of this chapter. As in Figure 3 (p. 24) the present income available for consumption in the present time period, t_1, is represented on the Y-axis and the future income available from investing income in t_1 is represented on the X-axis. The indifference curve, II, depicts the substitution of income in t_2 for consumption of income in t_1. The line NN_1 depicts the rate at which income in t_1 produces income in t_2, if invested back into the business.

Figure 4



In terms of the "savings" analysis, ON represents net income N_i, from any period "i". OL represents L_i, the portion of N_i that is consumed. LN represents P_i, that portion of N_i, available for investing back into the business. $P_i = N_i - L_i = ON - OL$, and is determined by k_L. k_L is represented in Figure 4 by OL/ON. OP represents the future income from the investment of $NL = P_i$. It is determined by k_N and P_i. A straight line, NN_1, depicts constant marginal productivity of the income invested back into the firm. As will be seen later, it does not depict a constant k_N for the total capital of the firm; k_N is constant only for the marginal increment. P_1 may be thought of as a marginal increment for the firm as a whole.

The slope of the indifference curve, II, depicts the household's marginal rate of substitution (m.r.s.) of income in t_2 for income in t_1. This m.r.s. is equivalent to "r", the farm household's rate of discounting future income. In the diagram, m.r.s. is in terms of the whole time period, t_2, whereas r is usually expressed as an annual rate. If r is expressed for the whole future time period, t_2, then it is equal to the m.r.s. expressed in percentage.

The Heady analysis of the choices involved in capital accumulation by the firm-household does not take into account the firm's total capital (beginning capital plus accumulated capital), although the two approaches are related in that LN in Figure 4 is the annual capital accumulated, P_1 in the "savings" approach. It is well to note here that for either analysis, the mathematical description of the path of capital accumulation, depends on regular relationships. This limitation affects the conformation to reality of both analyses, because of the variability in real-life data.

The usual level of income, the form of capital into which P_1 is converted and the amount of P_1 are all likely to affect the consumption - investment decision. The form of the capital influences the period of waiting for a return. The longer this period, the higher the rate of discount is likely to be, especially if the purchasing power of currency is declining. If a farm family with a relatively low level of living and low capital has a small P_1, the pressure to spend on current consumption is likely to be high in comparison with larger farms having higher incomes. There may be a tendency to discount returns from small investments quite highly. If the amount of P_i is higher, the operator has a wider range of opportunities for investing with likelihood of larger returns, which he would discount less. These are some reasons why small farms find it so difficult to reach a size where the rate of capital accumulation is reasonably rapid.

The farm family's rate of discount and its utility comparison of current and future incomes are subjective and impossible to quantify and measure by methods available to date. Much study is required to do this. However, the basic thesis in this study is that future income from P_i may be estimated with more accuracy than a random estimate would provide, and thereby afford information for more intelligent decisions.

Discussion of k_N

One of the hypotheses to be tested in this study is that k_N remains constant with increasing capital (p. 31). Since k_N = net income/total input capital, the size of k_N and the changes in this ratio, depend upon the size and direction of changes in its numerator and denominator, so the changes that occur in k_N as capital increases depend on the concurrent changes in net income. If net income increases proportionately, k_N will remain constant; if net income increases less than proportionately, k_N will decrease; and if net income increases more than proportionately, k_N will increase.

Associated with the hypothesis of a constant k_N is the postulation herein that $N = k_N A$, which implies another hypothesis that will be tested, namely, that all variation in N is accounted for by the variation in total input capital (p. 31). In mathematical terms, N is the dependent variable to be estimated from A, which is the independent variable. k_N is the regression coefficient and is derived empirically[a]. Error in prediction may be caused by the failure of variation in total capital to account for all of the variability in the net income, N.

Net income equals gross receipts minus operating expenses and depreciation. Changes in any one of the last three variables relative to the other two will change net income. Possible causes of variation in these components that is not attributable to variation in value of total input capital are (a) changes in gross receipts due to variations in natural conditions (weather, disease, pests, weeds, etc.), to changes in product prices, to changes in operator's labor and management and to changes in input proportions and (b) changes in input prices.

Variations in gross receipts due to varying natural conditions can be controlled to a considerable extent by investment in weed, pest and disease control, in irrigation, in fertilizer and possible other similar measures. To the extent that such investment influences output, the variability in output not accounted for by

a. If it is for a particular farm it must be derived from that farm's history of its ratios of net income to total input capital.

variability in total input capital is reduced.

The possibilities of changing input proportions without changing the value of total input capital are limited. It is true that excess capacity may exist in some inputs while other are limiting, but it is not easy to substitute limiting factors for excess capacity, which would be necessary if value of total input capital were not affected. Usually those items having excess capacity are not divisible and therefore cannot be partly substituted.

Variations in the quality of inputs, including labor, will affect output and therefore net income. If there are no imperfections in the factor markets, price will express variations in quality and will be included in the value of total input capital. For example, more productive land will have higher price than less productive land and the same acreage of each will affect the value of total input capital according to productivity. Insofar as market imperfections do not permit price to express quality, variations in total input capital will not account for variations in net income.

To consider the effect on net income, of an increase in capital from year to year for an individual farmer, assume natural hazards and weather to be held constant[a]. Also assume that the operator's labor and management increase in proportion to increases in capital inputs. The effect on net income, of an increase in total input

a. This can be justified, to a considerable extent, on the basis of the contributions of irrigation and improved technology to the reduction of these hazards. This is the only assumption that farm operators can make on the basis of experience because of the random nature of such natural influences. As the projection period lengthens these effects will tend to average out.

capital, can be postulated under the assumptions of constant prices and of changing prices.

1. Assuming constant prices:

When physical amounts of capital inputs are increased proportionally and gross receipts increase in the same proportion, net income will likewise increase in the same proportion. However, annual increases in capital, available as investment back into the business, are small, relative to total capital, and are not likely to be distributed over all capital inputs, but are likely to be allocated to one or two of the most productive types of capital each year. Thus a change in proportions would occur. Gross receipt would increase, the amount and proportion depending on the new combination of inputs. Operating expenses also would increase, the amount and proportion depending on the type of capital, fixed or operating[a].

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a. When the addition to total capital is in the form of operating capital, a one percent increase in total capital would constitute an increase in operating expenses of considerably more than one percent, simply because operating expenses are only a part of total capital, usually less than half. Thus, for net income to increase in the same proportion as the increase in total capital (to keep k_N constant), gross receipts would necessarily have to increase by more than one percent, although not as much, proportionally, as operating expenses. If the addition to total capital is in the form of fixed capital, usually, but not always, there is created an accompanying increase in operating expenses, which would constitute another, additional increase in total (as defined here). Nevertheless, the proportional increase in gross receipts, required to give a proportional increase in net income that will keep k_N constant, is less than in the case of addition to operating capital.

Depreciation would increase <u>only</u> if the capital increase is in the form of fixed capital. The effect on net income would be to increase it, but the amount and proportion would depend upon the elasticities of gross receipts, operating expenses and depreciation with respect to total capital increases.

Several hypotheses regarding the effect of an increase in various types of capital on k_N, may now be posed as first approximations. Table 2 summarizes these effects[a].

Stability of k_N feasible:

It is quite feasible that on the average, over a longer period of time, which is the context necessary for a projection of capital accumulation, say ten years or more, k_N remains constant. If a firm is in equilibrium with the limiting factor and the operator wishes to expand because of management's excess capacity, expansion will not be uniform because of the limited annual investment back into the firm. Likely the limiting resource will be expanded first, creating disequilibrium and a change in proportions of resources. However, as soon as other investment funds become available, the operator is likely to return to equilibrium and, at the new equilibrium level of inputs, the resources, except for management, would be in the same proportional combination as before, each having been increased proportionately. For inputs other than management, the firm may return to input equilibrium several times on the "path"

a. Any refinement of these approximations requires assembling a large amount of information, much of which is already available in various forms and locations. Such a project is beyond the scope of this thesis.

Table 2. Hypothetical effect on net income and k_N per dollar increase in capital items[a]

Item increased	Effect on gross annual receipts[b]	Effect on operating expenses
1. Land	Low	Low. (Taxes, fuel and lubricants, machinery repairs)
2. Machinery	Medium	Low. (Fuel and lubrication, repairs)
3. Irrigation equipment	Medium to high	Low. (Power and repairs)
4. Buildings	Low	Low. (Repairs)
5. Livestock	Medium	Medium. (Feed and labor)
6. Labor	Low	High. (All goes into operating expenses)
7. Fertilizer	High	High. (All goes into operating expenses)

- continued

Effect on total depreciation	Increase in net income	Effect on k_N
1. Negligible	Proportionate	Remains constant
2. Increase more than proportionally[c]	Proportionate	Remains constant
3. Increase less than proportionally[c]	In greater proportion	Increases
4. Increase less than proportionally	Proportionate	Remains constant
5. Increase more than proportionally	In lesser proportion	Decreases
6. Nil	In lesser proportion	Decreases
7. Nil	In the same or in greater proportion	Remains constant or increases

a. Assuming that only the item concerned is increased.
b. It depends on the marginal productivity of the item.
c. The proportional increase is greater or less than the proportional increase in Total Capital. Machinery depreciates faster than the average depreciation rate for all farm fixed capital; irrigation equipment and buildings less.

the "mature" equilibrium. (Presumably at mature equilibrium, management becomes the limiting factor.) The complementarity of certain inputs and the effect of customs and habits on management would accentuate this tendency considerably. If constant returns to scale exists then k_N will remain constant.

Mathematical difficulty:

Before proceeding further it is necessary to clarify the mathematical effects on k_N of the relationship between total capital and net income. If the relationship is represented by a straight line equation, for example $N = bA+a$ (where N is net income, A is total capital, "b" is the regression coefficient and the slope of the line, and "a" is the N - intercept), constant returns to scale exist only if $a = 0$, that is, the line passes through the origin. Inasmuch as $k_N A = N = bA + a$, $k_N = \frac{bA+a}{A} = b + \frac{a}{A}$. When $a = 0$, $k_N = b$ and remains constant as A increases. When $a \neq 0$, holding "b" constant, k_N decreases as A increases[a].

Constant returns to scale also exist when the relationship between net income and total capital is linear in the logarithms and the regression coefficients sum to unity[b]. Where the function $N = aA^b$ expresses the logarithmic relationship, constant returns to scale will exist if $b = 1$, regardless of the a-value. In this case $k_N = \frac{aA^b}{A} =$

a. This decrease in k_N is greater for larger than for smaller a-values. Conversely, it is greater for the smaller than for the larger b-values. Since there is a specific a-value and b-value for any particular farm or type of farm, this effect on k_N in the projection of capital accumulation presents no problem.

b. Most applications of the Cobb-Douglas approach to production-function analysis of farm input-output relationships discuss this type of equation, for example, see (70).

aA^{b-1}. When $b = 1$ then $k_N = a$, a constant, and k_N remains constant as A increases. If $b \neq 1$, but has a value less than 1, then b-1 will be negative, say $-i$ and $k_N = aA^{-i}$. With this relationship the value of k_N will decrease as A increases.

When $a \neq 0$ in the linear relationship or $b \neq 1$ in the logarithmic relationship, then the values $k_N = b + \frac{a}{A}$ or $k_N = \frac{a}{A^i}$ cannot be substituted for k_N in Equation 6 (p. 30). With the empirically derived equations available, k_N can be projected for each year, but its annual values depend on the beginning capital A, that is k_N is specific to A. To calculate it each year after Year 1, requires the calculation of P_i and with P_i already calculated, k_N becomes redundant for the projection of capital accumulation. However, it is possible to develop a predicting model from the regression equations $N = bA + a$, as an adaptation of the development of Equation 6, but this will not be presented until the other influences on k_N have been discussed.

2. Relaxing the assumption of constant prices:

If no change in quantities of inputs and output occur over time, the ratio k_N is likely to be affected by changes in output and/or input prices. If output prices alone rise, the numerator of the ratio will rise due to the increase in net income. If only input prices rise, the net income and the numerator will decrease and the denominator, total capital, will increase, thus having a two-edged effect on the decline that occurs in the ratio itself.

Over the projection period, k_N would change and $k_{N_1} \neq k_{N_2} \neq k_{N_3}$, etc. Under these conditions the development of Equation 6 (see Appendix A1) does not hold, since for this model it is necessary that all $k_{N_i} = k_{N_1}$. It is possible to express k_{N_i} in terms of k_{N_1} but the equation for total capital quickly becomes so complicated that it is easier to calculate TC_i (total input capital) for each year, using a value for k_N adjusted for price effect each year[a]. The price effect is determined from trends of appropriate price indexes. In some cases, indexes for aggregates of items must be used, which usually is the case for inputs. Insofar as the price trends used for calculating annual changes represent realized prices, these adjustments to k_N will account for some of the variability in net income that is not accounted for by variations in total input capital.

3. Effect of changing technology:

For projections over longer periods, say ten years, the influence on net income of continuously improving technology must be taken into account because of its effect on k_N. The trend in technological development in agriculture in the U.S.A. has generally been to increase output relative to total inputs, although some inputs have been affected more than others. If the net effect on output is assumed to be uniform for the future trend over the projection period, then a percent annual increase may be added directly to the

a. See Appendix A2 for these adjustments to k_N and their development.

percent increase in product prices, in the adjustment applied to k_N. If output price is increasing, the additional effect of technology would be complementary, magnifying the adjustment. On the other hand, if the output price trend is decreasing, the adjustment for the effect of technology would be compensating and tend to reduce the size of the total adjustment to k_N.

To recapitulate the discussion of k_N thus far, a method of estimating net income, N from the independent variable, total capital, A, by using the ratio $k_N = \frac{N}{A}$, has been outlined. This ratio, k_N, is to be derived empirically from usual inputs and outputs and current prices adjusted to trend, and applied to the present total capital to project future income. There are influences that are not taken into account by using the independent variable, A, and the ratio k_N, which are likely to result in errors in the predicted N. These influences along with the methods for dealing with them are as follows:

Source of error	Method for handling
Varying natural conditions	Assumed constant.
Changes in product price levels	Adjustments to k_N
Changes in input price levels	Adjustments to k_N
Changes in technology	Adjustments to k_N
Changes in proportions in resource combination	Assume constant returns to scale.
Changes in operator's labor and management	Assumed to increase in constant proportion with increase in other inputs.

Replacing k_N and k_L With Regression Equations

Referring back to the discussion of the mathematical effects of the functional relationship of N and A on k_N (p. 42) a regression equation, with A as the independent variable and N as the dependent variable, derived empirically from a sample of farms, is not likely to pass through the origin. There more likely will be a N- intercept. In this case a simple ratio such as k_N cannot be used in Equation 6 (p. 30). It is necessary, therefore, to adapt the projection model to the regression equation. On the assumption that the relationship between N and A is linear, a simple equation for a straight line will be used: $N = bA + a$.

However, before presenting this adaptation a similar phenomenon affecting k_L will be discussed and the necessary adaptation for k_L will then be incorporated into the model also. If k_L were constant, as implied in Equation 6, the relationship of L to N would be

$$L = k_L N \qquad (10)$$

the equation of a straight line passing through the origin. This does not represent a reasonable relationship at low income because it means that, at any income above zero, so long as k_L is less than one, some income would be saved. Actually saving does not start until incomes are considerably higher[a]. Below this, all income is spent for consumption, which may or may not be accompanied by borrowings.

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a. Various studies indicate that farm families do not begin saving until their disposable income is around $1,000 per year (61, p. 56), (22, p. 26), (2, p. 18) and (77, p. 13, 16). Farm families apparently begin saving at lower real incomes than do urban families. The income at which saving begins likely is higher today than these studies indicate, because of rising level of living.

If savings begin at an income of, say, $1,000, then the equation of the straight line representing L = f (N) takes the form

$$L = cN + d \qquad (11)$$

where d is the L-intercept. As explained for the net income-total capital relationship (p. 42-43), such a relationship does not permit $\frac{L}{N}$ to remain constant.

If the relationship between L and N were curvilinear, as some postulate (18, p. 77) and (62, p. 210), the equation might take the logarithmic form

$$L = dN^{c}. \qquad (12)$$

If the relationship were actually linear a logarithmic function would tend to overestimate borrowings at low incomes and savings at high incomes. More important to a projection with Equation 6, however, is the fact that, unless c = 1, $k_L = \frac{L}{N}$ does not remain constant.

Equations can be developed[a] for projecting total capital, net income, living expenditures and "plow-back" for the year "i" in the future, using Equation 11 or the changing ratio R[b] where $R = \frac{L}{N}$ and also is a function of N. The use of Equation 12 produces a very complicated model for projecting capital accumulation and income. In the income range with which this study is concerned, Equation 11 probably describes the data as well as a logorithmic function such as Equation 12. This will be tested later, in Chapter IV.

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a. See Appendix A4.
b. See Appendix A3.

Using the ratio R, and assuming k_N to be constant, for the year i

$$TC_i = A\left[1+k_N\ (1-R_1)\right]\left[1+k_N\ (1-R_2)\right] \ldots \left[1+k_N\ (1-R_{i-1})\right] \qquad (13)$$

where TC is total input capital, and

$$N_i = k_N\ TC_i \qquad (14)$$

$$L_i = R_i\ N_i \quad \text{and} \qquad (15)$$

$$P_i = k_N A\left[1-R_i\right]\left[1+k_N\ (1-R_1)\right]\left[1+k_N\ (1-R_2)\right] \ldots \left|1+k_N\ (1-R_{i-1})\right| \qquad (16)$$

The application requires a projection of R_i, based on empirical data. However, it is not necessary to use R_i in the case of the linear relationship $L = cN + d$ when the whole equation is incorporated in the projection model, as outlined next.

Replacing both k_N and k_L in the development of a projecting model, such as Equation 6 (p. 30), a model can be constructed on the basis of straight line, first degree equations. Using the following equations for net income and living expenditures respectively:

$$N = bA+a \quad \text{and}$$

$$L = cN+d$$

the following projecting equation results[a]:

$$TC_i = A + \theta\left[1 + (1+b\phi) + (1+b\phi)^2 + \ldots + (1+b\phi)^{i-2}\right] \qquad (17)$$

a. See Appendix A4 for the derivation of this equation.

where:

A is the original total capital,

b and c are the empirical regression coefficients,

a and d are the empirical N and L- intercepts, respectively, and are constant,

$\theta = (bA+a)(1-c) - d,$

$\phi = 1 - c$ and

TC_i = Total capital accumulated to the year i, and where the value of the term inside the square brackets is zero at the beginning of Year 1, one at the beginning of Year 2, 1 + (1+bc) at the beginning of Year 3, and so forth. From this[a]:

$$N_i = bTC_i + a \qquad (18)$$

$$L_i = cN_i + d \quad \text{and} \qquad (19)$$

$$P_i = \theta\,(1+b\phi)^{i-1} \qquad (20)$$

It may be possible to develop a better predicting equation for N by breaking total capital into two or more components and using them for independent variables in a multiple regression prediction equation. However, if an equation with more than one independent variable is used to replace k_N or $N = bA+a$ in the model, as capital accumulates in the model it would be necessary to allocate the effect of the constant, "a", and of living costs, to the input categories or types of capital being used as independent variables. There is no logical basis for this allocation so that the model breaks down.

a. It will be found that, by substituting a = 0 and d = 0 in Equation 17 and letting $b=k_N$ and $c=k_L$, Equation 17 reduces to Equation 6.

In the discussion of Choice Alternatives (p. 32), the parameters of Equation 6 were used to estimate future income (deriving from P) for discounting to the present, in order to aid in the decision as to whether or not to spend P or invest it back into the firm. Analagous present values of future incomes can be determined from the parameters in Equation 17[a].

To be useful for practical application the projection must recognize the effect of changing input and output prices over the projection period. Changing price relationships would cause the regression coefficient, b, to change, even if input and output quantities were to remain constant. Adjustments for price trends can be applied to the regression coefficient in a manner analagous to the adjustments applied to k_N[b]. These adjustments are developed in Appendix A6. It will be noted that Equation 17 for projecting total input capital no longer holds when the effect of price changes is introduced because, as the mathematical process develops from Year 1 to Year 2, etc. b changes, so that 0, representing $(b_1+A+a)-c(b_1A+A)-d$ cannot represent $(b_iA+a)-c(b_iA+a)-d$, since $b_i \neq b_1$. Although b_i can be expressed in terms of b_1, the formula gets so complicated, as capital accumulation builds up, that it is easier to calculate all of the variables annually and calculate b_i annually. However, Equation 17 is still useful to provide "bench mark" projections that assume no price changes, to compare with those that allow for price changes, thus providing a

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a. See Appendix A9.
b. See Appendix A2.

method for determining (in dollars) the effect of changing price relationships on capital accumulation. With b_i changing each year, under the influence of prices, it is necessary to calculate net income, living costs and "plow-back" for each year, before the total input capital for the next year can be determined. Thus, capital for Year i cannot be determined until these values for all previous years have been calculated[a].

The influence of continuously improving technology also applies here in the same way indicated for k_N (p. 44). For either k_N or b, the adjustment requires the determination of a trend in the influence of technology on output for the projection period.

Discussion of the Living Cost Component

The living expenditure component of the models discussed thus far is based on the assumptions that variability in net income accounts for the variability in living expenditures and that the relationship between net income and living expenditures is linear. Growth of the firm-household is a secular process so that changes in family size, changes in prices of consumer items and changes in composition of the "bundle" of goods consumed by a family will occur concurrently with this growth.

The effect of changing composition in the "bundle" of goods will be assumed constant. This effect on consumption is analagous

a. As seen later, in the discussion of the effect of income taxes, it is necessary, anyway, to make the annual calculations. It will be seen that when the model is applied in Chapter V, annual calculation provides considerably more flexibility in the changing of variables and parameters.

to the effect of technological changes on production. It would affect the regression coefficient, c, like technological changes affect the regression coefficient b. Unless a trend effect exists and can be isolated, the effect on c cannot be predicted.

The other two sources of variability in living costs mentioned above, can be incorporated into the models. It is possible to represent the living cost component in the model with a multiple regression equation, that will enable the use of net income and family size as independent variables[a], in the following type of equation:

$$L = cN + \gamma S + d \qquad (21)$$

where L is living expenditures,

N is net income,

S is size of family, measured in some type of consumption unit and

c and γ are partial regression coefficients and

d is the L-intercept.

With the growth in the firm both N and S will increase. Growth in N depends upon capital accumulation whereas growth in S depends upon births and growth of the children. The rate of growth in S will vary over time, in many cases, because children will not be born regularly. However, it will be assumed for the model, that growth in S over the projection period occurs at the rate of s percent per year.

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a. Income and household size were the two independent variables used to predict family expenditures in a Michigan study in 1960. The study reported a significant relationship between each independent variable and family expenditure (7, p. 544-546).

Using this equation for living expenditures and the equation $N = bA+a$ for net income, the following equation estimates total capital for the year i[a]:

$$TC_i = A + \theta\left[1 + (1+b\phi) + (1+b\phi)^2 + \ldots + (1+b\phi)^{i-2}\right]$$
$$-\Big[\gamma S\,(1+b\phi)^{i-2} + \gamma S\,(1+s)\,(1+b\phi)^{i-3} + \gamma S\,(1+s)^2$$
$$(1+b\phi)^{i-4} + \ldots + \gamma S\,(1+s)^{i-4}\,(1+b\phi)^2$$
$$+\gamma S\,(1+s)^{i-3}\,(1+b\phi) + \gamma S\,(1+s)^{i-2}\Big] \quad (22)$$

where $\theta = (bA+a) - c\,(bA+a) - d$,

$\phi = 1 - c$ and

where for Year 1 the bracketed terms have values of zero and for Year 2 the term $\left[1+ (1+b\phi)+ (1+b\phi)^2 + \ldots + (1+b\phi)^{i-2}\right]$ has a value of unity.

It should be noted that there is likely to be inercorrelation between income and family size in the growth context, because both are functions of time. This may result in the failure of each independent variable to account for as much variability in L when related in a multiple regression as accounted for by each in a simple regression; however, the multiple regression may still provide a better prediction of L than a simple regression using either net income or family size as the independent variable.

Changes in the price level of consumer items are usually expressed by a cost of living index. In the simple regression relationship $L = cN+d$, an adjustment for a change in trend of p percent per year (either constant or changing) can be applied to the

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a. See Appendix A7 for the development of this equation.

regression coefficient c in the same way that price-trend adjustments were applied to the regression coefficient b[a]. However, for a multiple regression relationship, since the price trend affects total living expenditures, L, the effect of price trend cannot be allocated (except arbitrarily) to the two independent variables. Fortunately, this is not necessary. When total capital, net income, living costs and "plow-back" have to be calculated for each year as the projection proceeds, the change in the trend can be projected before L and applied to L itself for each year in the calculations.

Effect of Income Tax

Income tax is paid out of net income and thereby diminishes the funds available for investing back into the business. It cannot be allowed for in operating expenses, and therefore in k_N or in the regression $N = bA+a$, because its calculation is based on net income. Because the tax depends upon exemptions and upon a graduated tax rate, the relationship between tax paid and net income may change every year at a different rate of change, even though the change may be in the same direction. These irregularities make it impossible to build a factor into the model that is correlated with growth of capital, net income and living costs, yet changes regularly with the changes in these parameters. To make a projection that will take the effect of income tax into consideration, the tax has to be calculated every year.

However, it is possible to develop an adjustment for income

a. See Appendix A4.

tax even though it is still necessary to calculate the tax every year, because of the changes in the tax rate and exemptions. Letting the tax paid be T_i and $T_i \neq T_{i+j}$, where i is any particular year and j is any period before or after Year i, it can be shown[a] that:

$$TC_i = A+\theta\left[1+(1+b\phi)+(1+b\phi)^2 + \ldots + (1+b\phi)^{i-2}\right] - \left[T_1(1+b\phi)^{i-2} + T_2(1+b\phi)^{i-3} + \ldots + T_{i-3}(1+b\phi)^2 + T_{i-2}(1+b\phi) + T_{i-1}\right] \quad (23)$$

To estimate TC_i it is necessary to calculate net income, N, and T for each year prior to Year i. It is not necessary to budget annually, for net income, living expenditures or "plow-back" if the relationships between total capital, net income and living expenditures are known. A knowledge of the exemptions and the tax rate for each year is required to calculate the tax for that year. The tax is subtracted from "plow-back" for that Year and the residual is added to total input capital accumulated to date to provide the total input capital for the next year. Current exemptions, E_1, and tax rate, R_{t_1}, will be known at the time of projection but their values will have to be estimated, in some way, for the future projection period. It may be noted here that E_i (exemptions) is closely related to S and s in Equation 22.

The inclusion of a second independent variable in the living expenditure component presents no obstacle in the use of the adaptation for allowing for the effect of income tax. It is pointed out in Appendixes A7 and A8 that the development of the second

a. Appendix A8.

square bracketed term in each of Equations 22 and 23 is independent of the development of other terms in the equations. Thus, to provide a model for projecting TC_i when $L_i = cN_i + \gamma S_i + d$, where $S_i = S\ (1+s)^{i-1}$ and T_i are both integrated into the model, it is only necessary to add to Equation 22 the last square bracketed term of Equation 23, thus:

$$TC_i = A+\theta\left[1+(1+b\phi)+(1+b\phi)^2+\ldots+(1+b\phi)^{i-2}\right] - \left[\gamma S(1+b\phi)^{i-2} + \gamma S(1+s)(1+b\phi)^{i-3} + \gamma S(1+s)^2(1+b\phi)^{i-4} + \ldots + \gamma S(1+s)^{i-4}(1+b\phi)^2 + \gamma S\ (1+s)^{i-3}(1+b\phi) + \gamma S(1+s)^{i-2}\right] - \left[T_1(1+b\phi)^{i-2} + T_2(1+b\phi)^{i-3} + \ldots + T_{i-3}(1+b\phi)^2 + T_{i-2}(1+b\phi) + T_{i-1}\right] \quad (24)$$

This model can be used to replace Equation 22 used above in the estimation of the accumulation of TC_i when income tax is taken out of net income.

Discussion of Reserves

It is possible to include in the model another component for cash reserves, if it can be assumed that a regular relationship exists between annual net income or total capital and cash reserves. An adjustment to the model based on such an assumption would be likely to complicate the model considerably. Whether or not farmers usually put away idle reserves each year, and thus fail to utilise their productive potential, is a moot question. It will be assumed, for this study, that no such drain on "plow-back" occurs.

In practise most farmers have their "reserves" against uncertainty available from productive capital and available credit. It is true that they usually have some cash in the bank or in a liquid form, but these funds are not likely to be idle, and they may vary considerably each year, due to being put to productive use.

Cash reserves provide the farm family with two types of utility, namely, security against uninsurable uncertainty and the ability to postpone some decisions. This utility must compete with utility to be derived from current consumption, investment in the business (future consumption) and building up of assets (which are productive) for future retirement. Security and ability to postpone decisions can be provided by credit or credit potential. Bradford and Johnson argue that, since the cost of unused cash reserves exceeds the cost of unused credit reserves, farmers have much more of the latter (6, p. 388-389,401).

Quite often life insurance is purchased to cover risk of death of the operator and to save for the future. It may not be generally recognized by farmers that the savings portion of the premiums that is accumulated in cash surrender value has a high opportunity cost in terms of accumulating productive capital and thereby does slow down the accumulating process. However, this and the whole broad question of farm insurance is an aspect of capital accumulation that will not be treated in this study, but will be left for future research. The cost of life insurance will be treated as a living cost and of other insurance as an operating cost in the empirical section of the thesis.

Inter-farm Intra-farm Relationships

To project the path of capital accumulation for a particular firm-household the relationship between total capital, net income and living costs should be determined from historical data obtained from that farm. It is necessary to have an historical knowledge of the input-output relationship for the farm and the living requirements, so that the "usual" or the trend can be determined. With this knowledge, an estimate can be made of the future trend for these parameters over the projection period in order to establish the most likely relationship that will occur. Attention is drawn to the fact that Equation 24, over the projection period, does not allow for changing relationships between the variables (net income and total capital or living costs, net income and family size), although it does allow for changes in the variables themselves. It has been pointed out that adjustments for changing price trends can be made to the regression parameter b, causing its value to change, over time. The parameters c and γ are not changed when adjustments to L for changing price trends are made. With an annual estimation of F_i, changes in the parameters b, c and γ can be handled each year in the projection. When estimating future capital growth for a farm, it is necessary to estimate these parameters and any changes that may occur in them over the projection period.

It may be possible to obtain better historical data from several farms, that are similar to the subject farm, than from the farm itself. Longer histories may be available and data may be available that are missing for the subject farm. A better "coverage" of past conditions, both physical and economic, that may be encountered by the subject farm in the future, is thus available[a].

Unfortunately, historical data of this type usually are not

a. By "better" data is meant data that provide a more accurate projection for the particular firm-household.

available and it becomes necessary, if a projection is to be made now, before historical data can be recorded, to resort to one-or-two-call surveys to obtain the parameters to be applied to a particular farm. Data are obtained for a single production period from farms as similar as possible in type to the subject farm[a]. The survey farms vary in size, within types, and from this cross-sectional effect of size is induced the effect of changes in size over time for a particular farm.

Applying parameters thus induced from a number of farms in a single year, to a particular farm assumes:

(a) That the various size of farm, however size is measured, do, in fact, represent the various stages of growth of a particular farm. This assumes that the inter-farm production function is the same as the intra-farm production function and movement along the former is the same as movement along the latter[b]. The corresponding consumption functions also are assumed to be the same. Grouping, or stratifying, farms into type-groups and soil groups by locality results in greater correspondence between these inter-firm and intra-firm functions.

(b) That the quality of management is the same on the survey farms as on the single farm. This is implied in assumption (a) , if

a. Actually the survey usually covers several types of farms and data are selected to apply to a particular farm. Certainly, surveys are not carried out for the benefit of a single farm.

b. For a good discussion of inter-farm intra-farm relationships, (19, p. 780-781). This also is discussed briefly in the author's Master's thesis (27, p. 18-20).

management, per se, is considered to be an input. A considerable amount of uniformity in management exists among farms of a particular type, due to dictation by the physical environment, competition and the economic environment and custom, which force conformity in order to survive.

On a single farm, of course, management is more or less held constant. Any increases in the management input will be accounted for by the results of the operator's decisions. These results will show up in the new parameters, that should be re-estimated when significant changes in input-output relationships occur or are planned for the projection period.

(c) That the effects of natural conditions remain constant in the future, at least over the projection period, for the particular farm. The ratio k_N derived from a one call survey is affected considerably less by variability in the effect of natural conditions than is the case for one farm over several years. If a projection of capital accumulation for a single farm is being made, the effects of natural conditions must be assumed constant, at the "usual" input-output relationships, over the projection period. The longer the period the more it is likely that these effects will average out and give the same results as predicted on the assumption that they remain constant.

(d) That price relationships remain the same in the future as at present. In a one call survey to derive k_N, prices are more or less "held constant" because the respondents in the sample are subjected to about the same market environment. Certainly many economic forces affect all respondents the same, in a particular year. However, over time, a single farm will encounter changes in price relationships. The model has provided a way to adjust for this.

Consideration of Other Components of the Model

(a) Total Capital: as used in the model developed herein, includes all inputs except the operator's labor and management. This is an unorthodox definition of capital but the model requires the inclusion of operating expenses as a part of the capital funds involved in production. These expenses include labor, both paid and unpaid. The latter is included to remove a source of error in relating net income to total capital. Even though the input is unpaid, it results in net income for which there would not be an accounting otherwise.

Total capital is evaluated at present value, which accounts, in a reasonably large measure, for variations in quality and quantity. The value used for a projection should be adjusted to the trend in input prices, to avoid starting out the projection with a total capital component that is unusually high or low simply because of input prices in the year at which the projection begins. The effect of land values must be recognized in adjusting to the trend in input prices, because of the high proportion of total capital that is made up of land value. The land portion of that capital should be adjusted separately, to the trend in land prices, to properly weight the aggregate adjustment. It must be pointed out here that insofar as values of land and other capital are based on non-productive uses, the model will err. For example, if land values express mainly value for recreation, residential location or some other non-productive use, they will distort their contribution as inputs for the agricultural net income that is to be estimated.

Some input prices are not as variable, over time, as others, and as output. Feed purchase prices, often a large component of annual inputs, of course are about as variable as grain selling prices. In the aggregate, however, the index of inputs purchased by farmers is not as volatile as the index of things farmers sell. Land has perhaps the most stable prices and, because of its relative weight in total input capital, tends to stabilize the aggregate index of input prices.

(b) Family labor: is a component of the total input capital herein defined, that, if not paid and not included in total capital, can result in capital accumulation which would vary considerably from the prediction. Its inclusion is necessary when deriving the parameters from a group of farms. Here is one possible difference between inter-firm and intra-firm relationships. For a group of farms, to reduce the relative variances of net income and total input capital it is necessary to include all labor in the latter variable. If a particular farm does not have the same proportion of unpaid labor as the average for the group of farms, yet uses the parameters for the groups, ceteris paribus, the rate of accumulation will differ from that indicated by the group, according to the direction and degree of difference in family labor. For a particular farm the parameters used for projecting would depend upon whether or not unpaid family labor were available. If available, the net income derived from the total input capital would be larger and accumulation would be faster than if not available. If the situation changes during the projection period a new projection would be necessary, based on a new parameter. Thus, in considering future accumulation for a particular farm it is necessary to project the time unpaid family labor will start, how much will be available and its rate of growth.

If a particular farm were using a regression coefficient, for net income and total input capital, derived from a group of similar farms, when unpaid family labor is available in quantities larger than that for which the group parameter accounts, the extra product would all be net income and available for "plow-back". When the projection is being calculated on an annual basis which method has been pointed out to be necessary when b_1 changes, the contribution of family labor can be added directly to P_1 each year. This contribution can be measured by the amount and value of hired labor it would be necessary to use if family labor were not available.

(c) Depreciation: in reality, is not met by an earmarked reserve fund, by most farm operators. The depreciation usually calculated in farm accounting, is accumulated in the firms assets somewhere, unidentifiable, but is used only when replacements are necessary. Sometimes it is used to spend on consumption and assets are thus depleted. Usually it is tied up in non-liquid assets so that credit is frequently required to finance replacements of worn out buildings and equipment.

Normally, new investment items are acquired every year. To the extent that these purchases are about the same each year a straight line depreciation charge covers these annual purchases. Otherwise, depreciation is met by "lumpy" or discountinuous expenditures, which would seem to be a source of error in predicting k_N for the projection of capital accumulation. Since, however, replacements are exchanged for assets within the business, already accumulated or, in the case of credit, to be accumulated, over a period of time, some assets must be set aside from accumulation, to maintain capital. The use of an annual depreciation charge accomplishes this in the projection model, and enables a projection of net income available for new capital accumulation. Thus, in such a projection, it is not necessary to treat depreciation as it is met in real life; any method is satisfactory for the model, so long as it is regular and uniform, and so that it is adaptable to the time series treatment. The straight line method is the simplest to use.

Conclusion

Two comments made a few years ago by the same person are apropos at this point:

1. "...Among the most powerful generalization suggested by experience in farm and home development is the fact that farm and home planning can begin just as easily on the consumption side of the family balance sheet as on the production side. This means both sides are variable and adjustable. From this generalization, the important conclusion stems that farm and home development is, in fact, concerned with the family balance sheet in the future, e.g.

> moving balance sheet. Within such a framework economic dynamics is of major importance" (55, p. 1396).
>
> "...We have agreed that getting and spending money must be kept in balance. This suggests a balance sheet ... The balance sheet with production on one side and spending on the other would have to be conceived as an over-all budgeting activity which changed with the progress and time ... Furthermore the notion of balance sheet as moving in time and changing with the knowledge of new and more accurate information is a most satisfactory means of doing long time planning" (54, p. 21).

The model developed herein has recognized equally the importance of consumption and production in the agricultural farm-household context, and has made some provision for variation and adjustment in both. It also is somewhat of the nature of a moving balance sheet and a new projection can be made as new and more accurate information is obtained.

An ultimate test of the ability of the method to explain the actual capital accumulation process on a particular farm, is possible only if an historical record of the variables involved exists for that farm, for ten to twenty years in the past, or become available over the same period in the future. Such data usually are unavailable so that such a test must await their accumulation. However, "pieces" of the model can be tested with inter-farm data from one-call surveys. The method depends on certain basic relationships and assumptions that can be empirically tested for validity. These relationships and assumptions are expressed in the following hypotheses, in order to test them statistically:

1. There is a relationship between net income and total input capital.

2. This relationship is linear rather than curvilinear.

3. The ratio of net income to total input capital changes with increases in that capital.

4. The relationship between net income and total input capital is not influenced by resource combination as expressed by type of farm.

5. The relationship is not influenced by soil type.

6. There is a relationship between gross income and total input capital.

7. This relationship is linear rather than curvilinear.

8. The relationship between gross income and total capital is influenced by type of farm.

9. The relationship between gross income and total capital is influenced by soil type.

10. There exists a relationship between living expenditures and net income.

11. This relationship is curvilinear.

12. The ratio of living expenditures to net income changes as annual net income increases.

13. The inclusion of a second variable, family size, in the regression equation for predicting living expenditures provides a better prediction than provided by one independent variable, net income.

Hypotheses 1 and 6 are logical to expect because total inputs are the only source of income. With a given efficient combination of these inputs, experience leads to the expectation that as the amount of inputs increase, income will increase, at least up to the maximum size of farm with which this study is concerned.

Hypothesis 2 is necessary in the model and is feasible in view of the fact that constant-returns-to-scale are feasible and that no satisfactory empirical proof exists to the contrary (34, p. 349-381) and (27, p. 14-16). Over the range of size with which this study is concerned there is likely to be little difference in effect on projection of capital accumulation between a linear relationship and a curvilinear relationship fitted to the data. Hypothesis 6 is based on the same arguments as for Hypothesis 2. If Hypothesis 2 is true, then Hypothesis 3 is true unless the regression equation has a zero N-intercept, which is not likely.

Hypothesis 4 may appear to be unacceptable on the basis of the logical argument that the same physical amounts of capital organized in different ways will produce differing total revenue. However, when total value of inputs is taken as the measure of total amount, because higher productivity inputs have higher values it may be expected that, given the same total value of aggregate inputs, net income would not be affected by the way inputs are organized, if pure competition conditions prevail. On the other hand gross income is affected by productivity but the value of inputs is not subtracted to obtain net income. Thus, Hypothesis 8 is expected to be true. By the same token, if soil resources are evaluated in a competitive market, Hypotheses 5 and 9 seem logical.

Hypothesis 10 seems reasonable to expect on the basis that larger "disposable" incomes enable larger expenditures on living and the latter will result if unsatisfied wants exist. In the growth stage of the firm-household, the existence of unsatisfied wants is very likely. Hypothesis 13 also is logical in that more persons to feed and clothe in a family require larger expenditures on living.

Hypothesis 11 is logical on the basis of increasing marginal rates of substitution of savings for consumption as income grows, up to a certain point, likely well beyond the range of the data of interest to this study[a]. Hypothesis 12 is based on the discussion of k_L in the development of the model (p. 46, 47).

These hypotheses will be tested with data obtained from a sample of farms in a fairly restricted local area, in Marion County, Oregon. Chapter IV will discuss these tests in detail.

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a. Savings refer to income which is not consumed but is either hoarded or invested.

CHAPTER III

REVIEW OF THE LITERATURE

It is regrettable that very little systematic study has been reported of capital accumulation in the agricultural firm-household context (55). A great deal of study has gone into the income earning activities of the farm firm, including the effect of size of business on income, and a considerable amount of study, though much less, has been made of the income spending activities of the farm household, but very little has been done to integrate these activities and associate them with the growth of the farm firm.

Farm family living has been studied for many years to measure and compare welfare, to economize on disposable income by forecasting and budgeting from past experience and to estimate rural markets for goods and services. Also, family spending as well as saving, have been related to income. But one has to search diligently to find studies that relate farm family living behavior to the growth of the family resources. This is not to say that no one has recognized the relationship. Every economist knows that resource accumulation depends on saving and saving is income not consumed. However, it is surprising that this key relationship, though recognized, has not been pursued as studiously, in agriculture at least, as farm family behavior in maximizing utility from disposable income.

Annual savings and investment in the general economy have been the subject of wide discussion and study by economists, particularly since the appearance of Keyne's General Theory of Employment, Interest and Money. The main interest has been in aggregates but any penetrating study of these leads to a consideration of the consuming and saving behavior of consumer units. Several economists have explored this behavior, both theoretically and empirically, in attempts to arrive at methods for forecasting aggregate savings in the economy[a]. However, relatively little attention has been given to the consumption-savings behavior of farm households, per se.

Several hypotheses have been developed and tested for the purpose of estimating savings. There is the Modigliani-Brumberg life-cycle model[b], "the cornerstone (of which) is the notion that the purpose of savings is to enable the household to redistribute the resources it gets (and expects to get) over its life-cycle in order to secure the most desirable pattern of consumption over life. ...the life pattern of the saving income ratio will depend on the life profiles of family size and income, and on the preferred pattern of consumption over life." Tests of this hypothesis are thoroughly discussed in the article by Modigliani and Ando (ibid.) in 1957. In the authors' words: "The conclusions ... were painfully meagre," yet they have performed a real service in the exploration, and they seriously invite further testing of the hypothesis. The model was designed to apply to survey data (on income, consumption and savings) of groups of people, presumably with the idea of applying it to the whole economy.

a. For a list of authors on this subject see the article on a savings hypothesis by Modigliani and Ando (51, p. 124); also (25, p. 3-6).
b. Referred to in (51, p. 105, 124).

Another type of hypothesis relates income alone to savings. Modigliani, in an earlier article (50) developed three-variable regression equations for predicting savings and consumption, using aspects of the rate of change in income as the independent variables. The model is designed for use with aggregate historical data and is not appropriate to apply to individual households. In the article Modigliani indicates the stability of consumption and the relative instability of saving. He also mentions in passing that "there is good reason to suppose that ... entrepreneurs, especially farm families, have, on the whole, a greater than average propensity to save". His concept of secular and cyclical influences on the aggregate savings income ratio has implications for predicting "plowback" for individual farmers that will not be recognized in the present study but needs to be explored in any refinement of the method developed herein.

Perhaps one of the best known recent models relating income consumption and savings is Milton Friedman's "permanent income hypothesis" (25). His main concern is with the income-consumption relationship and savings is treated as a residual, dependent upon the other two variables. The hypothesis is developed to estimate consumption of a simple consuming unit and the aggregate is thereafter determined, theoretically, by integrating the function.

Friedman conceives measured expenditures on consumption to be composed of two parts, a "permanent" component and a "transitory" component. Also, measured income is made up of a permanent and a transitory component. The permanent consumption component is related to the permanent income component. "The ratio between them is independent of the size of permanent income but does depend on: (a) the rate of interest at which the consumer can borrow or lend; (b) the relative importance of property and non-property income; and (c) the factors determining the consumer unit's tastes and preferences for consumption versus additions to wealth, such as the size of the household and members ages and the importance of transitory factors affecting income and consumption (25, p. 21-26).

The permanent component of income reflects the effect of those factors that the consuming unit regards as determining its wealth (capital value), for instance, the non-human wealth it owns, the personal attributes of the earners in the unit, and the characteristics of the economic activity of the earners (occupation, location, etc.). The transitory component reflects all other factors that have the nature of chance occurrences, although some are predictable. These tend to average out for a sizeable group of consumer units so that if they alone accounted for the transitory component "the mean measured income of the group would equal the mean permanent component and the mean transitory component would be zero." Where some influence affects the whole group, such as the weather affects groups of farmers locally, the mean transitory component would not be zero.

An analagous statement of factors producing permanent and transitory components of measured consumption expenditures can be made.

This very briefly outlines the approach Friedman takes to identifying variables and relating them to formulate an hypothesis that can be tested empirically. There is a certain similarity between this permanent income and consumption concept and the "usual net income" and "usual living expenditures" variables in the model developed in this thesis. Friedman's hypothesis holds considerable promise for any future refinement of the method described herein.

These studies, and others like them, approach the problem of decisions on the use of income from the point of view of determining the residual savings. The decisions on the productive use (investment) of those savings are separated from the decisions of the consumer unit, simply because a great number of consumer units do not decide to what productive use their savings will be put. In the case of agriculture, however, these decisions are generally made by the same consumer unit and therefore must be studied together.

It is to be expected that the first to grasp the importance of integrating the farm firm and the household in farm planning decisions would be farm management extension workers because it is at the farm level where the effect of the conflict between consumption and saving on building up the farm resource base is most sharply seen. Thus, this integrated approach to farm planning first appeared in the Missouri "balanced farming" plan and has since developed into the present "farm and home development" extension program that is nationwide in the U.S.A. (See Chapter I, pages 1-2).

The "conflict" between the firm and the household for net income suggests a theory of choice. The logic of choice has been well developed by Irving Fisher, Pareto, Barone, Johnson, Hicks, Samuelson and others[a] but Heady, at Iowa State University, was the first to apply the

a. Schumpeter credits Irving Fisher as being the real ancestor of the logic of choice (63, p. 226).

theory to the integrated decisions of the agricultural firm-household, although the theory did not fully cover the growth process of the firm. This latter has not yet been done, or if it has, nothing has been published. The elements of Heady's theory have been outlined previously in Chapter II (pp. 19-26).

In 1950 he delivered a paper at the University of Chicago on capital formation in agriculture[a]. The paper discussed hypotheses explaining and predicting the process, approaching it from the aggregate viewpoint, particularly why the rate of formation fluctuates so widely over time. Early in the paper he visualized three types of empirical studies of relevant variables and coefficients that can be designed: (1) inter-farm and intra-year, (2) intra-farm and inter-year observations, and (3) aggregate observations of a time series nature for American agriculture. (The empirical part of the present dissertation could be classified as Type I.)

On the basis of empirical work referred to in his paper, he concluded that, in agriculture, "capital seemingly is neither employed in quantities (in an ex poste sense) in which (1) its marginal cost is equal to its marginal value productivity and (2) its marginal value productivity is equated to that of capital in other industries," and he went on to seek other explanations of the process of, and limits to, capital formation. Noting that in agriculture capital is formed and changes form in "spurts" during periods of farm prosperity, he was led to examine the form of business in agriculture, which of course is

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a. See Chapter II, page 19.

predominantly of the firm-household type. Capital formation is conditioned by the direct competition between the firm and the household for each increment of income. Withdrawals or investments "are not questions unique to the firm but also must be settled within the framework of the household". It is in the discussion of savings and investment in agriculture, in the firm-household context, that he utilizes the combination of time-opportunity curves and time-indifference curves presented in Figure 3 (Chapter II, p. 24) to analyse the variables affecting level of savings.

The figure suggests three possible ways in which the farm operator can move to accumulate capital at a greater rate and increase living levels: (1) He can employ the most efficient set of techniques with the given stock of resources. If he has enough resources to attain the boundary or opportunity curve but is located below it due to inefficiency, he can adopt improved technology. (2) If he is already on the curve then he must acquire additional resources. He may do this through saving (foregoing consumption), random occurrences such as favorable price changes, lotteries, marriage etc., or by hiring capital from other resource owners. (3) He can develop new techniques. The stock of resources he has may be used to put him on a higher boundary curve by use of techniques previously unknown. This can be done only as old forms of capital can be transformed into new forms.

He points out that the theory assumes a static setting in agriculture and if this were real "the process of capital formation might be defined largely in terms of the rate of saving and the assets initially owned (and hence in the capital that might be hired) by farmers.

However he rejects the theory as an explanation of the major changes in rate of agricultural capital formation. He then discusses several other hypotheses which (apparently) must all be used to explain all facets of the process, as each does not provide a full satisfactory explanation.

It is not the purpose of this review to reproduce these hypotheses nor to pursue the discussion of each initiated by Heady in his paper. Although the remainder of his paper deals no further, explicitly, with the firm-household decisions, all of the hypotheses contain a mixture of consideration of capital accumulation in the aggregate (in agriculture) and the decisions of an implied typical firm (farm). Every hypothesis goes back implicitly to the decisions made by the firm-household in the production-consumption context. To fully explain the rate of capital accumulation in agriculture it is therefore necessary to determine the proportion of all farms that behave according to each hypothesis, because firm-households react differently, frequently to the same economic environment.

Heady was not looking for a single explanation for the varying rates of historical growth in agricultural capital but rather for a basis for an empirical model for predicting aggregate growth. It is apparent from his concluding remarks that he visualized incorporating several hypotheses into the model, which would take the form of a set of simultaneous equations. To the knowledge of this reviewer, the model has not yet been developed.

The portion of the paper of interest to the present study was the outline of the time-indifference and time-opportunity analysis of major variables in firm-household decisions affecting capital accumulation. The other influences hypothesized in his paper impinge upon these variables. The analysis was outlined in a more abbreviated form in another article the same year (33, p. 1129-1132) and it appeared in his book "Economics of Agricultural Production and Resource Use" in 1952 (34, p. 424).

A paper delivered by Professor K. O. Campbell of the University of Sydney (Australia) in 1958 (11) contains some interesting observations and viewpoints on capital accumulation in agriculture that are relevant to the present study. Like Heady, in the paper reviewed above, Campbell notes that nearly all capital growth in agriculture has been internally financed, at least since World War II, by gross farm income, in the United States as well as in Australia. That he rejected traditional investment models of economic theory as having very little relevance to agriculture is evidenced by the following:

> "The profit maximazation or marginal theories of investment, even in their more sophisticated form involving risk, uncertainty and expectations, seem to have their chief value in providing a basis for setting up ideal goals for agricultural investment rather than as an explanation of, or guide to, entrepreneurial action. ...there is no evidence that, in making plans for longer term investments of a developmental nature, farmers discount future returns or compound investments, though it is clear that farmers do discount the future subjectively in some rough and ready way... I believe that this (explaining much of seemingly non-rational behavior in terms of risk and uncertainty) is, in many ways, a blind alley so far as the development of an adequate theory of investment behavior in agriculture is concerned."

Then he makes a statement that is of particular significance to this thesis:

> "The most promising clues to the nature of the investment process in agriculture have come from empirical studies. These seem to point unequivocally to the prime importance of internal liquidity in capital formation. <u>The most plausible formulation would treat investment outlay as a residual, defined as the net income realized from current operations less tax commitments and some conventional allowance for family living expenses."</u>

This statement clearly substantiates the approach taken in the present study.

Apropos the "conventional allowance for family living expenses" he points out that farmers' consumption expenditure appears to be comparatively unresponsive to short run farm income fluctuations even though the latter have considerable amplitude, and is of the opinion that the relating of the more "permanent" components of income to living expenditures holds promise as an explanation of their stability.

Campbell also expressed the view that "farm savings are not held to any great extent as contingency reserves, but are characteristically invested in the farm business ..." He also states that "it can be readily shown that a high level of tax and/or sharply progressive tax can seriously affect income surpluses, which would otherwise be destined for investment."

In their book "Farm Management Analysis", published in 1953 (6), Bradford and Johnson have recognized the importance of the firm-household context to management decisions, and one of their final chapters (Chapter 25) deals specifically with farm and home planning. In this chapter they stress the importance to the farm family of defining their long run goals and reconciling them with the income-producing capacity, both present and future, of the firm. This reconciliation, they say, is the core of management. The planning tool suggested is "static" budgeting, continually revising the budgets as goals, current consuming habits and production resources change.

A section in their final chapter states that when the dynamic managerial principles are studied the importance of the distinction between the business and the home aspects of farming is reduced. The introductory comments to this section are very similar to the comments introducing this review of literature. They go on to say, among other things, that "farm management men have been increasingly aware of the relations, within an individual farm business, between consumption and the availability of savings for investments and development of a farm business. ...Home economists are becoming increasingly aware of the need to balance consumption against income producing power".

In his doctoral dissertation, Castle (13) presents a theoretical discussion of the effect of the conflict between the household and the firm (for net income) on the progress of the firm. He conceives a real conflict between the maximization of utility by the household and the success of the firm. The effect of the spending desires of the household on the decisions of the farm operator, who is a member of that household, may modify the objective of profit maximization. He refers to Hart's (31, p. 89) expression of the assumption of profit maximization under dynamic conditions, in the absence of uncertainty and capital rationing, where the assumption takes the form: the entrepreneur maximizes the discounted value of his expectations of net receipts. When this discounted value is identical with the maximum discounted value of expected withdrawals, as Hart shows it to be in the absence of capital rationing and under conditions of subjective risk where the entrepreneur thinks he knows what is going to happen, there may be no conflict between the firm and the household. This is because the (subjective) rate of discounting receipts from the future production plan is proportional to the value placed on present withdrawals for consumption. The point chosen, in the range where household utility and discounted future firm income are competitive vis a vis complementary, will be the point that maximizes the utility of the decision maker. Thus, production plans may differ among entrepreneurs with identical physical resources, since future returns will be discounted differently.

However, he points out, it is more realistic to suppose that uncertainty does exist. He utilizes a diagram borrowed from Boulding (5, p. 96) to show that uncertainty retards the movement (over time) to the profit maximization point. Other things may also retard this movement, namely, lack of credit available for consumption purposes, unwillingness on the part of the entrepreneur to put forth the additional effort that greater production may require, and exchanging production for consumption, via the market, may not bring a higher level of utility. Thus, in reality, resources may be allocated differently than the profit maximization goal would imply. The diagram is also used to illustrate that if a surplus net income is not produced (due to unfavorable production conditions, for example) equal to the minimum withdrawal, the new output (size) of the firm will be smaller.

Unless reserves exist or credit is available, there will be a minimum below which withdrawals cannot fall. Lack of availability of consumption credit may have an adverse effect on production. When the household and firm are closely connected, the distinction between consumption and production loans may not be meaningful. If a lender insists upon earmarking a loan for production and at the same time minimum withdrawals cannot be met without reducing the capital of the firm, the firm may not be able to achieve an economic allocation of resources. Lenders should view the firm and the household as a unit.

In 1956 an interesting experiment in educational processes was conducted at the University of Tennessee, in the form of a "rural family financial workshop for farm and home management specialists". The workshop was three weeks in duration; tuition was charged; scholarships were granted; and university credits were given to those participants desiring them.

The need for the workshop and the justification for the effort put into it, for the self-improvement of educational leaders, was felt to arise from the nature of the problems of rural families. First the commercial nature of farming, with dependence upon the market for income and goods and services for living, and with its financial problems rooted in such a context, increasingly characterize American agriculture. Second, farm family financial decisions involve, but not exclusively, the mustering of total resources for production to secure income. Third, these financial decisions also involve the uses of resources and income in consumptions. Fourth, and most important, these decisions include not only production and consumption, but these combined with a continuity of choices to achieve the entire range of family goals throughout the life cycle of the family. It is this interrelated nature of the problem that called for a combined educational effort for the farm and home.

Several background papers were given at this workshop and are contained in the report of its proceedings (69). A number of statements and comments pertinent to the subject matter of this thesis have been selected from these papers to include in this review.

Some comments by Professor Nesius have already been referred to but two additional comments will be reported here. He advocated two alternative approaches to planning the monetary income and need for the farm family: (a) consider the quantity of available resources to be constant, develop the best production plan and adjust the family spending plan to the income thus produced. (b) First determine the needs of the family for optimum satisfaction, hold these constant, then marshall resources and develop a production plan to meet these needs. He leaves the impression that planning cases fall into one of these categories and that either income is fixed or needs are fixed. However, at the same time he acknowledges the changeableness of family values and associated spending goals. This implied rigidity in plans may refer to single plans as of a certain date, but there is little doubt that Nesius and most other economists realize that farm family goals change as well as their productive resources change, so that plans must be changed when new data develop.

The second statement Nesius makes, apparently based on experience, corroborates the "philosophy" of the present study. He states "Many families leave to chance whether their hopes will be realized. When this is the case more hopes are not realized than fewer that are realized".

Professor Spitze, whose paper also has been referred to previously, presented data and analysis for a background on capital, income and prices in agriculture as they related to the subject matter of the workshop. He noted that total capital in agriculture has increased at a slow rate over the past 50 years, relative to the increase in most other industries, but there has been a tremendous change in capital per farm worker. The individual farmer's problems in acquiring production capital have increased proportionally. The form of this capital "has changed from being primarily land to machinery and livestock". This is relevant to any consideration of the form of capital into which to "plow back" surplus net income. (As with so many analyses of the changing structure of capital in agriculture, the investment tied up in operating expenses was omitted from the data. This type of capital is continually becoming relatively more important.)

Spitze also stresses the importance to farmers' financial problems of relative trends in prices received by farmers and prices paid. This is brought out forcibly in the projections of capital accumulation presented in Chapter V of this thesis.

Two papers by Professor and Mrs. Bratton of Cornell on decision making in farm management and rural family financial management have many stimulating comments on decision making, a few of which will be included here. Plans fail, they point out, because of insufficient knowledge and because of overlooking the fact that a plan is a static thing, but carrying it out is extremely dynamic. A plan is only a tool or a point of reference, for further decisions. Extension workers can assist in farm firm-household decisions by (a) teaching them a procedure for solving problems and (b) providing facts that can be used in finding and evaluating probable outcomes of alternative solutions. If there is one management function which education can and must strengthen it is the ability to see clearly the relation of all the activities on the farm and in the home to family purposes or goals.

There are some comments on planning in a paper by Professor Thorpe (University of Tennessee) that are pertinent to this thesis. All planning is for some specified time period and serves as a basis for decision making. It is a continuous process - a long run basic plan will need to be adjusted to changing on-farm and off-farm situations.

It is important, for the following reasons, that the period during which the plan will be in operation be specified:

(a) The length of run defines the fixed and variable factors;

(b) The sector of the life cycle of the family must be known, since family needs and resources change over time;

(c) Capital and experience need to be accumulated for some lines of production;

(d) The length of run determines the appropriate price-cost data;

(e) Technological change may shift production functions. The shorter and more close at hand the planning period the less the error will be in planning.

There are other papers reported in the proceedings of this workshop, which, along with the reports of each study group, provide good background to the study of firm-household long run planning. The workshop was extension focused and no theoretical analyses of firm-household choices were presented or discussed.

Up to this point this review has attempted to survey the literature available on the theory and approach to the study of integrated firm-household economic choices and planning. The remainder of the review will be concerned with published empirical work related to the problem.

There are several aspects of the problem of projecting capital accumulation for an individual firm-household that suggest the application of dynamic programming. This was done in 1959 by Loftsgard and Heady (45) who used this tool to determine optimum farm and home plans over time. Incidentally, this is the only publication that, analytically and empirically, directly attacks the problem of projecting capital accumulation for the agricultural firm-household, although Candler has published some comments on their article (12).

Essentially, dynamic programming determines the optimum (maximum profit) use of resources under limiting restrictions over a series of years, with the optimum for any one year depending on the optimum in other (previous) years. In the Loftsgard and Heady application, household needs are included in the activities and restrictions and become one of the determinants of resource supplies for each year. Based on resource supplies and optimum use in previous years the plan for each year of the planning period can be specified. This treatment of the problem is more sophisticated than the treatment developed in the present study in that the programming plans the optimum resource combinations to maximize profits each year, given the input-output coefficients and projected price data. Also, family expenditures are predicted by detailed annual budgeting for each year rather than by using a regression equation.

There are other differences and several similarities that are useful to compare. One advantage to the programming treatment is that it automatically indicates the best enterprise into which to plow-back accumulated operating capital each year. The method also provides a "sharper" way to quantify the effect of proposed expenditure on selected family living budget items in terms of returns foregone if the money were "plowed back" into production.

The main difference between the regression method and the programming method is that the latter specifies for the firm the organization of resources each year as the firm grows, and for the family, the annual composition of their living content; whereas the regression method assumes (a) that, on the average, and over the projection period, the firm will organize inputs like other similar firms do, (b) that the effects of size on inter-firm variability is the same as the inter-year variability for the single firm as it grows and (c) that family living composition for the subject farm family as it grows will be affected by income and household size in the same way that other similar families are affected by these two variables. Here again the effect of these variables on inter-family variability is assumed to be the same as the inter-year effect for one family.

Both methods estimate growth in capital and annual income on the basis of the original supply of capital in Year 1, and an annual subtraction of estimated living expenditures and certain other items from the annual net income estimated. However, Loftsgard and Heady show only the operating capital "plow-back"; the remainder of the "plow-back" available, which they call "added investments" is concealed in the item "fixed expenditures". Added investments may go into land, labor, buildings, machinery, etc. changing some of the resource restrictions or, if not affecting them, changing production coefficients. If the latter occurs, the program has to be changed as of the time of the occurrence, just as new projections have to be made when parameters change for the model developed in this thesis.

Both methods encounter the same problems in predicting net income. Presumably the net prices in the C_j row of the program tableau are determined from estimates of gross returns and fixed costs per unit of output, which estimates are obtained from variable data (on the subject farm, from farm surveys or from experimental data). The net price shown is a probability estimate of that price, projected into the future for the projection period of the program. The fact that it is expressed as a per unit net return does not diminish the effect of error in the estimate. The same type of error exists in the regression estimate of net income used in this thesis.

Both methods face the same problem in predicting price relationship of inputs, outputs and living items purchased. Because of the different ways in which prices are applied, there may be a difference in the aggregate error accumulated in the net income and "plow-back" estimates. Tracing the comparative effect of these predicting errors in each method needs to be done before a statement (about this error) that is meaningful to planning can be made.

Both methods recognize the effect of growth in the household on living costs, but this is implicit in the family living budgets for programming while it is made explicit in the method developed in this thesis. It is noted that family growth at any time during the projection can be taken into account in either method. In other ways, however, budgeting ahead is more flexible.

Although the projections in this thesis do not spell out or itemize the annual budget they do show the usual annual living expenditure made by similar families on similar farms. Within this total the family can budget various items. If more is required for a particular year the effect on income and capital accumulation is made apparent in the "plan" for the years thereafter.

Income and social security taxes apparently were pre-estimated in the programming method. These taxes cannot be accurately calculated until net income is known so that the program logically must include some method of doing this. The accuracy gained may not be relatively important but the method demonstrated in this thesis provides for calculating taxes on the basis of the appropriate income.

The Loftsgard and Heady article gives no consideration to the effect of the use of credit and concurrent periodical repayment of loans. This should be incorporated into the model because one of the chief uses of such a projection is to provide a guide in the use of credit.

This raises the question of the purpose of the programmed projection. Like most programming solutions, it is normative in nature in that, under the assumptions used, it shows the resource combinations that achieve optimum income over time, taking into account annual living costs. If the farmer wants to obtain this optimum, he must follow the plan and the method can be used for predicting outcome only if he does. On the other hand the method developed in this thesis is of a positive nature in that it projects what is likely to occur in the future under resource combinations and typical living expenditures that now exist, regardless of whether or not they exist to maximize (profits or utility) over time.

Extension type bulletins have been published by federal and state agencies, from time to time, on farm financing. Since the war, at least, most of these recognize and integrate the needs of the farm home with those of the farm firm. For example, in 1946 the U.S.D.A. published a small bulletin on the subject (26). It outlines actual steps in developing a farm and home financial plan:

(1) Plan the major long-time goals of the family.

(2) Determine what is owned (net worth).

(3) Estimate the income available for operation, investment and savings for the future.

(4) Estimate the income available for these items in the coming year.

(5) Plan the farm and home operations and investments for the coming year.

The method in this thesis is useful for item (3) above. Likely financial obligations are briefly outlined for each period in the married life of the household and consideration is given to all basic needs for income and sources of income.

The U.S.D.A. published another similar bulletin in 1948 which contains considerably more detail (43). In the second paragraph in the bulletin it states: "Three main elements must be properly combined if a farm is to be successful financially. They are: good farm management, an efficient farm unit and a well-managed home. No one element is more important than the others. Serious weakness in any one is likely to mean distress." Prices have an effect on all financial management. "...it isn't the prices for individual items alone that provide the basis for financial decisions. It is the relation between prices paid and prices received. It is also the relation of prices paid and received by farmers now to such prices in the future ...no one can foresee future events exactly, but broad movements can often be figured out fairly well." The ensuing discussion includes only the prices of inputs and outputs and neglects prices of living items. Yet several pages later (op. cit., p. 29) the authors state: "...the amount a farmer can save is one of the most important points in deciding the amount of credit that can be safely used to buy a farm. Essentially this is the amount of net income from the farm over and above necessary living expenses." The importance of living expenses to capital accumulation[a] and planning merits explicit discussion of future prices of living items purchased. This is not done in this bulletin and it is seldom done in similar bulletins that discuss financing and the use of farm credit. The bulletin covers the usual range of farm financing problems, that is prices, managing both on and off-farm investments, use of credit, reserves against risk and uncertainty, and insurance.

Several empirical publications exist on subjects that are related to the problem confronted in the present study, such as the farm family life cycle, beginning farming, accumulating capital on small farms, building up run-down farms, farm living costs and others. A brief reference to some of the more pertinent of these will be included in this review.

The problems of a beginning farmer are epitomized in the problems of capital accumulation. A good discussion of these problems appeared in a bulletin by Hansing and Gibson in 1955 (30). The objectives of the study were: (a) To discover how the initial capital investment in farms is acquired, (b) to determine the relation of the method used in acquiring the initial capital to the future rate of capital accumulation, and (c) to determine the effect of the size of initial investment, size of farm, age and education of the operator and the productivity of the soil upon the farmer's success in attaining full ownership.

The authors point out that a farmer usually makes a down payment

a. Using credit for expansion of the firm is merely accumulating capital in advance.

(previously accumulated) when he purchases a farm and assumes a debt contract for the balance. Thus, in attaining the goal of unencumbered ownership it is necessary to continue accumulating capital by savings from income. Frequently the ownership objective competes with accumulation of needed operating capital. Both require savings, so both are affected by economic conditions in the period required to pay off the debt.

A regression analysis was made of the effect of the following six factors on total amount of capital accumulated:

(a) The amount of initial capital invested, owned and borrowed;

(b) The size of farm (total excluding rented land) at initial ownership;

(c) The productivity of the soil;

(d) The operator's age at the time of acquiring initial ownership;

(e) The operator's education;

(f) The opportunity for accumulating capital as determined by the number of years the farm had been operated by the respondent and the general economic condition during this period.

Capital accumulation opportunity and soil productivity accounted for 39 percent of the variation in total capital accumulated; the other variables accounted for an additional 6 percent, and 55 percent was unexplained.

The authors describe an interesting device they used to compare economic opportunity among farms for which initial ownership was acquired at different times. An index was developed that "rests on the obvious truism that capital can be accumulated from supernumerary income only, that is, from income that is in excess of production expenses and needs for living". They developed a time series of estimates, for Virginia, of that part of individual farm income that is not needed for production and living expenses. Thus for each year an estimate was made of the average amount that could have been saved each year and the cumulative totals[a] were calculated for each year. To obtain the index the cumulative total for each year is divided by the supernumerary income for the base year, which is usually the year ending the period over which rate of capital accumulation is to be determined.

The authors were not attempting to project capital accumulation, explicitly, but they were obviously interested in the application of their findings to the future for individual beginning farmers. To utilize their "predicting" equation to make future projections it would be necessary to project the "economic opportunity" variable into the future. This would require a projection of "supernumerary income".

They may have accounted for more variability in total capital accumulated if they had included a variable for family size in their equation. However, some intercorrelation would exist between family size, operator's age and economic opportunity[b]. If a future study is made to utilize historical data suggested by the theory in the present

a. The total are accumulated backward through time from the latest year.

b. The living cost component of the last variable is related to family size.

thesis, a possible use of the Hansing and Gibson index of economic opportunity for capital accumulation can be visualized.

The importance of the farm household and its characteristics to the process of capital accumulation is one of the main themes of this thesis. Heady, Back and Peterson, 1953, published a report of a study that explored the effect of changes in the household on the production efficiency of the firm (37). Their chief concern in the study was the changes in quantity of and productivity of capital used by farmers as the household changes over its life cycle. The quantity of capital employed in production parallels the cycle of the farm family. Most young families desire to increase income but are limited mainly by productive assets. Capital productivity is high, diminishing as the firm-household approaches maturity at the zenith of the life cycle. Beginning farmers place a premium on investments in machinery, seed, etc. for cash crop farming because resources have a higher return and faster "turnover". Livestock farming is "grown into" as capital accumulates. The lower percent-age equity in the beginning stages inhibits use of longer term credit for livestock investment. As the firm-household gets older more intensive use of land is possible with accumulated non-land capital and operators are more efficient.

Accumulation of consumption assets occurs in the early part of the life cycle of the farm family. Thus, the competition between the firm and the household for use of capital is particularly strong in this stage. When asked how they thought farm income should be allocated between consumption and investment the farmer respondents in the study estimated about 50 percent to each. The estimates varied with age groups from about 54 percent to farm business at 25 years of (operator's) age to 47 percent at 55 years of age, and 35 percent at 65 years of age. This indicates the changing attitudes on consumption over the life cycle.

The growth phase of the firm-household covers a sizeable portion of the life of the operator, starting at about 25 years of age and going up to 47 or 48 on the average. This, the desire for the more productive inputs early in the cycle, the decline in capital productivity as the cycle develops and the early accumulation of consumer assets are all pertinent to a projection of capital accumulation.

In 1955 a study of capital accumulation on small farms in Georgia was published (38) which bears on the subject matter of this thesis. The data for the study were obtained from a sample of Georgia farm families who had used the government supervised credit program under the Farmers' Home Administration to purchase farms. Historical information for every year of operation on these farms was available.

The general approach is indicated by the following excerpt from the introduction:

> "The answers to...many...current farm finance questions - when stripped of their doctrinaire elements - must be found largely in the ability of farmers to save and to pay debts and in a knowledge of ways in which these abilities can be increased.
>
> ...In a strict sense, however, the ability to save and/or to pay debts depends upon both the size of one's income - not merely upon income added by a new investment[a] - and one's needs for income to meet sundry and often unpredictable living expenses.

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a. Here the author is referring to the common practice of taking the productivity of new investments as a measure of farmers' ability to pay debts incurred to make them.

> ...Furthermore, there is no mechanistic relationship between size of income and savings...saving is always a matter of choice, dictated by human purposes and valuations, between present and future uses of income. For this reason, the existence of goals for which savings are needed, combined with enough faith in one's ability to achieve these goals, to translate desires into purposeful action to achieve them, is necessary for savings to occur."

The majority of the farms in the sample started operations with very little capital and with fairly large families[a]. Over the ten year period of study, net cash income was about half of gross cash income and cash living expenses were about half of net cash income. This left the other half of net cash income available to use for debt payment, savings and investment[b].

An important section of the report is devoted to a study of factors affecting savings and debt-paying abilities. On these low income farms there was a need for emphasis on increasing production and income (to increase savings) rather than on "tightening the belt", that is, reducing consumption[c]. However, the author warns that with the wartime and postwar (World War II) increases in income accompanying price inflation, capital planning must receive attention. "The problem of getting ahead has become, to a larger degree than ever before, a matter of farm families' own choices between use of funds to buy automobiles, television sets, home freezers, or even more injudicious spending, and use of funds to make badly needed improvements in their

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a. Eleven percent had 7 or more children, 31 percent had 5 or more and 53 percent had 3 or more.
b. These ratios are higher than those indicated in the present study.
c. Low living expenses were associated with low incomes and low ability to accumulate capital.

farm production-improvements which will give them an income base that is far more substantial than a mere inflation of prices" (op. cit., p. 14, 15).

Operator's age was not associated with savings and debt-paying ability. Young, inexperienced farmers and older, experienced farmers exhibited about the same ability to pay for their farms and save. Also there was little association between beginning net worth and subsequent savings and debt-paying ability, or between acres of land in farms and this ability.

The most important factor accounting for variations in ability to accumulate capital was the way in which the farmers used their new opportunities (after obtaining FHA loans), as indicated by their kinds and methods of farming. Grade A (fluid milk) dairy farms had larger net incomes, higher living costs and more left for savings and debt payment than any other type of farm in the sample. Beef cattle - cotton farms were next, followed by poultry farms, Grade B (manufacturing milk) dairy farms, cotton farms and crop part-time farms in that order.

The authors recognize the inter-farm intra-farm problem of establishing causal relationship. Inter-farm comparisons "are helpful in narrowing investigation to the more relevant factors, but in establishing proof of causal relationship they have serious limitations unless there is a large degree of homogeneity except in the causal factor between the farms compared".

Another interesting observation made by the author, based on data presented, was that dollars invested in cost reducing practices (pasture and herd improvement) brought a greater return per dollar invested than output increasing investment (in adding to land milking herd and the barn). Also, increasing scale of operation may increase vulnerability to a market decline whereas reducing unit costs helps farmers to weather price uncertainties ahead.

The final section of the bulletin is concerned with applying the findings of the study to specified problems. "Pay-as-you-go" methods are compared with credit financing, with the consistent conclusion that credit enables more rapid capital accumulation, faster payment of debt and earlier unencumbered ownership of a farm, if the families actually save according to the ability to save indicated by the survey data in the study[a]. They conclude with a warning that farm families with low incomes can be helped with credit, given normal managerial ability, presumably, but it is important to resist high pressure salesmanship and advertising when purchasing input and living items and purchase only what is really needed.

A study of how tenant farmers get farms and accumulate capital was published by the U.S.D.A. in 1958, (15). The objectives of the study were quite similar to those in the study published by Hansing and Gibson in Virginia the previous year. They were (a) to examine the factors related to the access of opportunity to enter farming as a tenant and (b) to examine the forces that affect the economic progress of tenant farm operators. Economic progress was measured by change in net worth. Regression analysis was used to relate 9

a. It must be remembered that the data were obtained over a period in which cost-price relationships were favorable, i.e., product prices were steady or rising relative to input prices, not falling.

independent variables to the dependent variable, total capital accumulation since beginning farming. Of these 9, the most important in contributing to capital accumulation were, in order of importance: the size of livestock enterprise, opportunity to accumulate, years of experience as an operator, productivity of the farm measured by a crop yield index and size of farm measured in irrigated acres. Operator's age, beginning capital, operator's education and leasing arrangement were not found to be important (significant statistically). It must be pointed out here that size of farm and size of livestock enterprise are not causal factors of net worth. All three are different attributes of the same thing.

The author used an index of opportunity to accumulate capital that was constructed in a manner similar to the index devised by Hansing and Gibson. However, instead of using state statistics to arrive at income per farm available for savings, Crecink used farm record accounts maintained since 1924 by the Colorado Experiment Station. It is quite easy to see from such a series that the time at which the operator begins farming has an important effect on total capital accumulated over a period. This is mostly due to input and output price relationships.

Although tenancy arrangements had no statistical significance, paucity of data made this inconclusive. In a separate analysis of tenancy arrangements the author concludes that they also have an influence on the rate of capital accumulation.

In building up a run-down farm the problem is essentially that of capital accumulation, either to repay a loan or to build up the resource base paid for as the farm business grows. In 1956 Blosser reported a study of this problem for run down dairy farms in Ohio (3). Budgeting was used to estimate the receipts, expenses and net income for rebuilding the productive capacity of a run-down farm. Input-output data were obtained from three previous studies of land use and crop production in Ohio. A 13-year projection was made of capital (by major components), receipts and expenses. The author does not state which year the projection begins, presumably it is about 1955 or 1956. Prices used for calculating incomes for the projection were 1950-54 averages. No adjustment was made for changing price levels of inputs or output over the 13-year projection. The allowance for living costs was $2,500, with no adjustment for rising price levels.

Blosser's main contribution in the study was to point out the importance of quality of management to the rate of capital accumulation. Top grade management (associated with an annual average output of 10,000 pounds of milk per cow) could pay for soil building operations in a few years. If he allowed 4 percent interest on capital needed he could allow himself more than customary wages after the third year. With average management (7,000 pounds of milk per cow) 12 years would be required before the program would pay labor and capital only slightly more than average rates. Thereafter, financial reserves would accumulate so slowly that about 45 years would be needed to pay all previous costs. Even if they owned all needed capital and charged nothing for the use of it, they would not be able to pay themselves average farm wages until the seventh year of the soil improvement program.

With repayment of principal and interest charges necessary for loans, it was difficult (for Blosser) to imagine how an average farmer could borrow any sizeable amount of money on the soil building program studied. He concluded that some off-farm income would be necessary to enable average management to finance the early stages of a soil improvement program. Below average management would have an even more difficult time financing such a program.

Whether results would have been more or less favorable had Blosser attempted to be more realistic with living costs and price trends cannot be judged without re-budgeting under these conditions. In any case, the effect of management level as he depicts it would still be important, as it may be expected to be in all problems of capital accumulation.

Since 1937 the University of Illinois has been summarizing combined home account and farm account records for selected groups of Illinois farm families. Family income, expenditures and savings were summarized for each year from 1937 to 1956, inclusive, in their annual 1956 report (23). Although the expenditures are itemized in reasonable detail there is no way to relate them to gross income or total input capital. Even to relate them to disposable income[a] one must rely on annual averages for the entire group. This destroys the pattern observed on each farm.

The data have some predictive value if an estimate of disposable income is available for the prediction period. For example, the total income saved and invested as a percentage of disposable income tended to rise from 25.9 percent in 1951 to 41.6 percent in 1956, with

a. Referred to as "cash family outlay" in the publication.

considerable variation around the trend. Total family expenditures on living increased from $3,370 to $3,924 but declined percentagewise from 61.5 to 52.6. Trends in such percentages could be fitted for use in projecting probable future allocation of disposable income. However, if regression analysis were used to obtain the average of the pattern of relationship existing from farm to farm the projection would be more reliable. Even more useful would be the historical pattern of annual resources, income, expenditure and investment on each farm.

The 1956 analysis points out that "as usual, the peak load on family income came during 20-24 years of marriage...reflected the increased needs of children over those of the previous period, 15-19 years of marriage. The lightest load came on newlyweds and those couples married 35 years and over.

The author makes a statement that does not agree with findings of an earlier study by Longmore and Taylor (46). She states: "The variation in farm income from year to year makes it difficult for the farm family to judge just how much will be available for family use unless they make their plans on the basis of past records of both farm and family accounts. ...the amount of money required in the farm business for such items as new buildings, machinery, and livestock also affects the amount that will be left for family use". This implies that the part of net income available for family living is a residual left after the requirements of the firm are met. These requirements are for new investment, since operating expenses have already been paid of necessity before net income accrues.

Contrary to this, Longmore and Taylor demonstrate from selected data, a tendency of the level of living to which farm families are accustomed to be a standard which they tend to maintain. This tendency is so strong that it greatly influences investments and savings and, to a considerable extent, expenditures for production. Of the three major expenditure groups - farm operations, family living, and investments or savings - for which farm families utilize their yearly incomes, those for farm family living are the least flexible and tend to have the top priority[a]. On the basis of this conclusion it is reasonable to expect that, in any projection of capital accumulation in the firm-household context, the family living expenditure component would be the most stable component of the projection, with which less predicting error would be associated.

This priority placed on living expenditures increases risk of default on repayment of loans to low income farms. Hendrix' study indicates an "understandable reluctance" on the part of low-income families to postpone the "better life" until much capital formation has taken place. If external capital is needed to help low income farms, care must be taken to insure that managerial ability is increased to accomodate the capital so that incomes can grow fast enough to repay debt and satisfy their high marginal propensity to consume at the same time. This may also require a considerable amount of capital. In the past capital formation from internal sources was largely confined to inflationary periods for farm prices. The prospects for farm prices

a. This agrees with Modigliani's observation (see p. 71 above).

in the early 1960's are not favorable (47, p. 70).

Many publications are available on farm living expenditures per se. As early as 1934 University of Wisconsin reported a study of the effect of the life cycle of farm families on living standards and income-getting ability (42). The study shows that the amount which families had to spend for purchased family living items varied relatively little (less than $250) through the stages of family development. Total amount of family cash used for all purposes was distributed as follows, for grade school families:

Cash farm expense	53.0 percent
Capital goods increase	1.2 percent
Debt payment	.5 percent
Expense on outside business	1.1 percent
Purchased family living	34.6 percent
Family cash surplus	9.6 percent

This varied somewhat among the different stages of family development. A total of 11.3 percent appears to be available for "plow-back".

The U. S. Department of Agriculture Yearbook for 1940 contained an article on family living (53). The different components of family living expenditure were outlined and discussed. Average living expenditures in the income range $1,000 - $1,249 (average $1,127) were $1,137 and in the range $2,500 - $2,000 ($average $2,716) they were $1,939. This was for all non-relief farm families in U.S.A. in 1935-36, in the select ranges. The money incomes for these two groups were $634 and $2,028 respectively, and the money expenditures were $644 and $1,251. Thus, cash savings were -$10 and $777.

A publication by the U. S. Department of Agriculture in 1948 (77) shows that according to 1945 data, farm families in lower income areas save more at the same level of income than those in higher income areas. In the region of low incomes (South Atlantic and Southeast) at net cash incomes of $1,000, $2,000, $3,000 expenditures for family living and life insurance were approximately $420, $590 and $630, respectively. For the same net incomes in the region of high incomes (Mountain and Pacific) the comparable expenditures were $785, $920 and $1,045 respectively. These figures also indicate the relationship between savings and income that year.

Several state land grant colleges have conducted studies of farm family living costs from time to time. Reports of four of these will be referred to in this review. In 1949 a study of income and expenditure records of 322 Kansas farm families for the years 1941-1945 was published (29). The average size of family was 3.86 members. The average annual net income for the five-year period 1941-1945 increased as family size increased, although the net cash farm income was not associated with family size. Net cash income as a percentage of gross cash income averaged 27.9 percent. Cash living costs, excluding life insurance, averaged 47 percent of net cash income. There appeared to be a positive relationship between family size and the ratio of living costs to net income. Also, for the years 1934-45 there was an evident relationship between net cash income and cash living costs. It was also apparent that cash living expenditures were more stable, over the twelve year period, than net cash income. No attempt was made to project future living costs or income-living cost relationships by analyzing factors causing variability in these items.

In 1954 an Oklahoma bulletin was published that attempted to determine causal relationships associated with levels of living (20). The objective was to study the relationships between economic changes and changes in levels of living. Most of the economic changes that had increased levels of living could be said to have increased farm income. The swing from field crops to pastured livestock (and other labor reducing methods), the increase in size of farms, technological improvements, loss in farm population, hiring outside labor and machinery, and rising levels of education are all changes that increase net income per farm family. In fact, the author says, in effect, that full satisfaction of farm family social needs depends upon maximizing profits. So, this reviewer concludes that causal analysis and adjustments focused on improving net income per farm family on the farms represented by the sample, should automatically improve levels of living. The old orthodox criterion for optimum organization of resource, that is, the maximum profit criterion, is still valid.

The author states that his study raises two problems of the relationships between levels of living and agricultural organization, that are crucial, (1) the inevitable lag between and adjustment (of resources, presumably) and its reflection in levels of living and (2) to improve living levels of the whole farm population (in the State) many factors must be taken into account, e.g., climate, land fertility, distances to market and numerous other considerations that are likely to create inertia and friction, to impute improvements in family living. In economic terms this reviewer considers these two problems as part of the general problem of resource mobility, or immobility, affecting agricultural adjustments to bring about higher disposable incomes per farm family. The point that is relevant to the present thesis is the implication that variables used to predict net income may also be useful in predicting living expenditures.

A study of savings based on aggregate data for the United States was published by Bishop at Cornell in 1954 (2). The author is more concerned with macro-economics and devotes several pages to the theory of savings and to defining savings from the viewpoint of national accounts. In a discussion of rural-urban differences in saving she shows that farm families did not save as much (in 1935-36) in dollars per family or per capita as non-farm families but they saved a higher proportion of their income[a]. The proportion saved was 11.4 percent. Data presented for farm families in 1941 show saving began at about $1,000 net income and the proportion saved increased rapidly as incomes increased from 2.7 percent for average income of $1,157 to 40.9 percent for the average income of $4,491. This means of course that expenditures on living increased but in decreasing increments. The effect of family size on savings by income groups was shown. It can be summarized as follows:

Family Size	Income groups 750 - 1,000	1,500 - 1,750	2,500 - 3,000	5,000 - 10,000
		- percent saved -		
2 persons	1.5	24.1	40.0	57.6
3-6 persons	-9.0	10.1	29.6	51.8
7 or more persons	-7.2	3.2	17.5	52.4

a. This agrees with Modigliani's observations (see p. 71 above).

The effects of both family size and income are clearly seen in these aggregate data for farm families (U.S.A., 1935-36). This implies that both have a similar effect on living expenditures.

The author briefly reports some pertinent results of several other studies and provides a five-page bibliography on the subject.

Professor Freeman in Illinois has done a considerable amount of work on farm family spending and saving. Continuous firm and household records have been kept by farm families in Illinois for many years. In 1955 the University of Illinois published a summary analysis by Professor Freeman of the spending activities of these families (22). One of the objectives of the study was to determine whether these farm families had developed a pattern of savings and spending that could be useful to other farm families and to researchers. The sample is not representative in that the co-operating farmers generally have above average incomes and are above average in the care with which they manage their disposable income. Averages are presented for the main living expenditure and savings items for each year from 1933 to 1950, so that trends in each item relative to others can be determined and were indicated by the author.

Unfortunately the reader cannot obtain an idea of how much net income was "plowed back" into the business each year, since Freeman's term "savings" excludes all investments in the operation of the farm business. This exclusion stems from a major interest in the activities of the household and a failure to consider the firm-household as an integrated spender and saver of net income. They do include, however, purchases of land and principle payments on debts, most of which was investment in the business. The money allocated according to Freeman's various items of expenditure and saving is equal to net cash income *after* certain new investments in the business and other business expenses have been subtracted from gross income. It also includes income from all other sources. Nevertheless, for purposes of this thesis the study is useful for calculating a "propensity to consume", that is, it shows how farm families spend the income they do receive on living expenditures. From this knowledge one can infer similar behavior with income defined otherwise and can estimate the residual available for saving or investing back into the business.

The percent spent for family living, e x cluding life insurance, which is included in savings, decreases as incomes increase. For the post-war years 88-89 percent of income went to family expenditures at the $1,000 - $1,999 income level, while only 65-66 percent was spent at the $4,000 - $5,999 levels. In pre-war years, at the same income levels, the percent spent was 78 and 42 respectively, indicating an increasing pressure on incomes of rising living levels since World War II.

One of the conclusions in the study was that five categories of expenditures - purchased food, household operating expenses, clothing, transportation and education - tended to be inelastic, that is, the percentage spent on these decreased as net cash income increased. Medical expenses, personal expenses and furnishings and equipment tended to remain constant, percentagewise, while expenditures on recreation, gifts, and housing improvements and repairs tended to be elastic, that is, they tended to increase percentagewise, as net cash income increased. This indicates the categories that would be most difficult to reduce should a need for economizing arise in the future. The classification also takes on added significance in relation to Friedman's concept of permanent and transitory components of consumption.

From 1933 average family expenditures (for all farms in the sample) increased slowly while savings increased much more rapidly until they were at a peak in 1943. From then until 1948 savings declined steadily as net cash income remained the same (but extremely variable) and family expenditures increased rapidly. Income tax remained fairly steady from 1943 to 1948. These data are now 10 to 20 years old but they show the beginning of the trend for rising living levels to press against net income, at the sacrifice of savings, that has continued since 1948[a].

Family living expenditures and investments were integrated with gross farm income and expenses in a study done by Professors Freeman and Deacon and published by the University of Illinois in 1957 (24). The purpose of the study was to give farm families some basis for planning living expenditures. Net income had not been satisfactory. "They do not appear to base this year's spending on last year's net income, and they cannot know this year's net income until after the

a. Averages for 1949-1953 of data from the same farms show that 87 percent of disposable income went to family expenditures at the $1,000 - $1,999 income level and 69 percent at the $5,000 - $6,999 level (39).

decisions and the spending for farm expenses and other purposes have taken place." They needed some way to plan current spending in relation to current receipts. Current attention was being focused on relating family expenditures to gross cash receipts and the object of this study was to add to the understanding of this relationship to assist farm families to improve their money management.

Data were obtained from accounts kept by 48 farm families for a period of 16 years. It was found that, in allocating gross cash receipts to farm expenses, investments and family cash living expenditures, the living expenditure component was the most stable of the three, varying considerably less than the other two, both in dollars and percentage. Correlation coefficients were calculated to determine the association between gross cash receipts and each of the three expenditure categories. This also was done for grain farms, general farms and livestock farms. Age of operator was also considered, on livestock farms only. In all cases farm expenses were related more closely to gross cash receipts, the correlation coefficient "r" = .93 for all 48 families. The coefficient was lowest for operators 40-49 years of age (in 1938) on livestock farms, being .79. For family cash living expenses r = .56 for all farms and ranged from .78 for general farms to .22 for operators 50 years or over (in 1938) on livestock farms. For investments, r = .44 for all farms, varying from .34 for general farms to .62 for livestock farms with operators 40-49 years old in 1938. Farm expenses varied more than family living expenses but less than investment. Cash living expenses represented about 20 percent of gross cash receipts and nearly 49 percent of net cash income.

In analyzing the effect of fluctuations in gross cash receipts it was found that family cash living expenses were somewhat less responsive to increases in receipts than were farm expenses and investment but considerably less responsive than the other two when receipts decreased. This agrees with Longmore and Taylor's article earlier in this review. Farm expenses tended to have the closest relationship to increases in gross cash receipts and investments corresponded more closely to decreases in receipts.

This type of historical data is what is needed for projections of capital accumulation. However, it is necessary to derive probability estimates of parameters from such data to actually construct the projections.

Further analysis of the expenditures of these Illinois farm families was published by Milican in 1959 (49). By factor analysis he selected six stable factors from among 36 variables, namely, family size, older family, age and marriage cycle, savings, education and income, to test their relationship to family expenditures in a given year or over a period of years. A change in importance of family size over time was indicated, which is to be expected as children mature and leave the household. The "older family" factor was sporadic over time due to the changing requirements of children in their later 'teens and possibly due to part-time earnings of these children being used to pay some of their own minor expenses. The age and marriage cycle was the most stable factor over time. The savings factor indicated wide fluctuations over the 12 year pattern. The education factor (husband and wife) was also stable over time. The income factor was not consistent for the first three years of the period, that is until 1949, attributable, according to the author, to the domination of expenditures by past income in the last few years of the 1940 decade. There was a consistency between income and savings.

The authors conclude that (1) the analysis does show a fairly definite pattern of factors over a period of time, the most steady being the aging process, since it is the one about which the family can do nothing, and (2) in few instances is there a consistent pattern of expenditures (on various goods and services), which indicates a high degree of error in any attempts to project such a pattern into the future.

The latter finding is not important to this thesis but the aging factor is, in that it is closely related to household size over time, which is one of the variables to be tested for estimating living expenditures.

The final publication dealing with living expenditures and reported in this review is the one by Brake and Holm (7) on the influence of household size and income on farm family expenditure. By regression analysis they tested the relationship of these three variables. They found that by relating family expenditures to household size and income, estimates of family expenditures could be improved significantly over the use of family averages. Size of household was relatively more important than income in its effect on basic expenditures (food, housing, clothing, medical expenses, education and recreation, transportation, personal, non-farm interest, insurance and dues) and total expenditures, but that income was the more important in its effect on non-basic, less regularly recurring expenditures (contributions, gifts, non-farm business expenses, if any, non-farm investments and related expenses, purchase of equipment and furnishings and automobile purchases).

The authors state that "... a good estimate of family living expenditures is basic to an analysis of debt carrying capacity. There is strong evidence that families tend to maintain a given level of family living based on family size. Savings or new investments cannot be achieved until family living expenses are met".

The concern of this thesis with regard to income is the problem of projecting net farm income. Every study of resource use from the viewpoint of the farm firm, involving budgeting, production function analysis or linear programming, is explicitly or implicitly attempting to project net returns of some type. Far too much literature exists on the subject to attempt a review here. However, there is one study reported in which the author has used regression methods to estimate net income which may offer some lead to refinement of the method used in this thesis. Bolton (4) devised a method which subtracts a set of synthesized costs, estimated for each farm in a sample, from farm receipts for that farm. The costs were broken down into three groups and multiple regression methods used to estimate the cost component contributed by each. The three estimates were added to give a total cost to subtract from receipts. The net income thus estimated for each farm was subtracted from the actual net income for the farm and these differences were used to determine (a) the percentage of variance in net income explained by the independent variables and (b) the standard error of estimate. More than 85 percent of the variance in net income was thus accounted for. The independent variables were: (a) acres of the main cash crop (cotton), (b) acres of other cash crops, (c) investment in livestock, (d) yield of the main cash crop converted to dollars and (e) yield of other cash crops converted to dollars. Costs were used as the dependent variable.

Farm receipts were calculated in the usual way. Bolton does not indicate how future farm receipts are to be estimated, for a projection of net income, but it is evident that the estimate could be closely related to the five independent variables used to estimate costs.

The problem in using this method to estimate net income for projecting capital accumulation (in the firm-household context) is how to determine the effect of "plow-back" on the independent variables and on the estimate of farm receipts for the succeeding year. The effect would depend on the specific resources in which "plow-back" is invested.

A good deal of work has been done on living costs and saving, and this review has presented a cross-section of this work insofar as it relates to the subject matter of this thesis. It is evident that very little of this work is really approached from the viewpoint of integrating the decision problem of the firm and the farm household. There appears to be a slowly growing recognition of the importance of this approach to longer run farm planning. It is to be hoped that the tempo will increase in the future.

CHAPTER IV

EMPIRICAL TESTING OF HYPOTHESES

The Purpose of This Chapter

The development of the model in Chapter II, for projecting capital accumulation, involves certain key parameters which are based on fundamental assumptions that require verification, if the model is to have a utility other than for mental exercise. Those assumptions which this study will test were stated as hypotheses at the conclusion of the chapter. Although they do not provide a complete testing of the conformity of the model to reality, they do subject its major components to empirical verification or rejection. If the selected hypotheses can be accepted, more confidence can be placed in the projection provided by the model in that it will be closer to the real outcome than would a random estimate, and just as close as a budgeted estimate based on the same basic data. The model can save considerable time and effort compared with a budgeted estimate.

The purpose of this chapter will be to expose the selected hypotheses to empirical verification and, in the process, to establish application. The data used will provide tests under particular circumstances rather than general so that the application will be localized, and generalizing from the results must be done with caution. Perhaps of more interest, however, is the fact that the same procedure may be used with similar data for local application under different particular circumstances.

Parameters to be Tested

In the model it is clear that the following are fundamental:

1. The relationship between net income and total input capital - this relationship was expressed as a ratio k_N, and as a regression coefficient, b. The ratio k_N can be determined from a function fitted to farm data but, unless that function passes through the origin, k_N will change values according to the changes in the independent variable. Thus the model was modified to use the regression function directly. The parameters of main interest here are the regression coefficient and the N-intercept.
2. The relationship between living costs and two other variables, net income and family size - here again the focus will be on the parameters of the regression equation and not k_L, because the latter is likely to change with a change in the independent variables of the regression function, and because in application the model does not require k_L, but can use the regression parameters.
3. The relationship between gross income and total input capital - this relationship is necessary for the application of adjustments to the model because of projected changes in levels of prices of inputs and outputs. The likelihood of a changing ratio (k_R) of gross income to capital as the latter changes makes it necessary to focus on the parameters of the regression relationship between

those two variables.

To determine whether or not relationship 1 and 2 tend to be linear or curvilinear, straight line and curvilinear functions will be mathematically fitted. On the basis of preliminary visual inspection of the plotted data, the following functions will be used:

(1) $N = bA+a$

(2) $N = aA^b$

where N is net income and A is total input capital;

(3) $L = cN+d$

(4) $L = dN^c$

(5) $L = cN+bS+d$

where L is living expenditure, N is net income[a] and S is family size.

(6) $G = gA+k$

where G is gross income and A is total input capital.

These functions allow for either constant or diminishing relationships. With regard to the net income and gross income functions it is recognized that, for growing firms, there is the possibility of increasing returns to scale. Unfortunately data were not available to establish just where growth ceases[b] and to determine the relationship between net income and total input

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a. As will be seen later, a modification of net income defined as disposable income will be used, instead of the net income in equations 1 and 2.

b. This problem, in itself constitutes a study project of considerable proportions.

capital over this phase of the firm. However, the data were obtained from farms most of which were well within the growth phase. It is well known among observers of farm firms that there are many operators not yet retiring who are 60 years old and who are operating vigorous going concerns. Most of the firms in the sample, and in any random sample of farms for that matter, were striving to maximize income under the limitations placed on these efforts by the resources available.

For purposes of this study it is not necessary to test the rate of capital accumulation actually occurring in the various stages of the firm-household, and to explain why accumulation is not maximized. The purpose here is to determine the possibilities under usual production of net income and the usual consumption of income available for spending. In this sense the application of the model is normative; if it were positive, it would require data to show the actual rate of capital accumulation observed and an explanation of the departure, if any, from the possible rate.[a]

There is one other point that must be made regarding the

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a. It is necessary to distinguish here between possible or maximum capital accumulation under average production and consumption and the accumulation possible under optimum production and consumption. The former case takes the existing combinations of resources as given and assumes that the operators are maximizing net income and utility under existing conditions. The latter case does not accept the existing combinations as those that maximize income under existing conditions, so that not only is it necessary to solve the problem of maximum capital accumulation but also the problem of maximizing net income. The present thesis chooses to study the former case.

functions to be used, that is, that over the range of the data the difference between a linear and a curvilinear description of the data is not likely to be significant[a], but this should be demonstrated empirically.[b] If the linear regressions can be accepted they are much simpler to use in the projection model for capital accumulation.

The effect, on the net and gross income parameters, of varying resource combinations will be tested by stratifying the sample according to type of farm and determining the effect of each type on the relationship between income and total input capital. There is no logical reason to conclude that type of farm, per se, has an effect on the relationship between living expenditures and net income available for spending, so no such effect will be tested.

The effect of soil variability on the net and gross income parameters should be tested by stratifying the data according to soil types within each type of farm, thus holding constant the effect of types of farm. However, it will be seen that the sample used to provide data was too small to permit this sub-stratification. If type of farm has no significant effect on the parameters it may be possible to pool the data and stratify the whole sample by soil type. This will be discussed further in the section dealing with the effect of woil variability.

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a. This is the main reason why the question of returns to scale in agriculture has not yet been settled.

b. The same can be said of a function showing increasing returns to scale, which diminishes the seriousness of the omission of such a function from the analysis.

Source of Data

In 1957 a project was initiated at Oregon State University to study the problems involved in rating the soils of Marion County, Oregon, according to their economic productivity, and to rate these soils on the basis of the findings of the study. The basic problem in establishing an economic rating of the various soils was to determine the residual return to the land, having paid all other factors of production, under normal cropping practises and input-output relationships. Thus the basic unit of study was the soil-crop combination, a great variety of which is found in Marion County.[a]

In determining the input-output relationship (costs and returns) for soil crop combinations it was realized early that very few farms in the county would consist entirely of a single soil-crop combination. This meant that certain inputs and outputs, particularly inputs, measured only in terms of the total farm, had to be allocated in some way to the various soil-crop combinations found on that farm. Thus, although the main focus throughout the study was on the individual soil-crop combinations, it became necessary to make a preliminary study of whole farm units to determine how the soil-crop combinations were integrated into the total farm operation (41, p. 63, 65).

It was realized that the type of information required in this preliminary study could be used to test some of the major hypotheses arising in the capital accumulation model with which the present

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a. The approach to the problem is described in detail in a doctoral dissertation written by S.C. James in 1961 (41).

thesis is concerned. Specifically, the "usual" costs and returns data required for the productivity study provide the information on input capital and net returns useful for this study. It was decided to use these data, supplemented with information on living costs, for purposes of this thesis. Since no historical information of the type ideally suited for testing the model developed herein was available, it was necessary to substitute cross-sectional farm business data of the one-call survey type, to simulate the intra-firm effect of secular growth of total input capital on net income.

As everyone who has participated in a one-call farm business survey knows, (a) there is a limit to the size of the questionnaire that can be used, i.e., to the amount of information that can be obtained from a farmer respondent in the time he has available to answer questions, and (b) the questionnaire in a study of this type can very easily grow beyond a reasonable size for an interview. This is particularly true when attempting to obtain data for more than one study. In such cases "competition for space" in the questionnaire is inevitable and paring of the schedule must be done on the basis of the study having the highest priority. Such was the case with the present study so that the data available suffers in some respects from detail sacrificed in the interests (a) of time and research resources and (b) of the primary study. However, as will be seen, the data obtained are very useful in testing the basic hypotheses of the capital accumulation model developed in Chapter II, although they do provide a basis for only limited generalization. This will be clarified below in the section on sampling.

The Sampling Area

Criteria for the sample were derived from the soil productivity study's main objectives. Marion County, because of the great variety of crops grown there and the variability of its soils, appeared certain to provide every problem that might arise in attempting to develop techniques for rating the soils of an agricultural area according to their economic productivity. For purposes of this thesis this county also offered a variety of farm types and sizes from which to draw a sample. Other advantages were: the availability of up-to-date aerial photographs and a recent delineation of farms by the Marion County Agricultural Stabilization and Conservation Service.

The county is located[a] south of Portland, Oregon, the northern tip being some 15 miles south of that city, with the southern border running east and west some 50 miles further south. Salem, the capital city of Oregon is located roughly at the center of the western half of the county, mostly in the Willamette Valley, the eastern half being mountainous.

The soils of that portion of the county where farming is carried on have been grouped according to physiographic factors into four main groups: (1) upland or hill soils, (2) terrace or

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a. See map, Figure 5.

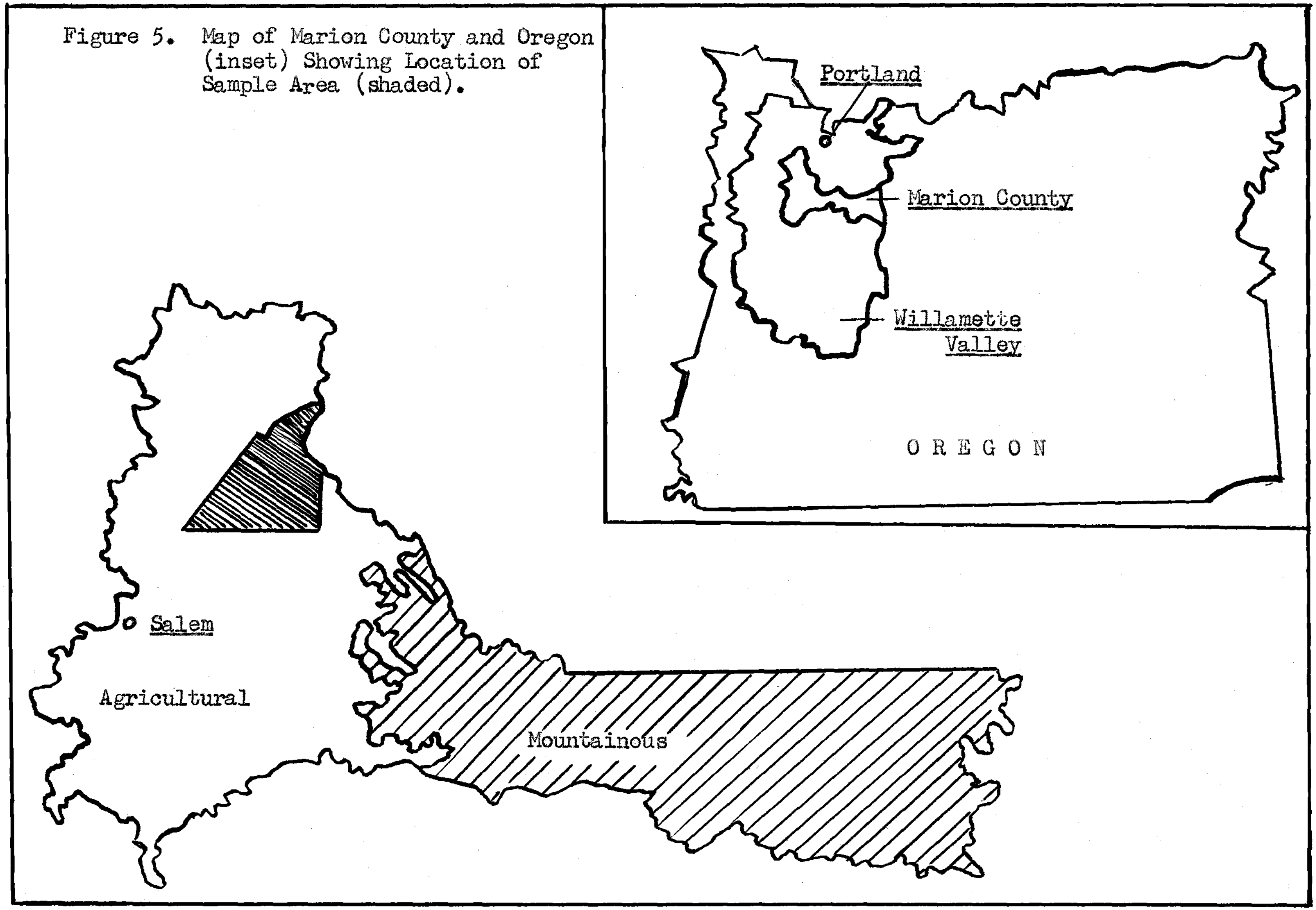

Figure 5. Map of Marion County and Oregon (inset) Showing Location of Sample Area (shaded).

bench soils, (3) flood plain or bottom soils, and (4) muck or peat soils. The upland soils are from basaltic parent materials and are well drained. The terrace soils constitute the main valley areas and are from weathered old alluvial sediments. They are moderately well drained. The bottom soils are from alluvial parent material of more recent origin. They are subject to flooding and are not usually as well drained as the terrace soils. The peat soils consist of accumulated organic matter in various stages of decomposition. They are subject to annual flooding. These groups are made up of 32 soil series, 16 of which encompass the majority of cropping land in the county. The estimated distribution of cultivated land by these main soil series is shown in Table 3[a].

The climate of Marion County is very favourable to the production of a wide variety of crops. The normal annual precipitation is about 42 inches on the west side of the main agricultural area and approximately 55 inches on the eastern side. The three summer months of June, July and August have very little rainfall so that supplementary irrigation is required for many of the intensive crops during that season. The frost-free period averages a little less than 200 days, varying with the altitude of a particular location. The average dates of the first and last frost at Salem are April 14 and October 28, respectively. The temperature rarely rises above 100° F. or falls

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a. A summary description of each of these soil series is given by James (41, p. 218-227.)

Table 3. Estimated total and cultivated acres of selected soil series in Marion County, 1958.[a]

Soil series	Total cultivated acres
Riverbottom	
Chehalis	18,500
Newberg	11,000
Wapato	6,000
Terrace soils	
Willamette	17,000
Woodburn	48,000
Amity	48,000
Concord	9,000
Dayton	9,000
Salem	4,500
Sifton	2,500
Clackamas	7,500
Hill soils	
Jory	21,000
Aiken	12,000
Polk	26,000
Sublimity	16,500
Muck soils	
Labish	19,950

a. Based upon estimates arrived at from survey data. (41, p.56)

below 0° F. Catastrophic weather phenomena are virtually absent.[a]

The area from which farms were sampled for the 1957 preliminary study, the data for which are used in this thesis, is located in a

a. The information on climate was obtained from S.C. James doctoral dissertation (41) triangular area between Mount Angel and Woodburn, on the eastern side of the main farming area of the county.[a] This area was selected because a new soil mapping, superimposed on aerial photographs, had just been completed there and most of the major series were represented in this area. The area also produces a wide variety of crops representative of many produced elsewhere in the county. Thus it afforded a fruitful source of major soil-crop combinations for initial study in the soil productivity project. Being on the eastern side of the agricultural area, the average annual precipitation is somewhat higher than on the western side of the county but not much higher than the average for the county farming area taken as a whole. Because of the variety of soils and crops in the area, the types of farming conducted there are reasonably representative of much of the farming in the county.

The main reason for selecting the area was because of the completion of the up-to-date soil mapping and the important information available therefrom. Unfortunately, the new mapping of the hill soils had not yet been completed and they were therefore omitted from the preliminary study. For purposes of this thesis this was not considered a serious limitation, because enough variety of soil and farm types exist in the area selected, to provide data for testing the hypotheses suggested by the model developed herein.

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a. See Map, Figure 5.

Sampling Procedure

The basic sampling unit in which the soil productivity study was interested was the soil-crop combination. On the soil map of the sample area, which had been superimposed on aerial photographs, each field that was made up entirely of a single soil series was delineated. A field was defined as a well delineated area appearing, in the aerial photograph, to produce only one crop. It was recognized that changes were likely to occur between the time of the photograph and the survey but it was assumed that, in general, the field boundaries would not have changed and that a particular field would still be producing a single crop, even though the crop may have changed.

It seemed reasonable to assume that each field thus delineated belonged to a farm, so the associated farm was next delineated and the headquarters located on the map. The farmers' names were obtained from records in the Marion County Agricultural Stabilization and Conservation Office. The farms were then listed according to the soil series for which they had been selected. If any farm had more than one soil series represented in the fields found on that farm, the farm was listed according to the soil that appeared in the most fields or the largest fields on the farm.[a] The farms were then randomized, from a table of random numbers, within each soil series.

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a. The criterion of a field being completely composed of one soil series was maintained.

Because of limited resources available for the preliminary study it was decided to limit the sample to 100 farms, to include the major soil series. These were allocated in proportion to the size of the lists of farms in each major soil series. Accordingly the sample was distributed as shown in Table 4.

Table 4. Distribution of proposed sample of farms according to soil series, preliminary soil productivity study, Marion County, 1957.

Soil series	Number of sample farms	Number of alternates
Willamette	30	15
Amity	20	10
Concord	15	0
Woodburn	20	15
Chehalis	8	5
Wapato	7	5
	100	50

The farmers were interviewed to obtain information on actual and usual inputs and outputs for crop enterprises on their farms where a whole field was composed of only one soil series. The number of these soil-crop combinations per farm interviewed varied from one to three. Information also was obtained for the whole farm on farm inventory values, operating expenses and receipts, usual yields, information to enable the calculation of depreciation, income from outside sources, living costs, reserves and available credit.

During the course of enumeration a running record of soil-crop combinations was kept and when enough of a particular combination had been obtained, no more farms having only those combinations were visited for interviews. It frequently occurred, however, that, to obtain a record from a farm that had a soil-crop combination that was needed, it was necessary to accept the other soil-crop combinations on that farm, whether they were needed or not. Since most of the farms had coarse grains and many of them had small fruits, the final sample contained a surplus of these soil-crop combinations. At the same time there were shortages in others.

For purposes of this thesis, this is not relevant. What is more important, however, is the fact that, although any selected farm for which an interview was completed had at least one field with a defineable soil series, this frequently was a minor part of the crop-land. In these cases, as a result, the whole farm could only be classified as being located on soil that was predominatly of a different series, or a mixture of series that differed from the series on which the selection of the farm was based. This interjected a confusing element into the sampling procedure as it concerns this capital accumulation study. Fortunately, soils tend to be associated together on one farm in similar series so that there was a tendency for the soils on the whole farm to be similar to the soil series in the field by which the farm was selected. Nevertheless, the farms available from the sample for stratifying by predominant soil type, are not distributed according to the distribution in Table 4.

It is considered herein that the sampling and interviewing procedure did not interfere seriously with the randomness of the sample. In randomizing the lists, stratified by soil series, the whole list was randomized and then the required sample numbers were first selected followed by the alternates from the farms following the selected farms in the listing. Thus each farm on each list had and equal chance of being selected, including the alternates used.

However, the lack of correspondence between a field selected for sampling and the predominant soil type on the farm possessing that field, breaks down the original proportionally of the sample, so that, if we consider a farm to be the sampling unit, about all that can be said of the sample is that it was selected randomly. It is not "prestratified" by soil series, by type of farm, by size of farm or by any other criterion, except insofar as the tendency holds for the predominant soil series on the farm to resemble the soil series in the field by which that farm was originally selected. Also there is a good possibility that a tendency exists for soil series to influence the type of farm, and insofar as this is true some "pre-stratification" by type may exist in the sample. However, this is all to the good since stratification by type is necessary for testing some of the hypotheses in Chapter II.

Altogether, only 70 complete records were obtained. Of these, 66 were suitable for use in the present study. The distribution of these farms by the soil type predominating on the farm is shown in the following table:

Table 5. Distribution by soil series, of sample farms providing useful records, preliminary soil productivity study, Marion County, 1957.

Soil series	Number of sample farms
Willamette	11
Amity	14
Concord	3
Woodburn	9
Wapato	1
Willamette and Woodburn	10
Amity and Woodburn	9
Chehalis and Willamette	2
Chehalis and Amity	1
Mixed	6
	66

From Table 5 it is apparent that only three groups may be suitable for testing the effect of variation in soil series on the relationship between net income and total input capital and between gross income and capital. The other seven groups have either too few farms or mixed soil series, both of which prevent a suitable statistical testing of the effect of soil series. The table also shows that the 66 farms tend to be distributed according to soil series in a pattern similar to the sample distribution planned (Table 4), although the Concord, Chehalis and Wapato series are poorly represented in the sample used herein.

A comparison of the percentage distribution of the sample farms, according to total acreage, gross sales, type of farm and age of operator, with the percentage distribution of the 1959 Census figures for Marion County will also help the reader to assess the representativeness of the sample. (Tables 6 to 9)[a]

Table 6. Distribution by total acreage of census[a] farms and 66 sample farms, Marion County, 1957.

Total acres	Sample farms	Census farms
	percent	percent
Less than 10	-	14.6
10 - 49	33.3	39.9
50 - 99	27.3	18.2
100- 179	27.3	13.4
180- 259	7.6	5.5
260- 499	4.5	6.1
500- 999	-	1.9
1,000 and over	-	0.4
	100.0	100.0

a. Percentages are calculated from the 1959 census. There were 3,788 farms reported for Marion County.

Table 7. Distribution, by gross sales of farm products, of census[a] farms and 66 sample farms, Marion County, 1957.

Total sales	Sample farms	Census farms
dollars	percent	percent
40,000 and over	1.5	10.0
20,000 - 39,999	10.8	13.7
10,000 - 19,999	40.0	18.8
5,000 - 9,999	35.4	23.8
2,500 - 4,999	9.2	28.0
50 - 2,499	3.1	5.7
	100.0	100.0

a. Percentages calculated from the 1959 census figures.

a. Census figures were obtained from James doctoral dissertation (41)

Table 8. Distribution, by type of farming, of census[a] farms and 66 sample farms, Marion County, 1957.

Type of farm[b]	Sample farms	Census farms
	percent	percent
Field crops farms	22.7	12.2
Vegetable, fruit and nut farms	40.9	36.5
Dairy farms	18.2	10.2
Livestock farms, other than dairy	9.1	11.5
General	9.1	29.6
	100.0	100.0

a. Percentages calculated from 1959 census figures. Omitted from the calculation of census percentages were 138 poultry farms and 1,813 unclassified farms.

b. The sample farms were not typed by the same criteria as census farms; the former were typed according to total inputs (see explanation page 140) while the latter were typed according to gross revenue. However, the two methods have similar results.

Table 9. Distribution by age of operator of census farms[a] and 66 sample farms, Marion County, 1957.

Age of operator	Sample farms	Census farms
	percent	percent
Less than 25	6.1	1.2
25 - 34	6.1	10.7
35 - 44	25.8	22.1
45 - 54	37.9	25.4
55 - 64	10.6	21.7
65 and over	13.6	18.9
	100.1	100.0

a. Percentages calculated from 1959 census figures for Marion County.

Although there are some differences between the sample and the census, the similarity is close enough to justify the assumption that the sample, to a considerable degree, is representative of the majority of Marion County farming. "General" farms are not proportionally represented and poultry farms were not included in the sample.

The farms included in the sample were fairly widely distributed over the sample area (Figure 6) and, in this respect, the sample is representative of the sample area. Insofar as the sample area represents farming in Marion County, the sample is also representative of Marion County. Generalizing to Marion County from the sample may be done, with some caution, but to go any further in generalization, that is, outside of Marion County, extreme care must be taken to ensure comparable conditions.

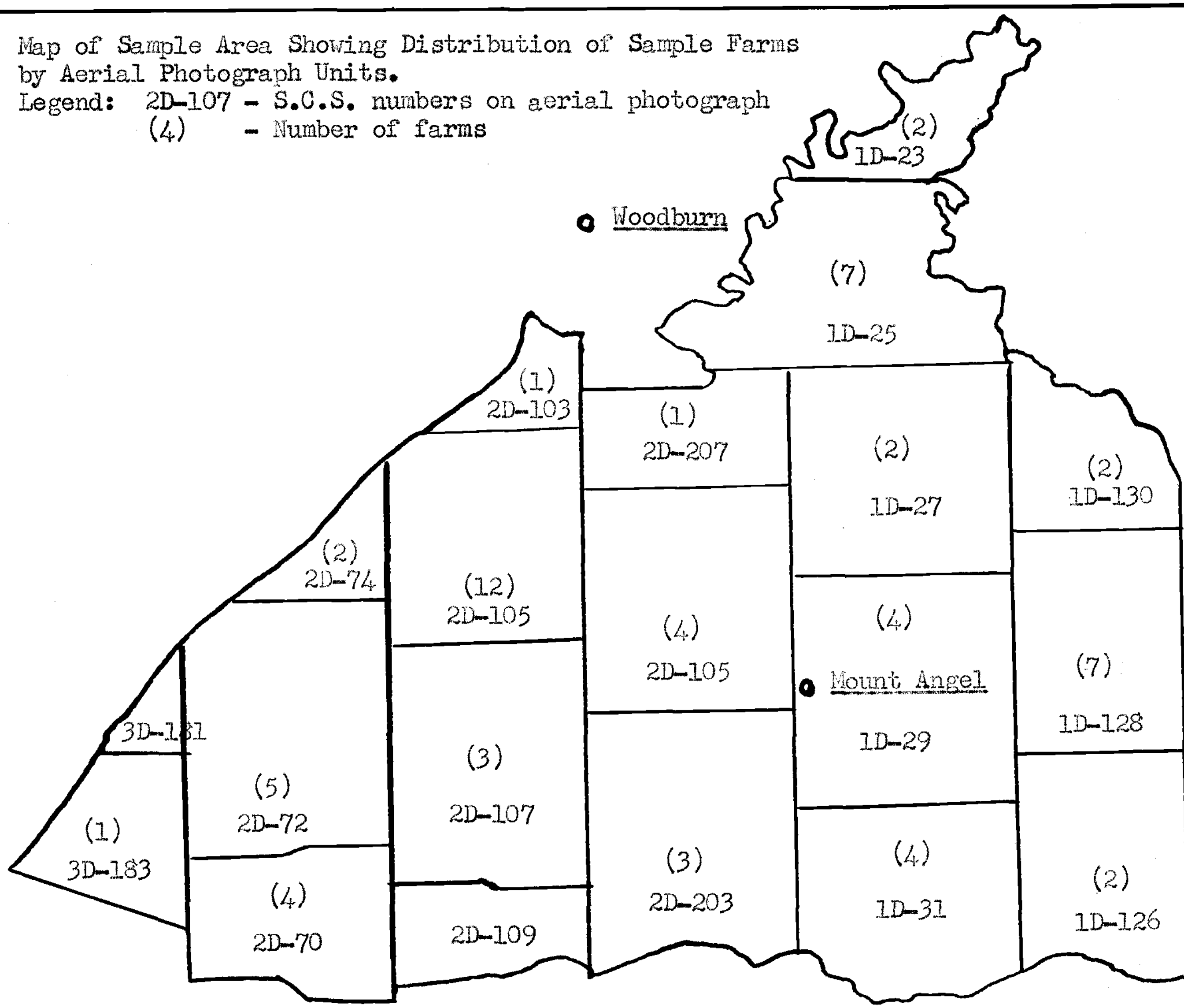
Analysis of the Data

It is not necessary to use a stratification of the sample by type of farm until the statistical testing of the effect of farm type on the parameters is discussed. However, tables will be presented, during the discussion preceding the statistical analysis, that show data by type of farm. It therefore is convenient at this juncture to present the method used to define the type of farming strata and categorize each farm into one of the strata.

Typing the Farms

Farm samples, such as the one used herein, are frequently

Figure 6. Map of Sample Area Showing Distribution of Sample Farms by Aerial Photograph Units.
Legend: 2D-107 - S.C.S. numbers on aerial photograph
(4) - Number of farms



stratified for various statistical purposes. One of the main objectives is to group the farms so that more homogeneity (less variation) exists within than between the groups. Homogeneity refers to the main characteristics of the farm that are to be studied.

It has been pointed out in this thesis that it is necessary to study the effect, on certain parameters, of variation in the way resources are organised on the sample farms. The organization of resources is determined by the product and the production process required to produce it. The product thus becomes a very good indicator of the way resources are put together by a farm operator. However most farms produce more than one product for sale. This means that to obtain an indication of the resource organization on a farm it is necessary to know what proportions of the total inputs go to producing each product. Since output quantity is closely associated with input quantity, farms can be categorized according to the proportional division of output by product. The name of the product is used to name or indicate the type of farm. Thus a dairy farm is so named because most of its inputs or resources are combined to produce one or more dairy products. This is a common way to type farms. If over a certain defined percentage of its gross revenue is obtained from a certain product, say fluid milk, it is called a fluid milk farm. This method of typing requires a calculation of gross revenue for each farm by products returning revenue on that farm.

In the present study it was necessary to type or stratify the sample farms before income calculations were make. Such a typing frequently may be useful when preliminary cursory studies of farm business data are required. For example, it may be necessary before income has been calculated, to make decisions on individual observations, that can be assisted by a comparison of the farm in question with farms of a similar type.

It is possible to type farms according to inputs themselves. For example, cash crop farms are sometimes typed according to the proportions of total cropland acres allocated to producing the various crop products of the farm. The preliminary typing done for this study used an input method which may be called a "land use intensity" method.

From a cursory study of the records, several types of farms were possible, according to the enterprise that absorbed the major portion of inputs and produced most of the income. Cash grain and forage (both hay and seed) farms, dairy farms, livestock (other than dairy) farms, and farms producing mainly intensive crops such as berries, mint, beans, fruit, potatoes, sweet corn, etc., could be easily noted. The sample farms were grouped into these four types plus a fifth, a general or mixed type. They are hereafter designated as E1, D, E2, I and M types, respectively. As usually occurs in classifying, the problem existed in deciding on borderline cases.

In Marion County the problem is aggravated by the intensive crops grown on many farms. A farm could have most of its acreage allocated to cash grain crops yet have the majority of inputs and output allocated to a few acres of berries. The same could occur on an otherwise dairy farm. It was decided to devise a system of weighting acreages according to the intensity of land use for each enterprise on a farm and summing these. The enterprise exceeding 50 per cent of the total weighted acreage for the farm determined the type of farm.[a] This method amounts to typing on the basis of inputs involved in the enterprise but since there is a close association between total inputs and output it achieves much the same result as typing by gross income attributable to each enterprise.

In using the "land use intensity" method the various enterprises can be given relative weights on the basis of some measure of intensity. This method is not as precise as the gross income method but achieves the purpose of typing just as well, which is to group the farms in strata that are more homogeneous within than among the groups. It may achieve this objective better because the method deals directly with inputs, and homogeneity is based on input organization.

In order to compare intensity of land use for the varying enterprises the total cost per acre was used as a "common denominator" measuring intensity. Enterprise summaries available from the Agricultural Extension Service at Oregon State University gave costs per acre for most of the enterprises encountered among the 66 sample farms. The data in these summaries were reasonably up to date and provided at least an index of intensity of land use. The livestock enterprises showed costs in terms of animals rather than per acre, but these were converted to per acre costs by using feed requirements and normal

a. Except for the mixed type, the major enterprise on all farms but two exceeded 60 per cent. The lowest of the two was 56 per cent.

yields to determine the number of acres required to support the livestock complements for which costs were given in the summaries.[a]

The following weights, based on the costs listed in Table 11 were given to each acre of land according to the use indicated:

Table 10. Land use weighting[a] for typing farms in the sample.

Land Use	Weighting[b]
Cash Grains	1.0
Grains Fed (except to dairy cattle and hogs)	2.0
Grains fed Hogs	1.4
Forage and Grains Fed Dairy Cattle	5.2
Forage (seed or feed except dairy)	2.0
Potatoes	6.9
Field Corn	2.6
Sweet Corn	3.8
Orchards and Nuts	4.5
Berries	15.7
Beans	28.9
Mint and Carrots	9.2

a. Based on Table 11 using average cost for grain crops, $31 equal 1.
b. Applied directly to acreage according to use reported by respondents.

The costs per acre calculated or taken directly from the enterprise sheets follow, in Table 11:

a. See Appendix B for details.

Table 11. Costs per acre of various enterprises, Willamette Valley farms, 1957.[a]

Enterprise	Total cost per acre (dollars)
Fall Wheat	35
Barley	29
Oats	29
Irrigated Pasture	56
Red Clover (seed and hay)	74
Rye Grass Seed	54
White Clover Seed	61
Alfalfa Hay	66
Field Corn	81
Irrigated Sweet Corn	119
Potatoes	214[b]
Carrots	285
Mint	285[b]
Filberts	147
Walnuts	113
Cherries	147[b]
Prunes	147[b]
Black Raspberries	344
Boysenberries	485
Loganberries	472
Red Raspberries	552
Irrigated Strawberries	582
Bush Beans	591
Pole Beans	897
Swine	38
Sheep	61
Beef Cattle (selling 450 lb. calves)	63
Dairy cows	163

Source: Oregon State University. Agricultural Extension Service. Enterprise cost sheets, 1953-1957. Corvallis, 1957. (Unpublished. Mimeographed.)

a. Latest information up to 1957 the year of the study.

b. Recent published information not available. Judgment estimates based on discussion with M. Becker, Farm Management Extension Specialist, Agricultural Extension Service, Oregon State University.

Defining the Variables

To test empirically the hypotheses listed at the end of Chapter II, it is necessary to define the variables precisely to obtain quantitative measurement of these variables from observed data and then to determine their relationship. This analysis will therefore proceed to do this as well as to describe the process by which the variables were measured or calculated from observed data and present the statistical analysis required to determine their relationship. At the same time the hypotheses will be tested.

1. Total input capital:

This variable, represented by A and P_1 in the models in Chapter II, was defined in that chapter, but the definition will be reviewed here for the sake of precision. Total input capital is measured herein by the present value of each farm's fixed and operating productive inputs. Thus defined, capital includes operating expenses.

In evaluating real estate, the westeland and natural pasture were omitted, because most of the unimproved land was unproductive. The value of the family dwelling was also omitted. Although the dwelling cannot be considered to be unproductive, its major role is that of a consumer good and is thus very difficult to associate with output if it is viewed as an input. Because of the variation in value that is not associated with variation in output, the dwelling is a large source of error when included in farm capital as an input.[a] In this analysis the dwelling of the operator and his family will be classified as a living cost. All other farm buildings used in the normal operation of the farm will be included as input capital.

The inclusion of the usual livestock complement and the machinery and equipment as part of capital is orthodox; however annual operating expenses are not normally looked upon as capital, even though they are always included as inputs. This analysis will take the viewpoint that all inputs constitute capital, except the operator's labor and management. Annual inputs and expenses, such as feed, fertilizer, feeder stock, taxes, hired labor, fire insurance, repairs, fuel and lubricants for power equipment, and so forth, compete with machinery, buildings, land and livestock for surplus income available for investing back into the business. This is one reason for including them in capital. Another reason is that the model depends upon a prediction of income from capital. This requires the inclusion in capital of all inputs associated causally with output. An explanation for the inclusion of unpaid family labor was given in Chapter II (p. 62).

It is necessary at this point to discuss the evaluation procedure. In general, present value was considered the best value to use because it gives a better relative measure of quantity, quality and condition

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a. It is well recognized that two farmers obtaining the same normal net income from the same type and size of farm may have dwellings that differ greatly in value simply because one may choose to spend his income on a beautiful home while the other may choose to forego a beautiful home and spend his income on a luxurious automobile or on annual holiday trips.

of the various input capital items and it coincides with the beginning of any projection of the future utilizing the model developed in Chapter II.

The method of evaluating total input capital is not critical so long as it provides the best estimate of income and is used consistently. Because present value gives a better expression of quantity and quality of inputs than does original cost or replacement cost, it is more likely to provide a better predictor of income.[a] Where possible, market value was used, because, theoretically, it expresses variations in quality. However, no market value exists for some capital items, for example, permanent farm buildings, once they have been built. In such cases the best alternative is to depreciate the replacement cost of the building according to its age. When this is necessary, the replacement cost should be associated with its present use and capacity in that use, if these differ from its original purpose. These methods were followed in this analysis. Using replacement cost in such cases has the advantage (over using original cost) of expressing the value in terms of current dollars, thus putting the value of the item on a comparable basis with those items evaluated by market value. Present value, being in current

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a. That is, in secular or cross-sectional association of total input capital and income, the variation in capital is likely to be more closely associated with the variation in income if capital is measured by present value than if measured by replacement cost or original cost.

dollars, may vary from the trend in the value of the monetary unit and if so, must be adjusted to the trend to eliminate a source of error in projection. This was also discussed previously (p. 61)

Evaluating land:

On the assumption that, better than anyone else, the farm operators know the condition of their land and its value relative to other land in the area, the respondents were asked for estimates of the value of their cropland, without buildings. Not all respondents provided a value so it was necessary to allow an estimated land value in these cases.[a]

Land values of "bare" cropland are usually estimated by the farmers as having no perennial crop on the land. Obviously a walnut grove or a blackberry patch will add value to the land if there is bearing life remaining in the crop. This additional value was estimated for those acreages in perennial crops and added into total input capital. It was assumed that a respondent's estimate of bareland value included grass and forage crops, however, so that these were not included in the additional values given for perennial cash crops.

Adequate information was not available from the 1957 survey to establish a value for these crops. However, in 1958 James obtained information on the cost per acre of establishing these crops on various soil series. (4, p. 116-175) It was assumed in the present study that the crops were half depreciated and they were given a value per acre equal to half of the cost of establishing them and bringing them to bearing age.

a. See Appendix B2 for an explanation of the estimates used.

Evaluating buildings:

Respondents were asked to estimate the replacement cost of each building, assuming a replacement of the same quality and fulfilling the same purpose. The age of the buildings was also reported. Where the respondent failed to provide an estimate, a description of the size and structure of the building was obtained.

For twenty farms the building replacement costs has been recently estimated by the County Assessor and these were obtained from his office. The costs were calculated on a square foot basis and averaged according to type of building[a]. These values were then applied to the data on size and structure for those buildings not estimated by respondents. Five records provided only the age of the buildings, in which case it was deemed better to estimate the replacement cost by a judgment comparison with sample farm similar in type and size, than to discard the otherwise useful record.

Having established the replacement cost, the building was depreciated by the straight line method for its age[b]. If the building was fully depreciated it was evaluated at 20 percent of replacement cost for a house and 15 percent for other buildings.

Improvements such as wells and fences, if not evaluated by the respondent, were usually reported in terms of miles (of fences) or feet (of well or tiling). In such cases the replacement costs used

a. Appendix D, Table 14.
b. See Appendix D, Table 6 for building life used.

are shown in Appendix D, Table 7. Where no age was reported the item was assumed to be half depreciated.

Evaluating Machinery:

The respondents were asked for the original purchase price of the item, the year they purchased it and their estimate of its future expected useful life. The original purchase price was inflated to 1957 prices by use of the best available appropriate index (74) and this price was depreciated, by the straight line method, for the period the respondent had owned the item. The annual depreciation rate was determined from the life of the machine estimated from the year of purchase, calculated by adding its present life (from the year of purchase) to the estimated future life remaining in the item. This method is applicable to machinery purchased new or secondhand. The value given by the respondent for small tools was taken as present value and they were assumed to be half depreciated. Where values and life estimates were missing in the records, the average figures for the same machines reported by other respondents were used. Where the age of an item was missing it was assumed to be half depreciated.

Evaluation of livestock:

The weights and the values or prices of the usual livestock complement, used to produce the livestock and livestock products usually sold each year, were enumerated in the survey. Where data were missing in a record it was necessary to make estimates from the information available, based on tabulations from reported data.[a]

a. See Appendix D. Table 2 for prices or values thus calculated and used.

Operating Expenses:

These will be defined later in the discussion of net income.

The average total input capital and its components are shown for each type of farm in Table 12.[a]

Table 12. Components of total input capital values[a] on sample farms, by type of farm, Marion County, 1957.

Farm Type[b]	Building[c]	Cropland	Livestock[d]	Machinery	Expenses	Perennial crops	Total capital
			- dollars -				
E1	5,402	33,624	617	7,736	3,871	478	51,729
E2	5,283	35,417	3,108	5,952	7,067	697	56,523
I	3,374	14,843	666	5,715	7,206	2,396	34,200
D	8,168	28,018	6,680	11,722	9,139	1,583	65,310
M	5,551	29,358	1,505	9,172	6,772	1,260	53,617
All	5,078	24,697	1,956	7,603	6,747	1,555	47,635

a. Values shown for each type are average for the type.
b. E1: Extensive cash crop farms.
E2: Extensive livestock farms.
I : Intensive cash crop farms.
D : Dairy farms.
M : Mixed farms, that is, the farms could not be categorized in any of the other types.
c. Excluding the house. Only the buildings usually in use were included.
d. Usual livestock inventory.

2. Net income:

This variable is designated as N_i in the model developed in Chapter II. It has been fairly well defined previously[b] but will be defined in more detail by the ensuing discussion of gross income, gross expenditures and depreciation. The net income pertinent to

a. The components are shown for each farm in the sample in Appendix C, Table 1.
b. See p. 19 and 26.

this study is the return to capital and the operator's labor and management. Before it is available from gross income, gross expenditures, including unpaid family labor and depreciation must be paid. The components of these variables will be discussed next.

Gross income:

This is another variable used in the model, in its own right, but it also is used to calculate net income. Some discussion of the concept of gross income best adapted to the purposes of this study is necessary. The problem is to project the relationship between net income and total capital investment over time. This is to be done on the basis of an empirical relationship. If annual records of income were available for each farm, the relationship between that income and the farm's total investment annually could be derived. Due to natural hazards and to price fluctuations, annual income varies considerably more than total investment. Much of the annual variation in income series could be removed by relating the trend to the "total investment" series. The income thus would be conceived more as a "usual" income, based on usual yields and prices, except insofar as new investments, i.e. additional inputs, raised the trend. The use of a trend would remove the effects of yield and price variations, leaving the effect of increasing investment.

Time series data of the type required were not available for this study. It was therefore necessary to note the effect of investment on income from "cross-sectional" data obtained at the same point of time from farms of various sizes. The effect of secular price variations on income variations is mostly removed in such data because at the time the data are obtained, all farms in an area face the same set of current prices for their products. The use of "usual" or average yields obtained by each farm eliminates the yearly variations caused by natural hazards. If the sample area is small enough all farms are subjected to much the same weather, diseases and insects; at least the inter-farm variability should be considerably less than the inter-year variability. For these reasons, gross income was calculated for each farm in the sample on the basis of its usual yields as estimated by the farm operator during the enumeration. Similarly the usual quantities of livestock and livestock products sold, were used. In all cases the current prices for the survey year were applied.[a] The perquisites (income in kind) were calculated in the same way.

Details:

Gross income includes usual sales of crops, livestock and livestock products. Crop sales were calculated by subtracting the usual amount fed and otherwise used on the farm, from the product of acreage and usual yields. For new plantings of perennial crops no income was allowed. On the other hand, no depreciation was charged.[b] Receipts from custom work done for others are included because they were derived from the annual inputs that partly constitute the total investment.

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a. See Appendix D, Tables 2-4 for prices and yields.
b. See "Overhead for Perennial Crops", Appendix B4.

Other off-farm receipts were not included because they were not derived from these annual inputs.[a] The components of gross income are shown by type-of-farm averages in Table 13. These components are shown for each farm in Appendix C, Table 3.

Table 13. Components of usual gross income[a] of sample farms by type of farm, Marion County, 1957.

Farm type	Improved acres[b]	Crop sales	Lvstk sales	Sales of lvstck products	Custom Work	Perquisites	Gross income
E1	111.0	7,613	665	367	352	212	9,209
E2	108.4	4,132	4,110	4,811	93	139	13,285
I	38.5	9,952	1,429	381	92	240	12,094
D	89.5	1,414	1,575	11,722	139	459	15,964
M	99.2	8,057	2,980	9,172	67	264	12,272
All	76.1	7,167	1,667	3,009	157	267	12,266

a. Off-farm receipts other than for custom work have been omitted. Since this is usual income, based on annual output, it is not necessary to consider changes in inventory.
b. Includes improved pasture, cropland acres, summerfallow, orchards, etc. but does not include the farmstead. This land does not produce output.

Gross expenses:

The usual items, such as repairs, feed, fertilizer and other operating costs are included.[b] Depreciation was also included. Life insurance, repairs and depreciation on the dwelling were charged as living expenditures. The details of methods used for estimating and calculating various expense items are given in Appendix B4.

a. In some cases the usual yields or sales of livestock and livestock products were not obtained in the enumeration. An explanation of how these were dealt with is given in Appendix B3.
b. See Appendix B4 for a more complete listing.

Most expense items vary considerably less from year to year than do yields and for this reason the expenses during the survey year were taken as a reasonable estimate of "usual" expenses. Taxes and usual depreciation are two sizeable items that remain relatively stable from year to year although the trend may be rising. This stability also occurs in many of the minor crop and livestock expenditures, telephone costs and fire insurance. Most of the expenses required to bring the crops into midseason growing condition do not vary a great deal annually but some expenses associated with harvest tend to vary with yields. The variation in the harvesting costs was assumed to be a minor influence on the variation in total expenses.

Depreciation was included because in the process of capital accumulation over several years, depreciation must be covered by income. Interest on debt was excluded because it is necessary to study the productive and accumulating power of capital itself, whether it is encumbered or not. The effect of encumbrances will be considered later but for the present unencumbered capital will be assumed.

Components of operating expenses and depreciation charges are shown in Tables 14 and 15, respectively.

The net income (Table 16) considered to be available for consumption, income taxes and capital accumulation was calculated by subtracting the gross operating expenditures and depreciation, from the gross income, as all three components are defined and presented above.[a]

a. The net income for each farm can be calculated from Tables 2-4, Appendix C.

Table 14. Components of gross operating expenses by type of farm, 66 sample farms, Marion County, 1957.

Farm type	Machinery	Building repairs	Livestock purchases	Labor	Custom work	Taxes	Other	Total
			- dollars -					
E1	825	291	134	502	353	804	963	3,871
E2	744	183	176	381	210	753	4,620	7,067
I	653	159	187	4,546	88	322	1,250	7,206
D	959	299	996	1,972	767	649	3,496	9,139
M	966	296	93	2,946	109	646	2,049	7,105
All	784	229	313	2,635	285	560	1,972	6,778

Table 15. Components of depreciation by type of farm, 66 sample farms, Marion County, 1957.

Farm type	Buildings	Machinery	Perennial crops	Total depreciation
E1	397	972	120	1,489
E2	327	659	60	1,046
I	230	626	619	1,475
D	514	1,308	253	2,075
M	371	1,007	467	1,845
All	341	865	374	1,580

Table 16. Average net income by type of farm, 66 sample farms, Marion County, 1957.

Type of farm	Net income
E1	$3,848
E2	5,173
I	3,417
D	4,759
M	3,655
All	3,939

3. Living costs:

As brought out in Chapter II, these constitute an important influence on the rate of capital accumulation for the firm-household, and are represented as the variable L in the model for projecting capital accumulation. They are defined as that portion of annual net income spent on consumption. This expenditure is not recoverable and is lost to the firm, although it provides utility to the household. The expenditures on the usual items of food, clothing, shelter, education, health, entertainment, travel, share to living of electricity, telephone and transportation costs, charity and gifts, were included. Expenditures on sons or daughters attending college were not included because (a) this is not a usual item - only 4 of the 66 farms reported assisting a college student; (b) some students earn a considerable portion of their own expenses which makes it difficult to put all farms under comparable circumstances; and (c) a college education for sons or daughters is one of the goals for which a farm might be planning and therefore cannot be included in the usual annual costs when estimating the rate of capital accumulation required to achieve that goal. Annual repairs on the dwelling were included in living costs.[a]

Farm perquisites were included in living costs. It would seem logical to omit them from gross income and living costs both and place the variables on a cash basis. However, since perquisites tend to remain stable regardless of size of farm or income, or even decrease with an increase in both of these, they affect the ratio of living

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a. These were calculated according to Table 8, Appendix D.

costs to net income as the latter changes and therefore must be included in the calculations of these variables.

Life insurance was included in living costs.[a]

Expenditures on purchases of durable consumer goods were not included as such. Rather, depreciation on these items was allowed as an annual expense to be met over the capital accumulation period.[b] The respondents estimated the aggregate value of these items in the household. Depreciation on the house was also charged as a living expense. Table 17 presents averages of the respondents' estimates of various expenditure categories to provide a concept of the relative magnitudes in the various categories.

Propensity to Consume:

When the usual net incomes calculated from the information reported were matched with the estimated usual costs reported by individual respondents, it was found that for 29 of them the living costs exceeded the net income. There undoubtedly are various explanations for this if the 29 farms could be studied more closely, and the explanations would vary among the farms. One hypothesis immediately suggested was that the disposable income available to the household should cover the living costs (other than the depreciation on the dwelling). Accordingly, to the net income of each of 64 respondents[c]

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a. See Chapter II, page

b. All furniture and larger appliances were depreciated at the rate of 7.5 percent per year. Information on useful life of household furniture and equipment is difficult to find. This rate was estimated from information appearing in the U.S.D.A.'s Family Economic Review (40) and the Journal of the American Statistical Association(60).

c. Only 64 of the 66 respondents in the sample who provided data for calculation of net income also provided estimates of living costs.

Table 17. Average living expenditures by type of expenditure and household size, 70 sample farms, Marion County, 1957.

Item	Household size grouping[a]								
	I	II	III	IV	V	VI	VII	VIII	IX
No. of families[b]	5	20	7	3	16	1	16	1	1
Average age of operators	42	56	43	58	44	45	42	48	n.i.
Food[c]	410	700	803	694	1,222	1,470	1,665	1,400	1,530
Heat[c]	47	97	116	158	121	n.i.	139	90	85
Electricity[d]	43	80	72	63	72	100	113	68	100
Clothing	109	172	226	100	327	200	503	700	400
Furniture and equipment[e]	107	199	257	184	235	75	284	400	375
Housing[g]	223	457	393	226	420	156	431	402	527
Transportation[d]	285	317	392	229	334	261	407	227	732
Health[f]	232	160	373	244	374	247	271	690	255
Donations	46	130	128	112	123	225	176	250	300
Entertainment	104	65	221	25	71	25	84	50	200
Trips	53	62	238	25	86	25	41	75	0
Education[g]	20	7	109	-	124	600	107	400	400
Reading material[h]	30	28	27	31	33	35	34	80	35
Life insurance premiums	64	135	105	64	203	100	80	110	240
Total[i]	1,641	2,652	3,302	2,116	4,015	3,519	4,510	4,942	5,487

a. I- one adult; II- two adults; III- two adults, one child; IV- three or more adults; V- two adults, two or three children; VI- three adults, two or three children; VII- two adults, four or five children; VII- two adults, six or more children; IX- three adults, six or more children.

b. Seventy records were available containing estimates of most of the items.

c. Purchased and perquisites.

d. Share to living.

- footnotes continued on the next page

Footnotes (cont'd)

e. Repairs and depreciation.
f. Medical and hospital bills and insurance premiums.
g. Excluding college.
h. Papers, magazines and books.
i. This is not the sum of the averages shown, but the average of total living costs for each farm. Of cource there is only one farm in three of the categories.

n.i. No information obtained.

was added the allowance for unpaid labor, total depreciation and perennial crops overhead and income from off farm sources. At the same time depreciation on furniture and equipment, the dwelling and the means of transportation (the share to living) was subtracted from the living costs as calculated. The result was that the income failed to cover living expenses for only five respondents. The discrepancy was not large for these.

For purposes of the model the fact that there is a discrepancy between living costs and net income on some of the farms is not critical. This can be due to unusual reasons not obtained in the interviewing because of lack of probing. What is necessary for projecting capital accumulation by use of the model, is the propensity of the households to consume their disposable net income, because the model assumes that the net income defined therein is disposable. It is also desirable to determine this propensity in association with the related capital and income relationships.[a] The point to be made here is that the non-depreciation expenditures on living that are associated with the disposable net income available give a good measurement of propensity to consume. Therefore, it is this income - living cost relationship that will be used to derive the relevant parameters for the model.

4. Household size:

An indication of the relationship between household size and living costs is available from Table 17. However, the criterion for

a. The propensity to consume of similar firm-households in other parts of the state or the country could be used, with intelligent judgment as to their comparability.

size does not take into consideration the effect of different ages of children on living costs. For the parameter to be used in the model the measurement of this variable will recognize the varying ages of the children and will convert all household members to a common "consuming unit", which will be called and "adult equivalent" herein.

The only study available to use as a guide in expressing children in terms of adult equivalents was done in Oklahoma in 1956 (68) This study showed the annual cost to farm parents in Oklahoma as of 1954, of raising a child through the age of 18. Although the costs may differ widely from comparable costs in 1957 in Marion County, Oregon, the information does show the relative costs at each age, so that a 5-year old can be expressed in terms of an 18-year old. It was assumed that these relative costs would be the same in Marion County as in Oklahoma. The ages were divided into three groups and expressed in terms of expenditures on an adult (Table 18). These adult equivalents were then applied to the households in the sample to measure the household size.[a]

Table 18. Adult equivalent consuming units by age groupings of farm household members.

Age group	Adult equivalent
Over 18	1.0
12 - 18	0.8
6 - 11	0.7
Birth - 5	0.5

a. For the reader's convenience, disposable net income, non-depreciation living costs and household size for each farm are combined in Table 5, Appendix C.

Statistical Analysis

1. Net income and total input capital:

A straight line equation, N = bA+a, where N is net income and A is total capital, was fitted to the appropriate data for each type of farm by the method of least squares. The following parameters were obtained:

Type of farm	Regression coefficient b	Correlation coefficient r	r^2	F-value	Degrees of freedom	a
E1	.0799	.69	.48	12.01	1 and 13	285
E2	.1387	.99	.97	145.15	1 and 4	2666
I	.1063	.71	.50	25.15	1 and 25	218
D	.0335	.11	.12	1.43	1 and 10	2578
M	.0554	.49	.24	1.29	1 and 4	684

The regression coefficient, b, was significant at the .01 level for the E1, E2 and I types. It was apparent that the b-values are fairly close to each other so it was decided to test the hypothesis that the population regression coefficients, represented by the b-values, are equal. Using the F-test,

$$\text{where } F = \frac{\dfrac{\sum SS_x (b - \bar{b})^2}{k-1}}{\dfrac{\text{Pooled residual SS}}{\sum n-2k}} \quad \text{and}$$

$\bar{b}$ is the mean of the k regression coefficients, (44, p. 346) the calculated F-value was 1.9316 (with 4 and 56 degrees of freedom). Since this value lies outside the critical region at even the .10

level of significance, the hypothesis that the population regression coefficients of the populations represented by the five types of farm are equal, cannot be rejected and therefore must be accepted. This leads to the conclusion that the regression lines are parallel, that is, each has the same slope (44, p. 353).

The calculated value of $\bar{\bar{b}}$ was .0775 and it was found to be significant at the .01 level ($F = 42.0793$ with 1 and 56 degrees of freedom).

When the regression coefficients are equal the analysis of variance can be used to test whether or not the regression lines coincide, by testing the hypothesis that the means of the dependent variable, in this case N, when adjusted to $\bar{A} = \bar{\bar{A}}$, are equal. Here $\bar{\bar{A}}$ refers to the general mean of all of the A-values of the farms in the five type-of-farm strata. Since $\bar{\bar{b}}$ was highly significant it was necessary to test the homogeneity of the adjusted means; otherwise, had $\bar{\bar{b}}$ not differed significantly from zero, the analysis of variance could have been applied directly to the strata means of the dependent variable, N. The following shows the results of this analysis:[a]

Source of variation	Sum of squares of A	Sum of products	Sum of squares of N	Degrees of freedom
Among sample	9,562,404,077	411,216,010	24,984,318	4
Within sample	40,947,733,061	3,174,568,269	618,841,710	61
Total	50,510,137,138	3,585,784,279	643,826,028	65

a. For details of this method of analysis see (44, p. 364).

Residual			
Sum of Squares	Degrees of freedom	Mean squares	F
16,540,338	4	4,135,084.50	0.6656
372,725,920	60	6,212,098.66	
389,266,258	64		

Here again the calculated F-value is outside of the critical region at the 0.10 level of significance so the hypothesis that the adjusted means adjusted to $\bar{A} = \bar{\bar{A}}$ are equal, cannot be rejected so it must be accepted. This conclusion, together with the previous conclusion that the regression coefficients of the populations represented by the five types of farm are equal, leads to the conclusion that these five populations have the same line of regression (44, p. 353). From this it may be concluded that type-of-farm has no significant effect on the regression.

On the basis of this, the data were aggregated to derive the following single regression equation for all of the farms:

$$N = .0699A + 609$$

where N is usual net income in dollars and A is present total input capital in dollars, both being defined as previously discussed in the relevant sections. The regression coefficient b = .0699 was significant at the .01 level (calculated F-value = 40.8396, with 1 and 64 degrees of freedom). The 95 percent confidence limits for b are:

$$.0481 < \beta < .0917$$

The value a = 609 was significant at the .05 level (calculated t-value = 2.0000 with 1 and 64 d.f.).

The 95 percent confidence limits for a are $-.93 < \alpha < 1219.19$ where β is the population regression coefficient and α is the population mean of N at the population mean of A.

This means that if another random sample is obtained from the same population in the same manner, there is a 95 percent chance that the regression equation calculated from the new sample will be somewhere between:

$$N = .0481A - .93$$

and

$$N = .0917A + 1219.19$$

Using the sample mean of A, 47634.58, to substitute in these equations, the predicted N has a 95 percent chance of falling in the range \$2290.26 and \$5587.28. If the probability of predicting N correctly is lowered to 75 percent this range N is narrowed to \$2980.35 and \$4899.09.[a]

Although the hypothesis that all the population regression coefficients represented by the 5 strata cannot be rejected, three of the groups had highly significant regression coefficients. The analysis is summarized in Table 19.

The table indicates that the equation for all farms provides predictions that are as reliable as those for types E1 and I. Type E2 has the highest r and the smallest confidence intervals but because

a. The 0.25 t-value of 1.1619, for 1 and 60 degrees of freedom, is tabulated from the F-table appearing in Snedecor's book on statistical methods (64, p. 279) $t = \sqrt{F}$.

Table 19. Parameters, correlation coefficients and confidence limits for selected type-of-farm groupings of sample farms, Marion County, 1957.

Item		All Farms		Type E1		Type E2		Type I	
r-value		.62		.69		.99		.71	
Corrected r[a]		.47		.38		.90		.50	
Parameters		b= .0699	a = 609.13	b= .0799	a = 284.71	b= .1387	a = -2665.65	b= .1063	a = 218.18
Confidence limits at:									
$t_{.05}$[b]	U[c]	.0917	1219.19	.1297	1125.66	.1706	-1898.56	.1500	665.72
	L	.0481	- .93	.0301	-1695.18	.1068	-3432.74	.0626	-1102.08
$t_{.10}$	U	.0879	1119.77	.1207	871.66	.1632	-2076.51	.1425	514.69
	L	.0519	100.35	.0391	-1441.18	.1142	-3254.79	.0701	- 951.05
$t_{.25}$	U	.0826	964.47	.1077	501.44	.1542	-2293.99	.1313	287
	L	.0572	255.65	.0521	-1070.86	.1232	-3037.31	.0813	- 724.07

a. From Chart by Ezekiel and Fox showing minimum correlation in the universe for varying observed correlations and sizes of sample (21, p. 294).

b. For all farms, with 1 and 64 degrees of freedom these three t-values are about 2.0000, 1.6710 and 1.1619 respectively.
For E1, with 1 and 13 degrees of freedom they are 2.160, 1.771 and 1.204 respectively.
For E2, with 1 and 4 degrees of freedom they are 2.776, 2.132 and 1.345 respectively.
For I, with 1 and 25 degrees of freedom they are 2.060, 1.708 and 1.179 respectively.

c. U: Upper confidence limit; L: lower confidence limit.

of the few farms in the stratum (n=6) it is suspect, subject to further testing with new data. The regression coefficients for the types not shown, namely types D and M, were not significant and the r-values were low.

For these reasons the parameters of the regression equation for the aggregate sample of 66 farms were selected as the best to use in the model for projecting capital accumulation.

Preliminary plotting of net income and capital for the farms indicated a straight line relationship. If the relationship was curvilinear the curve most likely to fit the data would be a logarithmic curve such as $N = aA^b$, which can be fitted to data by the method of least squares when expressed as linear in the logarithms, in the following manner:

$$\log N = \log a + b \log A.$$

This was done, with the following predicting equation[a] resulting:

$$N = 1.4624\ A^{.8241} - 1000.$$

The regression coefficient, b = .8241, was significant at the .01 level (F=28.3219 with 1 and 64 degrees of freedom). The correlation coefficient was r = .5539. Since $r^2 = .3068$, about 31 percent of the variability in N is accounted for by the variability in A. For the straight line regression, $r^2 = .3895$, indicating that more is accounted for (39 percent). On this basis, and because of the difficulty of

a. There were several minus quantities in the net income variable. The net incomes were converted to positive quantities by adding 1000 to each. Therefore, to predict N from any particular A, 1000 must be subtracted. This does not affect the parameters.

using it in the model, the logarithmic equation was rejected and the relationship between total input capital and net income was considered to be linear.

Annual input and net income:

In an effort to improve the predicting equation for N it is logical to associate net income with annual input capital rather than total input capital. Annual input capital was measured as the sum of an annual rental for land (assumed to be 5 percent, the usual interest rate at which net income from land alone is capitalized to calculate land value), depreciation on buildings, perennial crops and machinery and equipment, livestock inventory and operating expenses.

Testing the hypothesis that the population regression coefficients for the five types of farms were equal, the calculated F-value was 2.0254, with 4 and 56 degrees of freedom. The hypothesis could not be rejected at the .10 level so therefore was accepted. In testing for homogeneity of the adjusted means the calculated F-value was 2.1493, with 4 and 60 degrees of freedom. The hypothesis could be rejected at the .10 level of significance, however, to provide a comparison with the regression using total input capital, the data were pooled. The resulting equation, fitted by the method of least squares, was

$$N = .2632A + 909.79$$

The regression coefficient, b = .2632, was significant at the .01 level (F = 48.4490 with 1 and 64 degrees of freedom), r = .6564 and $r^2 = .4309$. In this regression relationship, the variability in A accounts for 43 percent of the variability in N, compared with 39 percent when A represents total input capital. Because of this small difference and because it is necessary to convert total input capital into annual input to use the model, and convert annual input back into total input capital after the projection has been made, it was decided to retain total input capital as the basis for predicting N for the model.

Effect of variation in soil series:

To test the effect of soil series on the parameters b and a it was possible to select from the data only three soil series on which enough farms existed, with a soil series predominating on the farm, to attempt a test. These soil series were Willamette, Amity and Woodburn, for which 11, 14 and 9 farms, respectively, were available.

It was noticed immediately that the effect of type of farm would tend to confuse the test. Of the 11 farms on Willamette soil, 10 were Type 1 and one was Type E1, all cash crop farms. On the Amity soils, of the 14 farms available, 6 were Type D, 2 were Type E2, 2 were Type 1, one was Type E1 and 3 were Type M. There is a tendency, in this group, toward livestock farms. On the Woodburn soils, 4 farms were Type E1, 4 were Type 1 and one was Type M. This group was predominantly cash crop.

In testing the homogeneity of the regression coefficients for these three groups of farms, the hypothesis that they are equal must be accepted, since the F-value was 1.7143 with 2 and 28 degrees of freedom, which is outside the critical region at the 90 percent level of significance.

The homogeneity of adjusted means was also tested and the hypothesis that they are equal could not be rejected, so must be accepted. The analysis of the test follows:

Source of variation	SS_A	SP	SS_N	d.f.
Among sample	2,175,506,948	120,407,169	7,679,832	2
Within sample	16,783,722,775	1,059,387,697	259,422,588	31
Total	18,959,229,723	1,179,794,866	267,102,420	33

Residual SS	Residual d.f.	MS	F
1,132,048		566,024	.0882
192,554,102		6,418,470	
193,686,160			

The weighted average regression coefficient, $\bar{b}$, was calculated to be .0631 and it was significant at the .01 level (F = 10.9143 with 1 and 28 degrees of freedom). This value is reasonably close to $\bar{b}$ = .0775 for the five type-of-farming groups (p. 162).

In view of the conclusion that type of farm has no effect, in the present sample, on the relationship between net income and total input capital, it may be reasoned that the effect of the soil series tested herein is negligible, also, that is, the apparent tendency of soils to influence the type of farm does not interfere with testing the effect of soil series on the net income-capital relationship.

Caution is necessary in generalizing from this testing of the effect of soil series. The three series involved are more closely related, in the scheme of soil classification, than would be a bench soil and a hill soil or a bottom soil. The test might have entirely different results with a wider divergence of soil series. Unfortunately, the data for such a test were not available for inclusion in this study.

2. Gross income and total input capital:

Although the relationship between capital and gross income is not necessarily required as a parameter in the model, it is necessary for adjustments to the net income parameter, b, to take into account changing output and input price levels. To express the relationship as a ratio k_R = gross income/total input capital, involves the same difficulties discussed for k_N, when the relationship is linear, that is to say, k_R changes with increasing capital. But, as discussed in Chapter II, a linear regression equation, $G = gA\ k$ (where G is gross income), can be used.

This equation was fitted to the appropriate data in the five type-of-farming groups in the sample, by the method of least squares, resulting in the following parameters:

Type of farm	Regression coefficient	r	r^2	F-value	Degrees of freedom	k
E1	.1691	.82	.68	27.3777	1 and 13	462
E2	.2932	.86	.74	11.2181	1 and 4	-3287
I	.4037	.91	.83	119.6849	1 and 25	-1712
D	.1866	.82	.67	20.1264	1 and 10	3778
M	.2391	.89	.79	14.9787	1 and 4	- 548

For E1, I and D types the regression coefficient, g, was significant at the .01 level. For the M and E2 types it was significant at the .05 and .10 levels, respectively. Also, the variability in A accounted for from 67 to 83 percent of the variability in G. This compares favorably with multiple regression equations, relating various categories of total inputs to gross value output, that appear in the literature.[a]

The F-test of the hypothesis of homogeneity of regression coefficients was applied and the hypothesis was rejected (F = 6.1162 with 4 and 56 degrees of freedom.) Also the hypothesis that the weighted mean regression coefficient equals zero was rejected. (F = 189.1702 with 1 and 56 degrees of freedom.) This means that the data cannot be pooled to use single values of g and k in the projection model, that it is not necessary to test for homogeneity of the adjusted means, and that type of farm does have an effect on the regression.

It was thought possible, however, that the data from some of the type groups could be pooled. Accordingly pairs of types were tested for differences in regression coefficients. The same F-test was used to test the hypothesis $\beta_i - \beta_j = 0$ (where i and j represent types of farms), with the following results:

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a. A number of production-function studies, relating several input categories to output, simultaneously, have been published in the Journal of Farm Economics and in theses since World War II. Two examples of these were referred to in Chapter II (p. 42, 59).

Type pair	F-value	Degree of freedom	Level of significance	Decision on hypothesis[a]
E1 and D	0.1141	1 and 23	.10	accepted
E1 and E2	2.6142	1 and 17	.10	accepted
E1 and I	22.3203	1 and 38	.01	rejected
E2 and I	1.9334	1 and 29	.10	accepted
E2 and M	0.2449	1 and 8	.10	accepted
D and I	16.0543	1 and 35	.01	rejected
D and M	0.4015	1 and 14	.10	accepted
I and M	4.6757	1 and 29	.10	rejected

a. An hypothesis was accepted if the F-value was outside the critical region at the level of significance indicated; it was rejected if the F-value was inside the critical region. Since these tests are two-tailed, the critical region at the .10 levels of significance are designated by the F-values at the 5 percent and the .5 percent points of the F-distribution, respectively.

On the basis of these results it was concluded that the regression coefficients for the populations represented by the four types, E1, E2, D and M, were equal. The test for homogeneity of adjusted means was applied, with the following results:

Source of variation	SS_A	SP	SS_G	d.f.
Among sample	1,315,271,477	597,801,110	310,009,457	3
Within sample	29,884,766,840	5,922,169,404	1,729,989,521	35
Total	31,200,038,317	6,519,970,514	2,039,998,978	38

Residual SS	Residual d.f.	MS	F
121,088,150	3	40,362,717	2.4664
556,412,005	34	16,365,050	
677,500,155	37		

The tabulated F-value at the 0.10 level, with 3 and 34 degrees of freedom is 2.2600 (64, p. 279). At this level of significance the hypothesis could be rejected. However, because of the level of significance and the fact that the E2 and M types each had only 6 observations, it was decided to pool the data for the four types. The results, with the 95 percent confidence limits, for these pooled data and Type I are presented below:

Item	Pooled E1, E2 D and M		I	
r-value	.81		.91	
Corrected r[a]	.71		.83	
Parameters[b]	g = .2090	k = 486	g = .4037	k = 1712.
Confidence limits				
at $t_{.05}$ Upper	.2581	1877	.4797	-174.
Lower	.1599	-905	.3277	-3251.
F-values	74.3840		119.6849	
Degrees of freedom:	1 and 37		1 and 25	

a. (21, p. 294).
b. The g-values were significant at the .01 level.

Effect of variation in soil series:

In analyzing the effect of soil series on the relationship between gross income and total input capital it is seen (p. 171) that, in this case, type of farm does have an effect on the relationship, at least in the case of Type I. Since all but one of the farms in the Willamette soil series, used in the test, were Type I, the influence of soil and type cannot be separated without a sample large enough to permit sub-stratification of Type I farms by soil series. However, farm types are mixed enough on the Amity and Woodburn soils in the sample, to provide some test of the effect of soil as between these two series, at least. Also, these two series are more distinct from each other than are the Willamette and Woodburn series. In applying the F-test[a] the hypothesis that the regression coefficients are equal must be accepted, since F = .0051, with 1 and 19 degrees of freedom.[b]

The hypothesis that the adjusted means are equal was tested with the following results:

Source of variation	SS_A	SP	SS_G	d.f.
Among sample	1,918,500,698	431,300,290	96,961,106	1
Within sample	12,147,391,862	2,340,920,357	742,452,256	21
Total	14,065,892,560	2,772,220,647	839,413,362	22

Residual SS	Residual d.f.	Residual MS	F
109,021,123	1	109,021,123	4.9855
437,350,697	20	21,867,535	
546,371,820	21		

The hypothesis can be rejected at the .10 level of significance.

If this is valid, the analysis means that the soil series has no effect on the slope of the regression lines but that the adjusted means differ, that is to say, the regression lines are separate but parallel, for these two soils. The results of this analysis and

a. The same F-test is used in all tests of homogeneity of regression coefficients.

b. n = 23 for the T_2 and T_4 soil series tests.

the analysis of the effect of type are reasonable. It may be expected that the production functions are the same shape but are at different levels. This would be expected to hold only within limited differences between soil series, that is, it would not hold between one soil that can absorb a relatively large amount of inputs per acre (intensive farming) and one that could only absorb a low level of inputs per acre (extensive farming).

For the particular area and type of farming represented by the present sample of farms, because of the low level of significance on the test of adjusted means, and because the application to the model will be simplified, the hypothesis will be accepted, that is, the soil series involved will be considered to have no effect on the parameters, g and k.

Recapitulation:

Since type of farm and soil series could not be proven to have an effect on the relationship between total input capital and net income, the parameters in the regression equation:

$$N = .0699A \quad 609$$

may be used to apply the capital accumulation projection to any farm represented in the sample.

In adjusting the model for changing price levels, the parameters in the regression equation:

$$G = .4037A - 1712$$

may be used for farms represented by Type I farms in the sample, and for farms represented by the other four types, the parameters in the following regression equation may be used:

$$G = .2090A + 486$$

3. Living cost parameters:

Assuming that type of farm and soil series have no effect on variation in living costs, other than through their effect on income, the data for all types were aggregated to obtain parameters for a predicting equation for living costs.[a] The effect of income was first analyzed, using disposable income (defined previously, p.150) as the independent variable. Income was plotted against living costs to obtain a first approximation of the nature of the relationship. A straight line or one slightly curved seemed to be the most appropriate. Accordingly, a straight line equation, $L = cN + d$ and a logarithmic equation, $L = dN^c$ (where L is living expenditures without depreciation on the dwelling and consumer durables and N is disposable net income), were fitted to the data by the method of least squares. The results for each were:

(1) The straight line equation:

$L = .1606N + 1553$[b]

$r = .58$

$r^2 = .33$

$F = 31.1211$, with 1 and 62 degrees of freedom.

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a. Only 64 of the 66 sample farms had usable living cost data.
b. This a-value was significant at the .01 level ($t = 14.8945$ with 1 and 62 degrees of freedom).

(2) The logarithmic equation:

$$L = 115.93N^{.3501}$$

$$r = .57$$

$$r^2 = .32$$

$F = 29.0827$, with 1 and 62 degrees of freedom.

Both equations fit the data almost equally well. The straight line equation is preferred to the logarithmic for use in the model.

However, a study by Brake and Holm in Michigan suggests that a multiple regression equation that includes household size with net income as independent variables, accounts for more variability in L and results, therefore, in a better predicting equation.[a] So the multiple regression equation, $L = cN + \gamma S + d$ was applied to the data, where L is living costs, N is disposable net income, S is household size in adult equivalents, c and are the net regression coefficients and d is the mean of L at $N = \bar{N}$ and $S = \bar{S}$. The following results were obtained:

$$L = .0903D + 488 + 394$$

$$R^2 = .64$$

$F = 53.4073$, with 2 and 61 degrees of freedom.

$$s^2_{L.c_i} = 500,769.97$$

$$C_{11} = 111,229 \times 10^{-14}$$

$$C_{22} = 935,955 \times 10^{-8}$$

$t_c = 3.8263$, with 1 and 61 degrees of freedom.

$t_\gamma = 7.1228$, with 1 and 61 degrees of freedom.

a. See p. 113.

The overall regression is significant at the .01 level. The independent variables account for 64 percent of the variability in L. Individually, each net regression coefficient is also significant at the .01 level. It may be concluded, therefore, that this prediction equation will give a more accurate prediction of L than will the equation using only the one variable, disposable net income. The parameters from the three-variable equation are therefore preferred for use in applying the model to farms represented by the sample.

The 95 percent confidence limits for these parameters are (64, p.418);

c : $.0903 \pm .0472$

γ : 488 ± 137

d : 394 ± 177

4. Unpaid labor:

The contribution of unpaid labor to capital accumulation was discussed in Chapter II and a method for taking it into account was indicated. It is reasonable to assume that there is a relationship between unpaid labor, size of the household and operators' age. Also, if unpaid labor were associated with net income or to total input capital, it would be predictable, insofar as these variables are predictable.

The unpaid labor charges for each farm in the sample were plotted against these variables for an approximation of the relationships. It was found from a visual inspection of the graphs that a linear relationship existed between household size and unpaid labor charges, although the association was not close, that is, the correlation coefficient "r" would not be close to unity.

When age of operator and unpaid labor charges were plotted, there appeared to be a curvilinear relationship depicted by a rather shallow inverted -U shaped curve. Again, the correlation coefficient would not be high because of the probable high residual squared deviation from the regression line. The apex of the curve occurred between the ages of 45 and 50. This relationship is reasonable because a smaller and younger family can be expected prior to an operator age of 40 and a smaller family available for unpaid labor can also be expected for an operator age over 50 or 55, when the children begin leaving home.

The association between net income and unpaid labor was similar to that existing between operator's age and unpaid labor. This also may be expected because of a similar association between net income and operator's age.[a]

The relationship between total input capital and unpaid labor is very difficult to determine, graphically, so the correlation coefficient would be quite small in any case.

From these approximations it is reasonably clear that the least complicated regression equation for predicting unpaid labor from the sample data, would require a linear term for size of household, a linear and quadratic term for operator's age and a linear and quadratic term for net income. Such an equation will not be derived in this thesis but is merely suggested as one possibility for predicting unpaid labor for the model in Chapter II.

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a. This relationship and a number of inverted -U curves are discussed in (37).

Conclusions

In addition to calculating parameters that can be used to apply the model to farms represented by the sample, the analysis provides bases for conclusions regarding the hypotheses listed near the end of Chapter II (p. 66-68). These conclusions are summarized as follows:

1. Relationship between net income and total input capital:

   (1) Hypothesis: The population regression coefficient is equal to zero.

   Rejected. The relationship is positive and is highly significant, not only for the pooled data but for type-of-farming groups E1, E2 and I.

   (2) Hypothesis: The population regression is linear rather than curvilinear.

   Accepted - on the basis of (a) visual inspection of plotted data and (b) fitting the most likely curve (logarithmic). The straight line equation fits the data better than the curvilinear equation, that is, r^2 for the latter.[a]

   (3) Hypothesis: k_N (the ratio of net income to total input capital) changes as capital increases.

   Accepted - because the straight line regression describes the data best and, in the equation $N = bA+a$, a differs from zero significantly.

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a. A probability test of the equality of the two regression coefficient was not made. If they are equal, the curvilinear equation would be rejected because of the difficulty of using it in the model.

(4) Hypothesis I: The regression coefficients for the sub-populations represented by the five type-of-farm strata, are equal.

Accepted.

Hypothesis II: The adjusted means relevant to these regression coefficients are equal.

Accepted.

The conclusion is, therefore, that variations in resource combination, as expressed by variation in type-of-farm, does not influence the variation in the relationship between net income and total input capital.

(5) Hypothesis I: The regression coefficients for the three sub-populations represented by the three soil series strata, are equal.

Accepted.

Hypothesis II: The relevant adjusted means are equal.

Accepted.

The conclusion is that, within the confines of the soil series represented by the sample, variation in soil series does not affect variation in the relationship between net income and total input capital.

2. Relationship between gross income and total input capital:

(6) Hypothesis: The population regression coefficient is equal to zero.

Rejected for (a) all type-of-farming groups taken together, (b) for the four types E1, E2, D and M, pooled and (c) for Type I. The relationship in all three cases was positive and highly significant.

(7) Hypothesis: The population regression is linear rather than curvilinear.

Accepted. This hypothesis was not tested by fitting a (logarithmic) curve, for three reasons: (a) the plotted data indicated a linear regression to be the most appropriate; (b) the correlation coefficients for all regressions fitted were high; and (c) for multiple regression analyses using similar input-output data, reported in the literature, in almost every case very little difference in fit between a linear regression and curvilinear regression has been demonstrated, where the linear correlation coefficients were high.

(8) Hypothesis: The regression coefficients for the sub-populations represented by the five type-of-farm strata, are equal.

Rejected. The conclusion is that variation in resource combination, as depicted by the variation in type-of-farm, does influence the variation in the relationship between gross income and total input capital.

The conclusion on which types, if any, for which to pool the data, was arrived at by testing the equality of regression coefficients for several pairs of types, and by testing the homogeneity of adjusted means for the types indicated for pooling. The data for four types, E1, E2, D and M, were pooled, as a result. The parameters for the pooled results must be used separately from Type I when applied to the model.

(9) Hypothesis I: The regression coefficients for two sub-populations represented by two soil series strata are equal.

Accepted.

Hypothesis II: The two relevant adjusted means are equal.

Accepted.

It was concluded that for the two soil series included in the analysis, differences in soil series did not affect the relationship between gross income and total input capital. Caution was indicated in generalizing from this conclusion (page 173).

3. Relationship between living expenditures and disposable net income:

(The conclusions regarding this relationship are assumed to apply to the relationship between net income and living costs in the model.)

(10) Hypothesis: The population regression coefficient is equal to zero.

Rejected. The relationship is positive and highly significant.

(11) Hypothesis: The relationship is linear rather than curvilinear.

Accepted. Here again, the basis was (a) visual inspection of plotted data and (b) fitting the most obvious curvilinear equation, which was logarithmic. The linear equation fit the data considerably better than did the logarithmic equation.

(12) Hypothesis: k_L (the ratio of living e xpenditure to disposable net income) changes as capital increases.

Accepted: - for the reason that the straight line regression best describes the data and in the equation $L = cN+d$, d differs from zero significantly.

4. Relationship between living e xpenditures and the two variables, disposable net income and household size:

(13) Hypothesis: The three-variable multiple regression equation provides a better prediction of living expenditures than the two-variable simple regression.

Accepted. The three-variable equation accounted for considerably more of the variability in living costs than did the two-variable equation.

CHAPTER V

APPLICATION

As indicated in the introductory Chapter, the main purpose of developing a model for projecting capital accumulation was to assist individual farmers in financial planning over a longer period than is normally planned. It will be seen in this Chapter that, in using parameters derived from a sample of farms, there are implications also for the population of farms represented by the sample.

For a particular farm the model can provide estimates of accumulated capital and net income under the several assumptions previously discussed. These estimates are useful mainly as guides to the operator and his family, to be applied with judgment respecting the conformity of his firm-household situation to the assumption. As new and better information becomes available on his operations, new estimates can be made to provide better guides for current decisions.

The required planning parameters from a particular firm-household can be estimated if the operator has a record of the relevant information. The longer the period for which annual observations are available the better will be the estimates and the more useful the projections. Observations for a minimum of two years are necessary for estimating a straight line regression, preferably three or four years apart rather than consecutive[a]. In lieu of better information the

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a. Assuming management and input organization remains constant, consecutive data of this type are more likely to be autocorrelated than data separated by several time periods. With no intervening time period the probability of error in a straight line data for these two years can be normalized from the operator's experience on his own farm and his knowledge of similar farms in the locality.

If he has no records, which is frequently the case, or his records are poor, he would be better adivsed to use parameters calculated from a group of farms similar to his in as many respects as possible. Even with good records, the operator's range of experience with regards to business and household growth, may be so short as to give estimates considerably less reliable than those available from a wider range of firm-households on farms of the same type as his. If he or his advisers are aware of the inter-firm-intra-firm assumptions involved[a], accurate pertinent survey data can provide reliable parameters to guide him. Such data are being used continually by farm management extension workers in advising farmers in their decisions on their own particular farms.

Every farmer, with several years of farming ahead of him, needs to be interested in the effects of such things as production efficiency, living costs, taxes, unpaid labor and non-farm sources of income, on the ability of the resources at his command to build up assets and income. These effects can best be seen by making some actual projections under assumed, but realistic conditions, utilizing the model and

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prediction is greater than with data separated by several periods. At best, such a prediction is not presumed to adequately substitute for a prediction based on data for several consecutive years.

a. See Chapter II, p. 57.

parameters that have been previously derived in this study[a].

In the remainder of this chapter a series of projections of the variables in the model will be presented for some of the various conditions likely to be encountered by the farms used as illustrations. It will be quickly realized that there are numerous combinations of conditions that can be depicted, but the main purpose of presenting these projections here is to illustrate the application of the method, albeit as realistically as possible, so only a few sets of conditions will be used.

Growth Projections for a Dairy Farm

The first series of projections will be made for a synthetic farm based on an actual farm selected from the farms in the sample that had operators less than 30 years of age. At the time of the survey this particular farm was a dairy farm. The operator was 25 years old. The total input capital was $52,800, all owned by the operator, having inherited it from his father who had died suddenly two or three years prior to the survey. The operator was still single, living with his mother, so it will be necessary to synthesize the household to make the projection more typical. Average management ability will be assumed.

The following parameters will be used for the projection[b]:

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a. The presence of the usual problem of communication between researchers and farm operators is acknowledged here, but the scope of this thesis is not designed to deal with this. It will be left for later solution by anyone who attempts to apply the method.
b. See Chapter IV, pp. 175, 178.

$b = .07$

$a = 609$

$c = .09$

$\gamma = 488$

$d = 394$

It will be assumed that the operator is married and the family size will be limited to 3 children, the first being born in Year 2, the second in Year 5 and the third in Year 8 of the projection period. Under this assumption, the household grows at the average rate of 7.15 percent per year over the twenty year period. Thus $s = .0715$.

Projection 1.

The first projection will assume all input capital owned. Projection Equation 24[a] will be used used, under the assumption of no change in price levels of inputs, outputs and items purchased for family living. Projections will be made for a ten year period and a nineteen year period. The latter is chosen because the oldest child will be 18 at the end of the period and very likely to leave home, creating a change in "s", the rate of growth of the household.

Assuming this size of household, no unpaid labor would be available for the ten year projection, unless the wife were to contribute some. At present it will be assumed that she does not. The assumption of no unpaid labor will also apply to the 19 year projection[b].

Equation 24 enables a projection with and without the inclusion

a. See Chapter II, p. 56.
b. 50 percent of the dairy farms in the sample had no unpaid labor.

of income taxes. Without tax the projection of total input capital can be made straightaway for the tenth year and for the nineteenth year, but with tax it is necessary to calculate all of the variables for each year. The quantities inside the first two square brackets (Equation 24) can be calculated for all years of the projection period without requiring a knowledge of income or tax, but when tax is included, quantities for year i cannot be calculated until those for year i-1 are known[a]. The resulting projection is shown in Table 20.

The effect of income tax can be seen readily. It should be noted that the difference between total capital without taxes and total capital with taxes, at the end of a period, exceeds the total tax paid for the period. This is due to the yearly loss to taxes of income otherwise available for productive investment. The effect on annual net income of the retarding of capital accumulation also is sizeable.

The net income allocated to living expenditures, based on the parameters calculated from the sample is:

Year	Without income taxes	With income taxes	Difference
5	$2,313	$2,291	$ 22
10	2,850	2,793	57
19	3,319	3,139	180

This projection provides a benchmark from which to note the effect of changing price trends. In the above projection it has been assumed

a. The details of the calculation are presented in Appendix E.

Table 20. Projected typical capital growth and associated net income on a selected dairy farm, Marion County

Year	Total input capital without taxes	Net income without taxes	Total input capital with taxes	Net income with taxes	Total income tax [a]
		-	dollars	-	
1 (1957)	52,800	4,305	52,800	4,305	867
2 (1958)	55,348	4,483	54,481	4,423	757
3 (1959)	57,988	4,668	56,309	4,551	795
4 (1960)	60,723	4,860	58,142	4,679	831
5 (1961)	63,550	5,058	59,973	4,807	722
6 (1962)	66,472	5,262	61,945	4,945	755
7 (1963)	69,490	5,473	63,920	5,083	789
8 (1964)	72,602	5,691	65,887	5,221	681
9 (1965)	75,806	5,922	67,982	5,368	716
10 (1966)	79,101	6,146	70,062	5,513	756
11 (1967)	82,484	6,383	72,111	5,657	787
12 (1968)	85,961	6,626	74,140	5,799	821
13 (1969)	88,412	6,798	75,017	5,860	836
14 (1970)	93,165	7,131	78,080	6,075	890
15 (1971)	96,827	7,387	79,892	6,201	921
16 (1972)	100,598	7,651	81,751	6,332	952
17 (1973)	104,405	7,917	83,309	6,441	980
18 (1974)	108,219	8,184	84,798	6,545	1,003
19 (1975)	112,166	8,461	86,244	6,646	1,029

a. Social security is not a tax but a form of forced saving. Since it is based on net income and is not available for accumulation of productive capital it is included here with income tax. State tax was calculated from the Optional Tax Table, 1956 Oregon Income Tax Form 40 (pages 5-8). Federal tax was calculated at the rate of 20 percent of taxable income up to $4,000. This rate was in force in 1957. (See U.S. Treasury Department's Farmers' Tax Guide for any year from 1955 to 1959.)

that production efficiency, indicated by the regression coefficient b, remains constant.

Projection 2.

The next projection presented is for the same farm, using the same parameters for Year 1, but allowing for the effect of changes in price levels of inputs and outputs and items purchased for living. As explained in Chapter II, the effect of relative changes in input and output price levels is applied in the model as an adjustment to the regression coefficient b. Since b changes every year, as a result Equation 24 cannot be used and all of the components of the models must be calculated for each year. However, it turns out that this does not require a great deal more calculation than that required for using Equation 24 with the inclusion of the tax component. There also is a great advantage to calculating each component annually in that components such as unpaid labor charges, non-farm income or family size, can be easily increased or decreased in any particular year, which enables considerably more flexibility than the mathematical equation permits.

The adjustment to the regression coefficient b requires the parameters from the regression relationship between gross income and total input capital, the rate of change in output prices and the rate of change in input prices for the projection period. The appropriate regression parameters to apply to the selected dairy farm are[a] :

$$g = .21$$

$$k = 486$$

As a measure of changes in output price levels the price indexes for all Oregon crops and all livestock and livestock products were used (57). The annual values for the indexes from 1945 to 1962, inclusive, were plotted to provide a visual estimation of the trend. The trend in livestock prices was rapidly upward from 1945 to an all

a. See page 173, Chapter IV.

time high in 1951. From that peak they descended annually to a low point in 1955 and 1956 and have been tending to rise very slowly since. The trend over the 9 year period since 1953 has been level. If 1951 and 1952 prices were included the trend would be down, which, if projected for 10 or 20 years would very likely result in a large departure from reality, in view of long run demand and supply forecasts for livestock and livestock products (16) and (9, p. 857). It was decided to use the 1953-1962 trend, which shows no increase or decrease in these prices.

Crop prices were slightly lower in 1945 than in 1962. They increased to a peak in 1947 and, after an intervening decline to nearly the 1945 level, another peak in 1952, somewhat higher than the 1947 peak. If 1952 is included, the trend since then is down. If it is excluded, the 9-year trend, 1953-1962, is level, that is, trend prices have not risen or fallen since 1953. The 4-year trend since 1958 has been upward, so it was decided to use the 9 year trend for projection purposes in this thesis.

Had the projection been made in 1957, without the benefit of the five years of price data since that year, they would have been more difficult, because prices of crops, livestock and livestock products were considerably more variable from 1945 to 1957 than from 1953 to 1962. Prices for livestock were starting upward in 1957, after a steady 5 year decline. It would have been risky to predict a further 10 year decline, particularly in view of the optimistic long run market outlook for livestock at the time. Taking all years from 1945 to

1957 a straight line projection of zero trend is indicated, even though the statistical error would considerably exceed that of a projection based on the 1953-1962 period, or even the 1945 to 1962 period.

For crop prices, a steady decline existed from 1952 until 1957 with no upward trend indicated. The straight line trend from 1945 to 1957 is downward, even though only slightly. The optimistic long run market outlook for livestock at the time may have justified a prediction of at least a leveling off of the crop price index trend because of the potential rise in demand for feed grains and forage. This, together with the weakness of the downward 1945-1957 trend and the stabilizing effect of government policies on crop prices, would justify a projection of zero trend from 1957 onward.

The best available indicator of input price trends is the Average Index Numbers of Prices paid by farmers for commodities used in production, United States, 1941-1962. The trend in this price index rises rapidly from 1945 to 1952, but with less variability around the trend than occurred in output prices. Input prices declined sharply from 1952 to 1953 but very gradually from 1953 to 1956. Since they have been rising slowly but steadily. It was decided to use the 1953-1962 trend to correspond with the output trends selected and to eliminate the effect of the immediate postwar upsurge in input prices. From 1953 to 1962 the trend rises from 250 to 270 (1910-1914=100), that is, 20 points in 9 years or 2.2 points per year.

The best available indicator of trends in prices of items purchased for living is the Average Index Numbers of Prices Paid by Farmers for Commodities Used in Family Living, United States, 1941-1962. This index shows a rapid trend upward from 1945 to 1951 after which the trend continues, but rises more slowly. The trend for the 1953-1962 period was selected for the same reasons stated in the previous paragraph. Over this period the annual variability in the index is very small. The trend rises from 265 to 295 or 30 points over the 9-year period, which is 3.33 points per year[a].

The projection model calls for a constant annual percent increase (or decrease) in the trends of these prices. For a straight line projection obviously a constant percentage change is mathematically impossible. Such a change can be approximated by calculating the percentage annual change based on the average of trend values at the beginning and the end of the projection period. A curvilinear trend is implied but it would not depart enough from the straight line trend to be significant for practical purposes. However, this complication can be avoided. Since it is necessary to calculate each component in the model each year, the annual percent change in price trends, based on the previous year, can be used easily. Thus, for the adjustment to b_1 to calculate the effect of input price trend on the projection, instead of the equation

$$b_1 = b_1 - \frac{p(gA + k - a)}{A_i} \quad (1+p)^{-1} + (1+p)^{-2} + \ldots$$
$$+ (1+p)^{i-1} \quad \text{(See Appendix A6}$$

a. It is noted here that the 1957 index was slightly lower than the trend for output prices and input prices but slightly higher than the trend for prices of items purchased for living. No adjustment to trend prices was made in the income, expenses or living cost data. The slight error which may result will have very little effect on the projections.

the following equation is appropriate:

$$b_i = b_1 - \frac{p_i\ (gA + k - a)}{A_1\ (1+p_1)(1+p_2)\ldots(1+p_i)}$$

where p_i is the annual change in index trend as a percentage of the previous year.

In the case of living costs, L_i, the annual percent change in price trend can be applied to each L_i calculated from the net income and family size for that year.

Some of the salient components of the projection of capital accumulation as influenced by predicted price trends are presented in Table 21. The details on which this table is based are given in Appendix F.

It is seen that the annual "plow-back" decreases steadily from Year 1. This is due to the steady decline in production efficiency[a] and to the rise in living costs. The latter is due to rising prices of items purchased for living, but mainly due to family growth. The decline in the value of b_i could be expected to occur historically in a real situation. If physical input-output relationships remained constant but input prices declined relative to output prices, a calculated b-value each year would decline. Net income increases each year for the first five years, but family size then causes it to diminish and the additional income tax exemptions are not high enough to counteract the decline. Although capital accumulates each year, because of the declining plow-back it does not accumulate fast enough to provide a steady increase in income.

a. Input-output ratio measured in dollar value.

Table 21. Projected capital growth and associated net income and living costs, as influenced by price trends, for a selected dairy farm, Marion County

Year	b_i	Total input capital	Net income	Household size[a]	Living expenditures	Total income tax	"Plow-back"
		- dollars -			- dollars -		
1 (1957)	.0700	52,800	4,305	2.0	1,757	867	1,681
2 (1958)	.0682	54,481	4,327	2.5	2,027	731	1,569
3 (1959)	.0665	56,050	4,338	2.5	2,030	734	1,574
4 (1960)	.0648	57,624	4,345	2.5	2,028	736	1,581
5 (1961)	.0632	59,205	4,349	3.0	2,275	600	1,474
6 (1962)	.0615	60,679	4,343	3.0	2,275	599	1,469
7 (1963)	.0599	62,148	4,333	3.2	2,372	594	1,367
8 (1964)	.0583	63,515	4,314	3.7	2,617	454	1,243
9 (1965)	.0568	64,758	4,285	3.7	2,615	445	1,225
10 (1966)	.0552	65,983	4,254	3.9	2,709	438	1,107
11 (1967)	.0537	67,090	4,212	3.9	2,705	425	1,082
12 (1968)	.0522	68,172	4,168	3.9	2,701	414	1,053
13 (1969)	.0508	69,225	4,126	4.2	2,845	403	878
14 (1970)	.0493	70,103	4,065	4.2	2,839	387	839
15 (1971)	.0479	70,942	4,007	4.2	2,834	371	802
16 (1972)	.0465	71,744	3,945	4.3	2,876	355	714
17 (1973)	.0451	72,458	3,877	4.3	2,870	337	670
18 (1974)	.0438	73,128	3,812	4.3	2,863	320	629
19 (1975)	.0424	73,757	3,736	4.4	2,906	300	530

a. In adult equivalents.

Projection 3.

The effect of family growth can be seen by projecting capital accumulation holding family size stationary (Table 22).

Net income increases slightly until the ninth year, at which time the decline in b_i can no longer be offset by plow-back. However the change in net income and plow-back is slow so that net income could be maintained at roughly the same level for several more years.

Projection 4.

By setting annual plow-back at a given level and working backwards

Table 22. Projected capital growth under changing price trends, with household size stationary[a], for a selected dairy farm, Marion County

Year[b]	Total input capital	Net income	Household size	Living expenses	Total tax	"Plow-back"
1 (1957)	52,800	4,305	2.0	1,757	867	1,681
2 (1958)	54,481	4,327	2.0	1,780	875	1,672
3 (1959)	56,153	4,345	2.0	1,782	880	1,683
4 (1960)	57,836	4,359	2.0	1,783	883	1,693
5 (1961)	59,529	4,369	2.0	1,783	885	1,701
6 (1962)	61,230	4,376	2.0	1,784	887	1,705
7 (1963)	62,935	4,380	2.0	1,784	885	1,708
8 (1964)	64,643	4,380	2.0	1,784	888	1,708
9 (1965)	66,351	4,376	2.0	1,783	887	1,705
10 (1966)	68,057	4,368	2.0	1,782	885	1,701

a. The b-values are the same as for Table 21.
b. Ten years are sufficient to demonstrate the point.

in the model the regression coefficient, b_i, required to maintain the annual plow-back at its level in Year 1 can be calculated, For example, the annual plow-back for Year 1 in Tables 21 and 22 is $1,681. To maintain this plow-back in the face of rising prices of items purchased for living and a growing family, requires a continually rising net income (Table 23). The capital base increases, of course, by the annual plow-back. If annual plow-back begins to decline in the face of required living costs then net income will decline. The only waysto stop such a decline is to stop household growth, which is difficult to do after the children are born, reduce living costs, or increase b_i, that is, increase production efficiency. Under the conditions assumed for Table 23, the decline in b_i is the minimum permissable to maintain the level of living that existed for the household in Year 1.

Table 23. Regression coefficient (for net income and total input capital) required to maintain "plow-back" on a selected dairy farm, Marion County[a]

Year	Plow-back	Total input capital	Net income	b_i	Living expenditures[b]
1	1,681	52,800	4,305	.07000	1,757
2	1,681	54,481	4,492	.07128	2,042
3	1,861	52,162	4,497	.06922	2,043
4	1,861	57,843	4,505	.06736	2,044
5	1,681	59,524	4,669	.06820	2,304
6	1,681	61,205	4,673	.06640	2,304
7	1,681	62,886	4,824	.06702	2,417
8	1,681	64,567	4,984	.06776	2,678
9	1,681	66,248	4,983	.06602	2,678
10	1,681	67,929	5,129	.06654	2,789

a. Details of the calculation are given in Appendix G.
b. Adjusted for rising price levels.

Table 23 indicates that to maintain the level of living, b_i can only decline 5 percent over the 10-year period. Table 21 shows that input price level changes cause a decline of 21 percent. This means that to counteract the projected rise in input prices to maintain the level of living and a constant plow-back, production efficiency must increase 16 percent in nine years or 1.78 percent per year. Such an increase is quite feasible at the current level of technology in the sample area in view of the values of b and a at the upper confidence limit for the regression, .09 and 1,219 respectively (See Chapter IV, p.165)[a].

a. The existence of farms in the sample, with levels of efficiency both above and below the average results in these confidence limits. The fact that there are farms of above average efficiency means that it is possible for less efficient farms to increase efficiency under existing technology, if operators have the managerial capacity. Efficiency may also be increased by the adoption of new technology, at least until widespread adoption

Projection 5.

The effect of rising input prices, relative to those of output, on the ability of total input capital to produce net income, can be readily seen by assuming all net income to be "plowed back" (Table 24).

Table 24. Effect of rising input prices[a] on the ability of capital to produce net income

Year	Total input capital	b_i	$b_i TC_i$	a	N_i
1	52,800	.0700	3,696	609	4,305
2	57,105	.0682	3,897	609	4,506
3	61,611	.0665	4,098	609	4,707
4	66,318	.0648	4,297	609	4,906
5	71,224	.0632	4,501	609	5,110
6	76,334	.0615	4,695	609	5,304
7	81,637	.0599	4,890	609	5,499
8	87,136	.0583	5,080	609	5,689
9	92,825	.0568	5,272	609	5,881
10	98,706	.0552	5,449	609	6,058

a. The effect of input price trend is applied in the adjustment of b.

Projection 6.

Supposing the operator wanted to consume all net income, rather than plow-back part of it, while at the same time maintaining his capital at $52,800, total net income after taxes would decline by only $100 (Table 25) over the ten year period. However, since living costs would rise, the remainder of net income (the part he would

influences product prices. Many things may occur to enable increased efficiency, but some basis for estimating these occurrences must exist, to allow for them in long run planning. The effect of secular trends in technological development has not been allowed for in these projections because of the difficulties involved in defining and measuring this effect.

Table 25. Projected net income available for consumption when total input capital remains constant, selected dairy farm, Marion County

Year	Total input capital	b_1	Net income	Living expenditures	Income tax	Plow-back	Living expenditures plus plow-back
1	52,800	.07000	4,305	1,575	867	1,681	3,438
2	52,800	.06825	4,213	2,017	700	1,496	3,513
3	52,800	.06653	4,122	2,008	675	1,439	3,447
4	52,800	.06484	4,033	2,000	651	1,382	3,382
5	52,800	.06317	3,944	2,239	492	1,193	3,432
6	52,800	.06153	3,858	2,230	490	1,138	3,368
7	52,800	.05992	3,773	2,322	486	985	3,307
8	52,800	.05833	3,689	2,560	329	800	3,360
9	52,800	.05677	3,606	2,553	307	746	3,299
10	52,800	.05524	3,526	2,643	286	697	3,340
19	52,800	.04240	2,847	2,431	203	213	2,644

otherwise plow-back) would diminish rapidly. The 10-year total of this portion of net income is $11,557, which would purchase the materials for a reasonably good new house. The components for the 19th year are included in the table to show that, after purchasing a house or otherwise spending $11,557, the level of living could be maintained with some net income to spare. If the family had no further desire to raise the living level, this level could be maintained for another few years, but not likely until the operator reached 60 years of age. If he were to transfer the farm to a son, there would not be enough income to sustain two families until the death of the parents. It is doubtful if it would sustain one family. Also, the son would be in a position where no capital could be accumulated. The only way he could get out of this situation, short of liquidating, would be to increase the farm's efficiency considerably and utilize credit.

Projections 7 and 8.

The effect of levels of living on capital accumulation can be seen by projecting capital growth with the parameters of the multiple regression equation for living expenditures at the upper and lower confidence limits and comparing the results with Table 21. Ten-year projections suffice to note the effects (Tables 26 and 27).

Table 26. Projected capital accumulation with high living level[a] on a selected dairy farm, Marion County

Year	Total input capital	Net income	Household size[b]	Living expenditures[c]	Income taxes	Plow-back
1	52,800	4,305	2.0	2,424	867	1,014
2	53,814	4,282	2.5	2,765	719	798
3	54,612	4,242	2.5	2,759	709	774
4	55,386	4,200	2.5	2,753	697	750
5	56,136	4,155	3.0	3,063	548	544
6	56,680	4,097	3.0	3,054	532	511
7	57,191	4,036	3.2	3,171	515	350
8	57,541	3,965	3.7	3,476	360	129
9	57,670	3,883	3.7	3,465	339	79
10	57,749	3,799	3.9	3,580	315	-96

a. Both Tables 26 and 27 use the b-values used in Table 21. The regression equation for living expenditures used in this table is: $L = .14\ N + 625\ S + 571$ (See Chapter IV, p. 178).
b. Measured in adult equivalents.
c. Inflated according to price trend.

Although capital accumulates and living expenditures increase to maintain the original living level as the household grows, the plowback diminishes rapidly, to zero within the ten-year period. From Year 10 on, the farm could not maintain the family living level without depleting capital.

Table 27. Projected capital accumulation with low living level[a] on a selected dairy farm, Marion County

Year	Total input capital	Net income	Household size	Living expenditures	Income taxes	Plow-back
1	52,800	4,305	2.0	1,091	867	2,347
2	55,147	4,373	2.5	1,285	746	2,342
3	57,489	4,434	2.5	1,287	763	2,384
4	59,873	4,491	2.5	1,290	779	2,422
5	62,295	4,544	3.0	1,469	651	2,424
6	64,719	4,591	3.0	1,471	664	2,456
7	67,175	4,634	3.2	1,542	674	2,481
8	69,593	4,668	3.7	1,722	547	2,399
9	71,992	4,696	3.7	1,723	555	2,418
10	74,410	4,719	3.9	1,794	561	2,364

a. The regression equation for living expenditures used in this table is: $L = .04N + 351S + 217$ (See Chapter IV, p.178).

Comparing these two tables, in Table 27 the operator has $15,836 less living expenditures, which is less than half, over the period, than in Table 26. He makes $4,491 more net income but pays $1,206 more taxes, so he realizes only $3,285 more net income. This income plus the saving on living expenditures exactly equal the amount by which capital accumulation in Table 27 exceeds that of Table 26, namely, $19,121. Thus, the income that is consumed in the first case is mostly accumulated as capital in the second case, the balance going to taxes. However, in the second case the operator still has as much net income available for plow-back as when he started and is in a much better position to go into the second 10-year period than he would be in the first case.

Projections 9 and 10.

The effect of level of management on capital accumulation can be illustrated by representing a high management level with the parameters of the upper 95 percent confidence limit of the regression equation for net income and total input capital (Table 28). Similarly the lower confidence limit can be used to represent a low level of management (Table 29). In doing so, the parameters g and k, used to adjust the regression coefficient b_1 for changing trend in input prices, will be taken from the relevant upper and lower 95 percent confidence limits of the regression equation fro gross income and total input capital.

Table 28. Projected capital accumulation at a high level of management[a] on a selected dairy farm, Marion County

Year	b_1	Total input capital	Net income	Living expenditures[b]	Total tax	Plow-back
1	.09000	52,800	5,971	1,907	1,307	2,757
2	.08770	55,557	6,091	2,188	1,183	2,720
3	.08544	58,277	6,198	2,198	1,213	2,787
4	.08322	61,064	6,301	2,206	1,238	2,857
5	.08104	63,921	6,399	2,462	1,110	2,827
6	.07889	66,748	6,485	2,470	1,134	2,881
7	.07678	69,629	6,565	2,576	1,154	2,835
8	.07470	72,464	6,632	2,828	1,026	2,778
9	.07266	75,242	6,686	2,833	1,037	2,816
10	.07064	78,058	6,733	2,935	1,050	2,748

a. The regression equations used are:
$N = .09A + 1,219$ (See Chapter IV, p.165).
$G = .26A + 1,877$ (See Chapter IV, p.173).

b. The same parameters and assumptions on household size are used as were used for Table 21.

The efficient operator could almost maintain the rate of capital accumulation in spite of rising price levels, while maintaining the family's living level at the same time. On the other hand, the inefficient operator is likely to be forced, by rising price levels and increasing family size, to begin depleting capital considerably before

Table 29. Projected capital accumulation at a low level of management[a] on a selected dairy farm, Marion County

Year	b_i	Total input capital	Net income	Living expenditures	Total tax	Plow-back
1	.05000	52,800	2,639	1,608	417	614
2	.04880	53,414	2,606	1,871	272	463
3	.04761	53,877	2,564	1,867	263	434
4	.04645	54,311	2,522	1,863	252	407
5	.04530	54,718	2,478	2,105	96	277
6	.04418	54,995	2,429	2,101	92	260
7	.04307	55,255	2,379	2,194	87	98
8	.04198	55,353	2,323	2,436	84	-197
9	.04091	55,156	2,255	2,430	81	-256
10	.03985	54,900	2,187	2,521	78	-412

a. The regression equations used are:
$N = .05A - 1$ (See Chapter IV, p.165).
$G = .16A - 905$ (See Chapter IV, p.173).

the end of the period.

The projections thus far presented are all on a "pay-as-you-go" basis. It is instructive to project capital accumulation, utilizing credit to varying degrees. The variables and parameters for the same farm will be used. The same tableau as used for the pay-as-you-go calculations (see Appendix F) may be used, with the addition of two columns; one for interest, which must be subtracted from net income to calculate taxable income for all income taxes, and one for the annual payment on the debt.

Projection 11.

Assume that the operator obtains a loan at 6 percent interest that can be repaid in ten years by an annual amortized payment equal to the first year's plow-back on the pay-as-you-go projection, that is, $1,681. This will obtain a loan of $12,372. The beginning capital for the 10-year projection is now $65,172. The components of the projection are shown in Table 30.

Table 30. Projection of capital accumulation with a loan at 6 percent repayable in 10 years by plow-back from owned capital for Year 1[a], selected dairy farm, Marion County

Year	b_i	Total input capital	Net income	Living expend-itures	Income taxes	Pay-ment	Plow-back
1	.0700	65,172	5,171	1,835	902	1,681	753
2	.0682	65,925	5,105	2,098	756	1,681	570
3	.0665	66,495	5,031	2,091	753	1,681	506
4	.0648	67,001	4,951	2,083	749	1,681	438
5	.0632	67,439	4,871	2,323	606	1,681	261
6	.0615	67,700	4,773	2,314	599	1,681	179
7	.0599	67,879	4,675	2,404	592	1,681	- 2

a. See Table 21.

By the end of the seventh year the farm firm could no longer make the annual payment without reducing the level of family living. Neither could the operator postpone some of the payment hoping for a higher farm income in the future to "catch up" on payments, because net income continues to decline as the input price trend rises, relative to output prices.

At the end of seven years there is still $4,492 owing on the loan, which means that his equity is $63,385. He has been able to spend $15,148 on living. On the pay-as-you-go plan he is able to accumulate $63,515 but has had $14,764 available to spend on living. So, with the credit plan he has $384 more (in 7 years) to spend on living but accumulates $130 less capital. He also pays $96 more taxes.

Projection 12.

The projection in Table 21 shows a capital growth, in the ten-year period, of $14,290. It would seem feasible that if the farm could accumulate this much on a pay-as-you-go basis, the operator should be able to borrow this much in Year 1 and repay it in 10 years, having more input resources to start with in Year 1. Table 31 shows that this is not the case, however. The operator will be unable to meet his payment at the end of the 6th year, without reducing the family's living level. At this point of time, the projection shows a total of $407 more living expenditures than the pay-as-you-go plan (Table 21) but $115 more in income taxes and $87 <u>less</u> accumulated equity capital. Clearly, credit obtained on the basis assumed for these last two projections (Tables 30 and 31) offers very little economic advantage over the pay-as-you-go plan, and has the disadvantage of the risk the farmer takes when borrowing.

Table 31. Projection of capital accumulation with a loan at 6 percent repayable in 10 years, of an amount equal to the 10-year capital growth on a non-credit basis[a], selected dairy farm, Marion County

Year	b_1	Total input capital	Net income	Living expenditures	Income taxes	Payment[b]	Plowback
1	.0700	67,090	5,305	1,847	907	1,941	610
2	.0682	67,700	5,226	2,109	763	1,941	413
3	.0665	68,113	5,139	2,100	755	1,941	343
4	.0648	68,456	5,045	2,092	750	1,941	262
5	.0632	68,718	4,952	2,331	607	1,941	73
6	.0615	68,791	4,840	2,320	600	1,941	-21

a. See Table 21. The amount borrowed is $14,290.
b. Amortized at 6 percent for 10 years.

<u>Projection 13.</u>

Instead of plowing back surplus net income not required for payment on the debt, living or taxes, the operator could apply it on the loan and maintain total input capital at the amount in Year 1. The projection in Table 32 shows that the operator can pay off the loan in a little over 10 years this way, without sacrificing living level.

Table 32. Projection of capital accumulation repaying loan[a] with all net income available for "plow-back", selected dairy farm, Marion County

Year	b_1	Total input capital	Net income	Living expend-itures	Income taxes	Pay-ment	Debt balance
1	.0700	67,090	5,305	1,847	907	2,551	12,596
2	.0682	67,090	5,185	2,106	760	2,319	11,033
3	.0665	67,090	5,070	2,094	753	2,223	9,472
4	.0648	67,090	4,956	2,084	748	2,124	7,916
5	.0632	67,090	4,849	2,320	606	1,923	6,468
6	.0615	67,090	4,735	2,310	599	1,826	5,030
7	.0599	67,090	4,628	2,400	592	1,636	3,696
8	.0583	67,090	4,520	2,636	448	1,436	2,492
9	.0568	67,090	4,420	2,627	447	1,346	1,271
10	.0552	67,090	4,312	2,714	434	1,164	171
11	.0537	67,090	4,212	2,705	423	1,084[b]	-
12	.0522	68,003	4,159	2,700	413	1,046	
13	.0507	69,049	4,110	2,844	398	868	

a. The amount borrowed is the same as in Table 32 $14,290.
b. $913 of this can be invested back into the business. All subsequent "payments" can be also "plow-back".

The following comparison of the four methods of financing shows that at the end of six years[a] there is not a great deal of difference in advantages to the farmer:

Method	Total owned capital	Living expenditures	Income taxes	Interest paid
Table 21	62,148	12,392	4,267	-
Table 30	62,055	12,744	4,365	3,538
Table 31	62,040	12,799	4,382	4,086
Table 32	62,060	12,761	4,373	3,706

a. All of the figures are totals for the six years.

The benefit to net income, of using credit to start the period with more resources, is mostly lost to the farmer in interest paid out. He also pays slightly more income taxes (a little over $100 more) but he spends $250-$300 more on living. The slight advantage to the farmer is not enough to interest most farmers in credit, under the assumptions used. If the loan of $14,000 were used to increase the efficiency of the farm operations the results likely could justify the loan.

A similar comparison of the pay-as-you-go process of capital accumulation (Table 21) and the use of credit when all "plow-back" is used to repay the loan (Table 32), shows the same sort of result at the end of 10 years:

Method	Total owned capital	Living expenditures	Income taxes	Interest paid
Table 21	67,090	22,705	6,198	-
Table 32	66,919	23,138	6,294	4,429

The use of the $14,290 loan gives $433 more living expenditures but $96 more taxes and $171 less total input capital. Here again, the interest paid out offsets the advantage of the additional resources the credit provides in Year 1. In effect, although the operator has more resources to work with, his additional effort and the product of the additional resources go largely to interest.

Projection 14.

A farm operator with $52,800 owned assets could bourrow considerably more than $14,290. It is next assumed, therefore that he borrow $48,200, which will give him an even $100,000 total input capital to start Year 1. Assume also that he obtains this loan for 20 years at 5 percent, and is to repay it in equal annual amortized payments. The projection of capital accumulation in this situation is shown in Table 33.

Table 33. Projection of capital accumulation with a large loan[a] for a selected dairy farm, Marion County

Year	b_1[b]	Total input capital	Net income	Living expenditures	Income taxes	Payment	Flowback
1	.07000	100,000	7,609	2,054	1,102	3,868	585
2	.06824	100,585	7,473	2,314	945	3,868	346
3	.06651	100,931	7,322	2,300	927	3,868	227
4	.06481	101,158	7,165	2,285	910	3,868	102
5	.06313	101,260	7,002	2,517	747	3,868	-130

a. $48,200, amortized annually at 5 percent for 20 years.
b. It may be noted that b_1 is not always the same from table to table. This is because the adjustment for price trend varies with variations in total input capital in Year 1.

This loan provides only $200 more annually for living expenditures than the $14,290 loan. The total provided for the five years is $11,470. Roughly $150-$200 more taxes are paid annually. The total interest paid over the 5-year period is $11,284. Even with a relatively large loan, lower interest rate and longer repayment period the operator could not meet his total payment at the end of the fifth year.

The basic difficulty is the effect of adverse trends in the prices of things farmers buy, the input price component being by far the most important. If the changes in price trends of both input and output prices were the same, relative to each other, so that b_1 did not decline but remained constant, capital would grow fast enough to maintain or even increase annual plow-back. Under these conditions larger resources would result in faster accumulation. The importance of choosing, if possible, a product whose input and output price trends are likely to have this favorable relationship, can be seen readily. With the price trends used in these projections the farm operator, whose only income source is the farm and who has no unpaid labor, can maintain his annual plow-back only by constantly increasing the efficiency of the operation.

Projection 15.

Agricultural economists have realized for years that land constitutes a large portion of the total capital required by a farmer. It seems logical that, if the farmer did not have to tie up so much capital in land but could use it for other inputs, he could obtain more net income for his owned capital. Thus, proposals have been made for longer and longer term mortgages and even "perpetual mortgages", to reduce annual land costs to a minimum. A "perpetual mortgage", except for institutional devices of the property-right nature to provide security of tenure, amounts to perpetual payment of interest with no reduction of principal.

It is instructive to project capital accumulation under the assumption that land is not owned but an annual payment is made for it. For the dairy farm that has been used thus far in the illustrations, the land value (productive land) was $22,700, about 43 percent of total input capital. Assume this to be held under an agreement whereby the operator has security of tenure and has to pay 5 percent interest annually on the value of the land[a]. Under this assumption the operator's investment at Year 1 is only $30,100 plus the annual land payment, $1,135. However, he still has the same total input capital to work with, assumed to be organized in the same way. Thus the parameters and variables are the same as used for the previous projections. Table 34 shows the projected capital accumulation.

Table 34. Projected capital accumulation when land is not owned, on a selected dairy farm, Marion County

Year	b_i	Total input capital	Net income	Living expenditures	Income taxes	Annual[a] payment	Plowback
1	.07700	52,800	4,305	1,757	558	1,135	855
2	.06825	53,655	4,271	2,022	412	1,135	702
3	.06659	54,357	4,225	2,018	398	1,135	674
4	.06484	55,031	4,177	2,013	385	1,135	644
5	.06317	55,675	4,126	2,255	238	1,135	498
6	.06153	56,173	4,065	2,249	222	1,135	459
7	.05992	56,632	4,002	2,342	205	1,135	320
8	.05833	56,952	3,931	2,582	98	1,135	116
9	.05677	57,068	3,849	2,574	93	1,135	47
10	.05524	57,115	3,764	2,665	89	1,135	-125

a. The annual payment is 5 percent of $22,700. Since this would be classified as interest it is deductible from gross income fmr income tax purposes.

The same difficulties in accumulating capital are encountered under these conditions as in most of the previous projections. The total input capital at the end of the tenth year is $56,990, a gain of $4,190. If land values rise at the trend rate, the value of the land at the end of the tenth year will be $24,437 leaving owned capital of $32,553. Thus owned capital has increased $2,453.

a. The agreement would require some sort of an adjustment for inflation or deflation.

Growth Projections for an Intensive Crop Farm

All of the projections thus far have been for one type of farm, although the parameters apply to all types. It is instructive to project capital accumulation for another type of farm, to include the effect of unpaid labor as well as to widen the application.

One of the intensive cash crop (I-type) farms was selected with an operator 25 years of age. The total input capital of the farm amounted to $18,800. This particular operator was married and had a 2-year old child. Thus the household size at the beginning of the projection is 2.5 adult units. It will be assumed that a second child is born in Year 3 and a third in Year 6. The wife provided unpaid labor valued at $600 and the operator made $100 off-farm income. It will be assumed that, except for the years of child birth, the wife will contribute the same quantity of labor over the period of the projection and the operator will contribute the same quantity of off-farm work. It will be necessary to inflate the value of this labor to take into account rising price trend for farm labor[a].

For this type of farm in the sample, unpaid labor was typical of most farms visited. The intensive crops grown provide considerably more opportunity for family labor than do the other types of farms in the sample. Therefore, as the family grows, the additional value of unpaid labor provided by the growing children is added. It was

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a. This income was inflated on the basis of the 1951-1960 trend of the Index of Composite Farm Wage Rates - Pacific Region (73). The visually fitted straight line trend rises from an index of 467 in 1951 to 567 in 1961, in 9 increases, or 11.1 points per year.

arbitrarily assumed that a 12-year old child provided \$250 worth of labor during the year (mostly between May 1 and September 1), a 13-year old \$350 worth and a 14 to 18-year old \$500 worth.

In applying the adjustment to b_i for input price trend it is necessary to use the regression equation for gross income and total input capital for the I-type of farm (See Chapter IV, p.170), that is, $G = .404A - 1,712$. It was found that this produced an adjustment causing an even faster decline in b_i than that shown in the previous projections above.

Since, in the statistical analysis in Chapter IV, it was found that the regression coefficient of net income and total input capital for the farms of the I-type was highly significant and indicated a higher input-output ratio than for the pooled data, it was decided to use the parameters for the I-type regression to project the capital accumulation for the selected farm. These parameters are: $b = .1063$ and $a = 218$. (See Chapter IV, p.161.)

The same parameters for the multiple regression equation for living expenditures will be used.

The same tableaux outlined in Appendix F can be used for the calculations, with the addition of three columns for "other income" (unpaid labor plus off-farm labor), the "wage inflation factor" and "inflated additional income", respectively. The latter is calculated from the first two (by multiplying them) and added to the "plow-back".

Projection 1.

Table 35 shows the projected capital accumulation for this farm, under the stated assumptions, on a "pay-as-you-go" basis.

Table 35. Projected capital accumulation on a selected intensive crop farm, Marion County

Year	b_1	Total input capital	Net income (farm)	Living expend-itures[a]	Income taxes[a]	Added income[b]	Plow-back
1 (1957)	.1063	18,800	2,020	1,859	302	700	559
2 (1958)	.1038	19,359	2,227	1,901	360	715	681
3 (1959)	.1013	20,040	2,248	2,094	86	104[c]	172
4 (1960)	.0988	20,212	2,215	2,149	232	744	578
5 (1961)	.0964	20,790	2,222	2,250	238	758	492
6 (1962)	.0940	21,282	2,218	2,437	79	110[c]	-188
7 (1963)	.0917	21,094	2,152	2,493	107	787	339
8 (1964)	.0894	21,433	2,134	2,590	107	802	239
9 (1965)	.0871	21,672	2,106	2,588	107	816	227
10 (1966)	.0849	21,899	2,077	2,587	106	831	215
11 (1967)	.0827	22,114	2,047	2,761	162	1,148	272
12 (1968)	.0805	22,386	2,020	2,771	190	1,290	349
13 (1969)	.0784	22,735	2,000	2,788	238	1,500	474
14 (1970)	.0763	23,209	1,989	2,867	324	1,842	640
15 (1971)	.0743	23,849	1,990	2,880	366	2,001	745
16 (1972)	.0722	24,594	1,994	2,912	457	2,335	960
17 (1973)	.0702	25,554	2,012	2,986	531	2,599	1,094
18 (1974)	.0683	26,648	2,038	2,548	542	2,098[d]	1,046
19 (1975)	.0663	27,694	2,054	2,571	609	2,336	1,210
20 (1976)	.0644	28,904	2,079	2,577	625	2,372	1,249

a. Based on the net income from the farm business plus the allowance for unpaid labor and off-farm earnings.

b. The value of unpaid labor plus income earned off the farm. The total is inflated annually by the trend of the composite farm wage index for the Pacific region.

c. It is assumed that a child was born each of these years so that the wife could not assist in the farm work.

d. The first child is 19 this year so it is assumed that he leaves home and is not available to assist in the farm work.

This projection clearly illustrates the importance of unpaid labor and/or off-farm income to capital accumulation. It is true that living expenditures and income taxes are somewhat higher, due to the additional income, but it is apparent that without this income the firm would have almost zero "plow-back" right from the beginning, and could not maintain the living level of the household. The "plow-back" is considerably less than the "added income" for most of the years.

The availability of unpaid labor, whose value is inflated each year by wage trends, partially offsets the decline in b_i due to rising trend of input prices. As the family grows and become old enough to provide steadily increasing additional help, the decline in b_i is more than offset by the contribution of unpaid labor.

Although it is a long way in the future, some idea of the position of the firm when the children leave home can be obtained by continuing the projection through the 26th year (Table 36). It is assumed that the children leave home at the age of 19, but that the wife continues to work in the crops during the summer, even though by the time the children all leave she will be around fifty years old.

Table 36. Continuation of projection of capital accumulation in Table 35

Year	b_i	Total input capital	Net income (farm)	Living expenditures	Income taxes	Added income	Plowback
21	.0625	30,153	2,103	2,122	591	1,699	1,089
22	.0607	31,242	2,114	2,125	600	1,724	1,113
23	.0588	32,355	2,120	2,128	609	1,749	1,132
24[a]	.0570	33,487	2,127	1,675	556	1,035	931
25	.0553	34,418	2,121	1,671	558	1,049	937
26	.0535	35,355	2,109	1,573	559	1,064	943

a. All the children are assumed to have left home by the beginning of Year 24.

Although the decling value of b_i causes net income to decline during the last three years, the decline is offset by a decline in living expenditures and by the inflationary rise in wages (for unpaid labor). Income would be available for "plowing back" for several more years, but only if the wife continued to provide the same amount of unpaid labor.

Projection 2.

Assuming that the operator is capable of operating a farm with double the inputs, at the same efficiency, it is instructive to project capital accumulation beginning with a $20,000 loan, using the same assumptions on family growth, added income from unpaid labor, etc., as for the pay-as-you-go plan (Table 37). It will be assumed that the loan is for 30 years at 5 per cent interest and that the operator repays it with all surplus income otherwise available for "plowback".

With the assumed unpaid labor and off-farm income the loan can be repaid in 19 years. Of course, obtaining a loan on the strength of this growth in the household involves considerable uncertainty. When the children are born they could be insured to cover their contribution in unpaid labor. The insurance premiums would have to be subtracted from net income, which would retard the repayment rate. For present purposes it will be assumed that this household growth is normal.

The following comparison of the two projections at the end of the nineteenth year can be made:

Plan	Net capital accumulated	Total living expenditures	Income taxes	Social security	Interest paid
Credit	20,209	50,516	6,595	2,667	10,586
Pay-as-you-go	10,104	48,032	3,006	2,137	-
Difference	10,105	2,484	3,589	530	10,586

Table 37. Projecting of capital accumulation with a $20,000 loan for a selected intensive crop farm, Marion County

Year	b_i	Total input capital	Net income (farm)	Living expenditures	Income taxes[a]	Added income	Payment
1	.1063	38,800	4,342	2,068	652	700	2,322
2	.1038	38,800	4,245	2,085	649	715	2,226
3	.1013	38,800	4,148	2,267	341	104	1,644
4	.0988	38,800	4,051	2,316	497	744	1,982
5	.0964	38,800	3,958	2,407	490	758	1,819
6	.0940	38,800	3,865	2,587	133	110	1,255
7	.0917	38,800	3,776	2,640	334	787	1,589
8	.0894	38,800	3,687	2,731	331	802	1,427
9	.0871	38,800	3,597	2,724	316	816	1,373
10	.0849	38,800	3,512	2,717	309	831	1,317
11	.0827	38,800	3,427	2,887	380	1,148	1,308
12	.0805	38,800	3,341	2,892	407	1,290	1,332
13	.0784	38,800	3,260	2,902	450	1,500	1,408
14	.0763	38,800	3,178	2,975	532	1,842	1,513
15	.0743	38,800	3,101	2,981	571	2,001	1,550
16	.0722	38,800	3,019	3,004	643	2,335	1,707
17	.0702	38,800	2,942	3,071	719	2,599	1,751
18	.0683	38,800	2,868	2,624	725	2,098	1,617
19	.0663	38,800	2,790	2,638	783	2,336	1,705
20	.0644	39,009[b]	2,730	2,636	795	2,372	1,671[c]

a. Interest must be subtracted from net income in calculating taxable income and social security tax.
b. Of the $1,705 payment only $1,496 is required; $209 can be plowed back".
c. All of this is available for "plow-back".

The aggregate difference amounts to $27,294. Since the same aggregate value of unpaid labor and off-farm income, $23,156, enters each projection it is evident that this additional income ($27,294), generated by the farm itself, is due to the additional resources provided by the credit. The unpaid labor enables the farm firm to utilize the credit to generate the extra income. Of this extra income the lender gets $10,586, the state and federal governments get $3,589 and the farmer gets $13,119.

The interesting question arises as to whether more net income is generated over the projection period by doubling the size of the farm, ceteris paribus, or by two farms of the same size. Under the pay-as-you-go plan the farm capital produces \$39,763 aggregate net income in the 19 years; while with credit that initially doubles the size of the firm, the total input capital produces \$67,107 net income, only 1.7 times that of the pay-as-you-go plan[a]. This indicates that, using the same assumptions for each case, two small farms would add more to the gross national product over the projection period, and employ more people, than one farm initially made twice the size of the small farms by the use of credit, even though the farm family on the large farm would be considerably better off than each of the families on the small farms.

Matching present resources with future income goals.

An estimation of total input capital in Year 1 required to achieve future income goals is difficult, even without the uncertainty that increases as the length of the projection period increases. For example, suppose the household had the goal of putting all three children through four years of university. If they started at the age of 19, there would be one child in university every year from Year 18 to

a. It may be seen that the pay-as-you-go plan (Plan A) adds to total input capital at an annual rate that is high enough to offset the effect of prices on b_1. Net income stays about the same over the projection. On the other hand, the credit plan (Plan B) does not add to total input capital after the initial increase, so that net income declines under the full effect of prices on b_1. At the beginning, net income for Plan B is 2.14 times as much as for Plan A but at the end of the period it is only 1.35 times as large.

Year 27 inclusive, and in each of Years 21 and 24 there would be two. Average annual costs of attending public college has been estimated at $1,500 per student for 1957 (76). Parents or relatives provide about 60 percent of this. If these figures are inflated by the trend in the cost of living index used in the projections, the per student cost in Year 24 may be estimated to be $2,460, of which $1,476 would be provided by the parents. Two students that year would require $2,952 from the parents, based on these assumptions. This year would put the greatest strain on the income of the farm firm-household.

To estimate the total net income required that year it is necessary to add the living costs of the parents and the income taxes to the university costs. But estimating the taxes requires the net income figure, which leaves the estimator at an impasse. Living costs could be indexed upward from that required by the two parents in Year 1, but to estimate the Year 1 living expenditures one must have the net income for that year. To estimate this requires a knowledge of the total input capital in Year 1, which is the ultimate item to be estimated. So here is another impasse. The adjustment to b_i also depends to some extent on the total input capital in Year 1.

These impasses must be faced in any attempt to work backwards in the model from a net income goal to original capital required in Year 1; nevertheless a rough idea of original capital may be obtained from the forward projections. For example, Table 36 shows that $1,675 are available for living expenditures. This is based on an original capital of $18,800 (Table 35). Assuming the same parameters and income from unpaid and off-farm labor one may estimate roughly that another \$2,952 for college in Year 24 would require \$52,000[a] total input capital in Year 1. This can then be tested by a projection based on this estimate. Two successive approximations should suffice to provide a reasonably close estimate. With a projection of the growth of the farm business, such as those herein demonstrated, the operator and his family have a guide for matching resources with future goals. It is evident from this illustration that the operator, if he is about average in ability, must either build up capital and income considerably more rapidly or give up the goal of contributing to 3/5 of the college expenses of his children. The importance of unpaid labor, off-farm income and production efficiency is also clear. He must increase one or all of these to achieve the university goal if price trends continue to persist.

The uncertainty involved in making such long run projections is recognized; nevertheless the model provides a useful guide by making the major components of such projections explicit. As pertinent experience and information become available, new projections can be made. Better information and a shorter projection period both reduce projecting error. Meanwhile an annual "yardstick" is available for measuring the firm-household's conformity or departure from the projected growth pattern and estimating the effects of such departures.

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a. $\frac{2,952 + 1,675}{1675} \times 18,800$.

Decision: to Consume or Invest ?

There has been no discussion yet of the problem of deciding whether to spend all income or to "plow-back" some of it. Table 25 illustrates a situation where no income is plowed back, but more aspects of the decision required at the end of the first year can be added. The operator has $1,681 available, after normal living expenditures andincome taxes, about which to decide the use to which these funds can best be put. From the table it is estimated that over the ensuing 9 years there will be 9 more such annual sums available, diminishing in size each year and each requiring a decision. Only the first will be discussed as an illustration of the type of information needed for deciding on each subsequent sum.

If the operator and his family compare Table 25 with Table 21, where all P_i is "plowed back" he can see the difference in the amounts available for spending each year. Even if he gave away all of P_i each year, the normal living expenditures, as influenced by net income and family size, would be only $30 to $60 per year lower than if he plowed it all back. Thus if he decided to invest it all in industrial stocks, say, and let it accumulate, the slightly lower living would not influence the decision much.

The indicators for deciding whether to spend the money or invest it cannot be quantified for illustration. For instance, Heady points out that when the household is involved with the firm the problem is one of allocating resources to maximize utility over time and when the maximization of household satisfactions becomes the criterion, the market rate of interest (which compares the profitability of investing a sum of money that will bring income at a later time with loaning it out at interest) is no longer relevant (34, p. 423). What the decision will be will depend upon the way the operator and his family weight household satisfactions compared with their views on the long run growth of the firm. Tables 25 and 21 provide some assistance in clarifying the choice. Plowing back (Table 21) gives a total living plus capital accumulation of $36,995. Spending all net income (Table 25) gives total of $33,886. The net advantage for plowing back is $3,109. Also, at the end of 10 years the firm has more assets to continue operations.

Assuming a decision to forego consumption and to invest, the question then arises whether to invest it back into the farm or elsewhere. If it is to be plowed back into the business the easiest comparison can be made if it is assumed that the household keeps its living expenditures at the level shown in Table 25. Since income taxes deducted each year will be much the same in either case, they can be omitted from the comparison. It also is necessary to assume that within the firm, over a period of 10 years, the different forms of capital included in total input capital, are substitutable for each other, either physically or value-wise.

The amount of net income produced by each dollar invested in total input capital is given by the regression coefficient, b_i. The growth of $1.00 from Year 1 plowed back would be:

Year 2: 1.06825
Year 3: (1.06825) (1.06653)
Year 4: (1.06825) (1.06653) (1.06484)
:
:
:
and so forth.

It is clear that, so long as the regression coefficient exceeds the interest rate on alternative investments, it pays to plow-back surplus net income into the farm. It has been shown in the projections for a selected dairy farm, that b_i declines under the influence of rising input prices. When a Year is reached in which b_i is less than the interest rate in alternative investments, a transfer of investment is indicated. However, a farmer cannot immediately transfer part of his input capital without liquidating. Therefore, at the time the decision is made (beginning of Year 2 in this case) it is necessary to look at the whole projection period and compare the estimated aggregate net income with that of the alternative investment for the same period.

Computing Devices

The projections of capital accumulation, presented here as illustrations of the application of the method, suggest that there are numerous additional planning situations to which the method can be applied. Each situation must be calculated as indicated in the projections and in Appendixes E to G. With the "inputs" all at hand it requires one to two hours with a desk calculator to calculate one projection, if no mistakes are made. This is not only tedious but reduces the experimentation that can be made with the model.

An examination of the calculating procedures in Appendixes E to G suggests that simple programs for these can be written for an electronic computer. This would greatly reduce the calculating time required. The mathematics involved in the calculations are simple. The regression analyses required to provide the parameters are easily programmed and can be "tied" to the projection calculations.

Summary

The projections presented in this Chapter provide important guidance on several fundamental planning problems faced by farmers:

1. The effect of consuming or plowing back surplus net income;
2. The importance of increasing efficiency in the face of rising input prices (relative to product prices);
3. The results of using credit versus pay-as-you-go plans, the effect of length of repayment period, amortized payments versus payment as rapidly as possible;
4. The importance of unpaid labor and off-farm income;
5. The effect of living costs on capital growth;
6. The importance of products the price trends for which are likely to be favorable, relative to price trends for inputs;
7. The matching of income goals with resources, and limitations and directions to move for obtaining additional resources.

With awareness of the assumptions and limitations associated with its use, the method for making these projections provides a useful tool to assist in solutions to these problems and a number of others likely omitted from the list.

CHAPTER VI

CONCLUSION

The specific objective of this study has been to devise, partially test and illustrate a method for projecting capital accumulation for a particular farm over a period of years into the future, in order to estimate the future net income available at the time future needs are likely to arise. Farmers also are usually interested in the growth of assets for retirement. Such estimates are necessary in long run planning of family expenditures and of production.

Capital growth on most farms depends mainly on net income, that is, the amount of net income that is converted into capital. In the firm-household context, living expenditures are important and long run planning must explicitly recognize their influence on capital growth. Such planning must therefore estimate annual net income, living costs and other withdrawals from net income so that the residual available for "plowing back" into the business may be estimated. This study has developed a method for projecting the main components in capital growth of an agricultural firm-household, recognizing explicitly the effects of living expenditures, as well as price trends, income tax, unpaid family labor and income from off-farm sources.

The method relies on regression estimates of the main variables. Total input capital is the independent variable used to estimate usual net income. The independent variables used to estimate usual living expenditures are usual disposable net income and household size, in adult equivalents[a]. The parameters relating these variables, are to be obtained by fitting regression equations to appropriate data obtained from the farm for which the projection is to be made or from a group of similar farms.

Utilizing the variables indicated above and their associated parameters, three models are developed for projecting capital accumulation. One model is based on the assumption of no change in relationships between input and output prices and no income taxes. It is unrealistic and serves only as a "benchmark" for comparison with projections using the other models. Another is based on the same price assumption but taxes are included in the projection. This model is more realistic but is still unsatisfactory. It is more useful in that a projection, making use of it, can serve to note the effect of price level changes, when compared with the third model. The third allows for changes in price relationships and for taxes. It is the most realistic and the most flexible and is selected as the only one of the three for practical application.

Conclusions from Statistical Analysis

The use of the method rests on several hypotheses that were statistically tested with inter-firm survey data obtained from a random sample of farms in the Mount Angel-Woodburn area of Marion County. The analysis led to the following conclusions:

1. Total input capital was significantly related to usual net income.

a. These variables have been defined in Chapter IV.

This relationship is linear. The variability in total input capital "accounts for " 39 percent of the variability in usual net income.

2. Variation in general organization of inputs, as this organization is expressed by type of farm, had no significant effect on the relationship between usual net income and total input capital. This indicates that the addition of new enterprises will not affect this relationship, if management remains constant. Such stability in the relationship tends to reduce the error in projecting capital accumulation for a particular farm.

3. Total input capital was significantly related to usual gross income (defined on p.151) and accounts for 67 to 83 percent of the variability in usual gross income, depending on the type of farm. There was a significant difference, between the intensive crop farms and other types of farms, in the relationship between total input capital and usual gross income. There was no such difference among the other types of farm (dairy, extensive crop, extensive livestock and mixed). The effect of type of farm on the relationship must be recognized in the method when adjusting for the effect of price trends on the relationship between total input capital and net income (See Appendix A6).

4. The sample showed no significant difference among the Amity, Willamette and Woodburn soils in their effect on the relationship between usual net income and total input capital. Such a conclusion may be anticipated if land is priced in a reasonably competitive market and price expresses agricultural productivity. This type of stability in the relationship reduces the inter-farm-intra-farm type of

error likely to occur when applying the (net income-capital) parameter obtained from a sample of farms, to a particular farm in the population represented by the sample.

5. Usual disposable net income and family size accounted for more variability in usual living expenditures (64 percent) than did usual disposable net income alone (33 percent). Both variables were significantly related to living expenditures, the relationship being linear over the range of the data.

It is recognized that the main problem in using the method is in the prediction of usual net income based on the single independent variable, total input capital. A better prediction of net income might be developed by breaking down this variable into several independent variables. However, in the accumulation model it would be necessary each year to allocate the annual "plow-back", or its effect, to each of these independent variables. At present, no logical basis for doing this is at hand.

Dynamic programming solves this problem by optimally allocating "plow-back", on the basis of projected price relationships and input-output coefficients. Budgeting could do this, also, but determining the optimum allocation by trial and error methods would be a prodigious task. If, in budgeting, past use of capital were to serve as the basis for allocating future plow-back, or a normalized allocation were assumed, there would be no advantage, in this regard, over the regression method developed in this study.

Another problem that exists for any method of estimating the value of a variable for Year i based on the estimate for Year i-1, is the compounding of error. It may be that such error is partially offset by compensating errors.

The regression approach to projecting capital accumulation, because of the nature of the statistical logic involved, forces explicit recognition not only of these problems but of the problems of projecting input-output coefficients, price relationships, family size and living expenditures. Budgeting and dynamic programming tend to conceal sources of error in projecting these components. A test of which method provides the most accurate projection of capital accumulation over a long period requires appropriate historical data.

Conclusions from Projections of Capital Accumulation

The statistical testing of the hypotheses also provided parameters for applying the method in projecting capital accumulation for farms selected from the sample as illustration. Depending upon the reliability of the projections, several conclusions can be made and some interesting suggestions raised from projections:

1. Assuming a constant relationship among trends in prices of inputs, products and items purchased for living, the effect of income taxes (federal, state and social security) on capital accumulation tends to accelerate over a long period of time. Over a twenty year period, assuming no change in input-output relationship, the loss in capital accumulation over the latter 10 years is considerably greater than

(almost twice) the loss during the first 10 years. However, under the assumptions, the ability of the firm to forego the capital is greater in the latter half of the period.

2. The effect of the relationship between input and output price trends on projected capital accumulation for the selected farm was estimated. The straight line trend of prices from 1953 to 1962 inclusive was used to estimate price relationships over the projection period. The trend in product price level shows no change; the input price index trend rises 2.2 points per year; and the trend of the index of item purchased for farm living rises 3.3 points per year. As a general statement, the prices of things farmers buy are tending to rise relative to the prices of things farmers sell.

Price trends have an accelerated effect similar to that of income taxes. The illustration farm (a dairy farm starting the projection with $52,800 total input capital, and assuming a 25-year old operator in a typical household situation) could accumulate $4,100 more capital in the first ten years if price trends were to maintain a constant relationship to each other rather than the trends estimated above. In the last 9 years of the projection another $8,400 could be accumulated. Estimated annual net income would be $1,300 more in the 10th year and $2,900 more in the 19th year. (This assumes payment of income taxes and maintenance of living standards for a household of normal size and growth). The effect of the adverse price relationships is to diminish the amount "plowed back" each year. The trend in input prices relative to output prices has a considerably greater effect in this decline in "plow-back" than does the trend in prices of living items purchased.

If the projected relative price trends, income taxing rates and input-output relationships were to continue unchanged, the annual plow-back for the illustration farm would decline to zero in 25-30 years after which the household could not continue to maintain living standards, at the 1957 level, without depleting capital[a]. This estimate does not use discounting procedures; if these were used this situation could be estimated to occur considerably sooner.

3. If household size, measured in adult equivalents, remains constant, which in effect means having no children, the annual "plow-back" and net income remain about the same each year, for the illustration farm. The effect of the adverse price trends is just offset. If the operator and his wife have no family, capital growth is $2,100 more, over ten years, than if they had the three children assumed for the other projections. The living expenditure per adult equivalent in the tenth year would be $890 with no children and almost $700 with children.

4. For a particular farm the main way in which the effect of adverse price trends can be offset is by increasing efficiency. In order for an average operator and family in 1957 to maintain a constant "plow-back" each year it is concluded necessary, under all the other assumptions, to increase net income-producing efficiency by 16 percent over the 10-year projection period. The effect of adverse price trends

a. If annual "plow-back" declines steadily, even though capital is being accumulated, it is only a matter of time before "plow-back" reaches zero and the household must choose between depleting capital or lowering its living level.

is brought out strikingly for the illustration farm, if <u>all</u> net income is assumed to be plowed back annually into capital, over a ten-year projection. It was estimated that total input capital would have to be increased 80-90 percent, over the period, to produce an increase in annual income of 40 percent.

5. Using the lower confidence limits of the estimating equation for living expenses as an arbitrary low level of living, which means starting the projection with living expenditures 38 percent below the average, the size of annual "plow-back" can be just maintained[a]. When living expenditures are estimated at the upper confidence limits, which starts the projection with living expenditures 38 percent above the average, annual "plow-back" diminishes to zero by the end of the ninth year of the projection. Maintaining living standards thereafter would require depletion of capital.

The opportunity for reducing living expenditures is small. In the face of the estimated price trends, the importance of even preventing any rise in living expenditures is clear.

6. The effects of high and low levels of management are also simulated by using the values of the upper and lower confidence limits in the estimating equation for net income. For a ten-year projection, the high level of management, which starts the projection with a net income 39 percent higher than the average, can maintain the level of "plow-back" with an above-average level of living. For the low

a. The living expenditures in the tenth year would be 34 percent below those estimated for the average level of living. The 4 percent gain is due to a relatively more rapid accumulation of capital with the lower living expenditures.

level of management, the "plow-back" declines annually to zero by the eighth year and thereafter capital would have to be depleted to maintain the level of living.

7. Several projections were made assuming various simulated credit situations. Under the estimated price trends, household growth and level of efficiency, it is clear that longer run loans (10 year repayment or more) would be very difficult to repay on an amortized basis. Increasing the size of loan, reducing the interest rate and lengthening the repayment period do not assist much. They merely postpone the day when the payments can no longer be met out of current income. Under all of the assumed situations, inability to meet the annual payment developed within 10 years of the time repayment began[a]. For the longer run loans, amortized payment can be made only under those conditions that enable the firm-household to maintain the size of the annual "plow-back".

On the other hand, the projections show that under the same price, household and efficiency assumptions, loan repayment can be made successfully if repaid as rapidly as possible, that is, if all "plow-back" (exceeding normal living expenditures) is paid on the loan. The advantage of rapid repayment is clearly demonstrated.

8. Under the assumptions, it is indicated that credit offers only a slight advantage to farmers represented by the sample, very likely not enough to induce its use. The benefit to net income of more assets

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a. Welch found for a somewhat similar sample of Oregon farms, that "net farm income in many cases was not sufficient to make loan payments and still provide for a modest level of family living" (80).

to start the period is mostly lost to the operator in interest paid on the loan. If the credit funds could be used to increase efficiency above the average, to counteract adverse price trends, results likely would justify the loan. So long as the estimated price trends persist, caution is indicated on longer run loans in average farm situations of the types represented by the sample farms. Without an increase in efficiency the borrower is likely to be in difficulty sooner or later.

9. The unpaid family labor provided by a growing household, along with income from off-farm sources, can offset the effect of adverse price trends, depending on the amount contributed to net income by each[a]. More important is the assistance that these sources of income can be to the firm in utilizing credit. The previous conclusion (No. 8 above) indicates only a slight advantage to the farmer in using credit compared with operating on a "pay-as-you-go" basis. However, utilizing unpaid family labor and a relatively small amount of off-farm income, under the same assumptions the use of credit has a distinct advantage over the "pay-as-you-go" operation.

10. If the farm family wishes to consider alternative non-farm investment uses of the "plow-back", assuming the same income taxes and projected living expenditures, it will pay to invest the money back into

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a. An intensive crop farm (Type I) was selected from the sample to illustrate the use of the projection method while allowing for unpaid labor and off-farm income. Unpaid family labor was typical on the farms of this type. The operator was 25 years old and the total input capital was $18,800. The wife contributed unpaid labor in the summer. The operator earned $100 in off farm work.

the farm so long as the regression coefficient b_i^a, as influenced by the price trends, exceeds the return on alternative investments. However, because much of the farm input capital is not liquid, average values of b_i over long run projection must be used for comparison with alternative investment opportunities, to make the decision currently.

11. The projections for the intensive crop farm suggest that two farms of the same size (in size range of the illustration farm and household), can produce more net income and employ more people, over a 19-year period on a pay-as-you-go plan, than one of these farms doubled in size by use of credit. (It is assumed that no change in efficiency occurs from doubling the size, and that the loan is repaid as rapidly as possible while maintaining the original standard of living.)

12. The method can be useful to the individual farm family to map out in a general way a long run plan for the growth of the firm, income available for family spending and the effects of credit, non-farm income and unpaid family labor on growth and income. The effects of various income withdrawals can be planned, also. It is possible to use the plan to replace depreciation accounting with "capital replacement" accounting by integrating the withdrawals for replacements into the projections and eliminating depreciation from the calculation of net income. The model is flexible enough to embrace simulations of varied facets of long run problems faced by farm operators and their families, to assist in their planning decisions.

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a. Expressing the relationship between net income and total input capital.

Future Research

It is recognized that the sample used for testing the hypotheses is small and localized. Further testing is needed, using a larger sample covering a wider variety of farm types and soil conditions. Most needed, for testing the accuracy of the model in projecting capital accumulation, are historical data on individual farms sampled. These are needed also to help provide better parameters for application.

The model itself needs refining to increase the accuracy in estimating net income and living costs. Some of the works reviewed in Chapter III suggest avenues of approach to refine the method. Further research is needed on the effect of the age of the operator and his family on consumption-investment decisions. How does age affect discounting? Only a brief mention of the effect of discounting has been made in this study and it was not taken into consideration in the projections. Although subjective discounting is difficult to deal with, the usual form of discounting in the business world may offer an avenue for refinement of the model, and may become more necessary as farms become more businesslike.

The method will benefit from any refinements and progress in projecting prices and price trends of inputs, outputs and living expenditure items. Undoubtedly more refinement in price prediction that exists in this thesis can be made by recognizing cyclical trend vis a vis straight line projections[a]. Also, price trends for a more

a. In 1953 Nielson published a good short discussion of the use of long-run price forecasts in farm planning (56).

detailed breakdown of individual product groups could be used to apply to the different types of farms.

General Comments

The viewpoint taken in this thesis is to provide a guide for decision-making by the farm operator and his family, not to lay out specific plans to be followed inflexibly. The main decision in which the study is interested is that of consumption of net income versus investment. The model developed herein to deal with this, encompasses the basic factors in the financing problems of most farm operators, namely, the level of living desired, the productivity of the farm, the capital necessary and the firm-household relationships. It helps to separate out the problem areas and to integrate them at the same time. This aids in clarifying both research and planning.

Heady has recently pointed out that in the future the problem of the individual farmer in supplying his capital needs will indeed be greater than the problem of credit institutions in supplying enough credit for the agricultural industry (35, p. 129). In view of such a possibility, the whole subject of long run planning by the agricultural firm-household has received inadequate attention to date. Perhaps this is because of the difficulties involved. Heady has broken ground in this field and Loftsgard, assisted by Heady, has made an important contribution. It is hoped that this study will constitute a useful addition and will stimulate further study of the subject.

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APPENDIXES

APPENDIX A

Derivation of Estimating Equations

1. Deriving the equation for projecting total capital, net income, living costs and "plow back", i.e., investment back into the business, for the year i, in the future, given present total capital = A and the empirical ratios of (a) net income to total capital and (b) living costs to net income.

Let k_N = ratio of net income, N, to total capital;

k_L = ratio of living costs, L, to net income;

A = total capital at beginning;

P = amount of N re-invested the following year. $P = N - L$.

To simplify the writing, let $k_N = a$ and $1 - k_L = b$

Year 1: $TC_1 = A$, total capital at the beginning of year 1.

$N_1 = k_N A = aA$

$L_1 = k_L N_1 = k_L k_N A$

$P_1 = N_1 - L_1 = k_N A - k_L k_N A = k_N A (1 - k_L) = abA$

Year 2: $TC_2 = A + P_1 = A + abA = A (1 + ab)$

$N_2 = k_N (A + P_1) = k_N (A + abA) = aA (1 + ab)$

$L_2 = k_L k_N [A + k_N A (1 - k_L)] = k_L aA (1 + ab)$

$P_2 = N_2 - L_2 = aA (1 + ab) - k_L aA (1 + ab) = aA (1 + ab)$
$(1 - k_L) = abA (1 + ab)$

Year 3: $TC_3 = A + P_1 + P_2 = A + abA + abA (1 + ab) = A (1 + ab)^2$

$N_3 = k_N (A + P_1 + P_2) = a [A + abA + abA (1 + ab)]$
$= aA (1 + ab)^2$

$$L_3 = k_L N_3 = k_L aA (1 + ab)^2$$

$$P_3 = N_3 - L_3 = aA (1 + ab)^2 - k_L aA (1 + ab)^2 = abA (1 + ab)^2$$

Year i: $TC_i = A + P_1 + P_2 + \ldots + P_i = A (1 + ab)^{i-1}$

$$= A\left[1 + k_N (1 - k_L)\right]^{i-1}$$

$$N_i = aA (1 + ab)^{i-1} = k_N A \left[1 + k_N (1-k_L)\right]^{i-1}$$

$$L_i = k_L aA (1 + ab)^{i-1} = k_L k_N A \left[1 + k_N (1-k_L)\right]^{i-1}$$

$$P_i = abA (1 + ab)^{i-1} = k_N (1-k_L) A \left[1 + k_N (1-k_L)\right]^{i-1}$$

2. Development of adjustments to the ratio k_N for changing trends in prices of outputs and inputs.

To isolate the effect of price, the method similar to that used in price-index construction, whereby a "bundle" of goods is held constant in quantity and quality and only price changes are indexed, will be applied.

Output price-trend increase:

To derive the adjustment to k_N it will be assumed that output quantity, input quantities and input prices remain constant.

(a) Assume that the trend in output prices increases p percent per period.

Where N is net income, GR is gross revenue and GE is gross expenditure, N = GR - GE. Thus, $N_1 = GR_1 - GE_1$ for Year 1.

$k_{N_1} = \frac{N_1}{A} = \frac{GR_1 - GE_1}{A}$, where A is total input capital beginning Year 1. $k_{N_2} = \frac{N_2}{A} = \frac{GR_2 - GE_1}{A}$. Note that only GR_1 changes under the assumptions.

But,

$GR_2 = GR_1 + pGR_1$, where p is expressed as a decimal fraction.

So,

$$k_{N_2} = \frac{GR_1 + pGR_1 - GE_1}{A}$$

$$k_{N_2} - k_{N_1} = \frac{GR_1 + pGR_1 - GE_1}{A} - \frac{GR_1 - GE_1}{A} = \frac{pGR_1}{A}$$

Thus,

$$k_{N_2} = k_{N_1} + \frac{pGR_1}{A}$$

Continuing:

$$k_{N_3} = \frac{N_3}{A} = \frac{GR_3 - GE_1}{A} = \frac{GR_2(1+p) - GE_1}{A} = \frac{GR_1(1+p)^2 - GE_1}{A}$$

$$k_{N_3} - k_{N_2} = \frac{GR_1(1+p)^2 - GE_1}{A} - \frac{GR_1(1+p)-GE_1}{A} = \frac{GR_1\left[(1+p)^2-(1+p)\right]}{A}$$

$$= \frac{pGR_1(1+p)}{A}$$

Thus,

$$k_{N_3} = k_{N_2} + \frac{pGR_1(1+p)}{A} = k_{N_1} + \frac{pGR_1}{A} + \frac{pGR_1(1+p)}{A}$$

$$= k_{N_1} + \frac{pGR_1}{A}\left[1+(1+p)\right]$$

Similarly,

$$k_{N_4} = k_{N_1} + \frac{pGR_1}{A}\left[1 + (1+p) + (1+p)^2\right]$$

and

$$k_{N_i} = k_{N_1} + \frac{pGR_1}{A}\left[1 + (1+p) + (1+p)^2 + \ldots + (1+p)^{i-2}\right]$$

Let $\frac{GR}{A} = k_R$ so that $\frac{GR_1}{A} = k_{R_1}$ and substitute in the above equation. Thus k_{N_i} for Year i can be estimated from k_{N_1}, A, GR_1 and p. The adjustment is not necessary for Year 1 and for Year 2. the value of the term inside square brackets is unity.

(b) If the projected price is estimated by a straight line projection the percentage change in the trend changes, that is p is not constant. The result is that k_{N_i} cannot be calculated with the equation shown in (a). The appropriate adjustment is developed as follows:

$k_{N_2} = \frac{GR_2 - GE_1}{A}$, as in (a); but now $GR_2 = GR_1 + p_1GR_1$ and

$$k_{N_2} - k_{N_1} = \frac{p_1GR_1}{A}$$

$$k_{N_3} = \frac{GR_3 - GE_1}{A} = \frac{GR_2 + p_2GR_2 - GE_1}{A} = \frac{GR_2(1+p_2) - GE_1}{A}$$

$$= \frac{GR_1(1+p_1)(1+p_2) - GE_1}{A}, \text{ and}$$

$$k_{N_3} - k_{N_2} = \frac{GR_1(1+p_1)(1+p_2)-GE_1}{A} - \frac{GR_1(1+p_1)-GE_1}{A}$$

$$= \frac{GR_1(1+p_1)(1+p_2-1)}{A} = \frac{p_2GR_1(1+p_1)}{A}$$

Thus,

$$k_{N_3} = k_{N_2} + \frac{p_2GR_1(1+p_1)}{A} = k_{N_1} + \frac{p_1GR_1}{A} + \frac{p_2GR_1(1+p_1)}{A}$$

Similarly,

$$k_{N_4} = k_{N_1} + \frac{p_1 GR_1}{A} + \frac{p_2 GR_1(1+p_1)}{A} + \frac{p_3 GR_1(1+p_1)(1+p_2)}{A}$$

and

$$k_{N_i} = k_{N_1} + \frac{GR_1}{A}\Big[p_1 + p_2(1+p_1) + p_3(1+p_1)(1+p_2) + \dots + p_{i-1}(1+p_1)$$
$$(1+p_2) \dots (1+p_{i-2})\Big]$$
$$= k_{N_1} + k_{R_1}\Big[p_1 + p_2(1+p_1) + p_3(1+p_1)(1+p_2) + \dots + p_{i-1}(1+p_1)$$
$$(1+p_2) \dots (1+p_{i-2})\Big]$$

Here also the adjustment does not apply to Year 1 and for Year 2: the value of the term inside square brackets is p.

Output price-trend decrease:

(a) Assume a constant decrease of p percent per period and holding the other components of N constant:

$$N_1 = GR_1 - GE_1$$
$$N_2 = GR_1 - p(GR_1) - GE_1 = GR_1(1-p) - GE_1$$
$$k_{N_1} = \frac{GR_1 - GE_1}{A}$$
$$k_{N_2} = \frac{GR_2 - GE_1}{A} = \frac{GR_1(1-p) - GE_1}{A}$$
$$k_{N_2} - k_{N_1} = \frac{GR_1 - pGR_1 - GE_1 - GR_1 + GE_1}{A} = \frac{-pGR_1}{A}$$
$$k_{N_2} = k_{N_1} - \frac{pGR_1}{A}$$

$$k_{N_3} = \frac{GR_3 - GE_1}{A} = \frac{GR_2(1-p) - GE_1}{A} = \frac{GR_1(1-p)^2 - GE_1}{A}$$

$$k_{N_3} - k_{N_2} = \frac{GR_1(1-p)^2 - GE_1 - GR_1(1-p) + GE_1}{A}$$

$$= \frac{GR_1(1-p)(1-p-1)}{A} = \frac{-pGR_1(1-p)}{A}$$

$$k_{N_3} = k_{N_2} - \frac{pGR_1(1-p)}{A} = k_{N_1} - \frac{pGR_1}{A} - \frac{pGR_1(1-p)}{A}$$

$$= k_{N_1} - \frac{pGR_1}{A}\left[1+(1-p)\right]$$

Similarly,

$$k_{N_4} = k_{N_1} - \frac{pGR_1}{A}\left[1 + (1-p) + (1-p)^2\right] \quad \text{and}$$

$$k_{N_i} = k_{N_1} - \frac{pGR_1}{A}\left[1 + (1-p) + (1-p)^2 + \ldots + (1-p)^{i-2}\right]$$

Substituting k_{R_1} for $\frac{GR_1}{A}$

$$k_{N_i} = k_{N_1} - pk_{R_1}\left[1 + (1-p) + (1-p)^2 + \ldots + (1-p)^{i-2}\right]$$

(b) Assuming a constant straight line trend where p is not constant, it can be shown, by the same procedure used for the rising trend that

$$k_{N_i} = k_{N_1} - k_{R_1}\left[p_1+p_2(1-p_1)(1-p_2)+\ldots+p_{i-1}(1-p_1)(1-p_2)\ldots(1-p_{i-2})\right]$$

<u>Input price-trend increase:</u>

(a) Assume a constant increase of p percent per period holding output and output prices constant and holding physical inputs constant:

$$k_{N_1} = \frac{N_1}{A_1} = \frac{GR_1 - GE_1}{A_1}$$

$$k_{N_2} = \frac{N_2}{A_2} = \frac{GR_1 - GE_2}{A_1 + pA_1} = \frac{GR_1 - GE_1(1+p)}{A_1(1+p)} = \frac{GR_1 - GE_1 - pGE_1}{A_1(1+p)}$$

$$k_{N_2} - k_{N_1} = \frac{GR_1 - GE_1 - pGE_1}{A_1(1+p)} - \frac{GR_1 - GE_1}{A_1}$$

$$= \frac{GR_1 - GE_1 - pGE_1 - (1+p)(GR_1-GE_1)}{A_1(1+p)}$$

$$= \frac{GR_1 - GE_1 - pGE_1 - GR_1 + GE_1 - pGR_1 + pGE_1}{A_1(1+p)} = \frac{-pGR_1}{A_1(1+p)}$$

$$k_{N_2} = k_{N_1} - \frac{pGR_1}{A_1(1+p)} = k_{N_1} - \frac{pGR_1}{A_1}(1+p)^{-1}$$

$$k_{N_3} = \frac{GR_1 - GE_1(1+p)^2}{A_1(1+p)^2}$$

$$k_{N_3} - k_{N_2} = \frac{GR_1 - GE_1(1+p)^2}{A_1(1+p)^2} - \frac{GR_1 - GE_1(1+p)}{A_1(1+p)}$$

$$= \frac{GR_1 - GE_1(1+p)^2 - GR_1(1+p) + GE_1(1+p)^2}{A_1(1+p)^2}$$

$$= \frac{GR_1(1-1-p)}{A_1(1+p)^2} = -\frac{pGR_1}{A_1(1+p)^2}$$

$$k_{N_3} = k_{N_2} - \frac{pGR_1}{A_1(1+p)^2} = k_{N_1} - \frac{pGR_1}{A_1}(1+p)^{-1} - \frac{pGR_1}{A_1}(1+p)^{-2}$$

$$= k_{N_1} - \frac{pGR_1}{A_1}\left[(1+p)^{-1} + (1+p)^{-2}\right]$$

Similarly,

$$k_{N_i} = k_{N_1} - \frac{pGR_1}{A_1}\left[(1+p)^{-1} + (1+p)^{-2} + \ldots + (1+p)^{-(i-1)}\right]$$

Letting $k_{R_1} = \frac{GR_1}{A_1}$,

$$k_{N_i} = k_{N_1} - pk_{R_1}\left[(1+p)^{-1} + (1+p)^{-2} + \ldots + (1+p)^{-(i-1)}\right]$$

(b) Assuming a constant straight line upward trend in input prices, when p is not constant but is different every period, the same logic used thus far to develop adjustments to k_N shows that

$$k_{N_i} = k_{N_1} - k_{R_1}\left[\frac{p_1}{1+p_1} + \frac{p_2}{(1+p_1)(1+p_2)} + \ldots + \frac{p_{i-1}}{(1+p_1)(1+p_2)\ldots(1+p_{i-1})}\right]$$

<u>Input price trend decrease</u>:

(a) Allowing input prices to decrease by p percent per period and holding all other components of N constant:

$$k_{N_1} = \frac{GR_1 - GE_1}{A_1}$$

$$k_{N_2} = \frac{GR_1 - GE_1(1-p)}{A_1(1-p)}$$

$$k_{N_2} - k_{N_1} = \frac{GR_1 - GE_1(1-p)}{A_1(1-p)} - \frac{GR_1 - GE_1}{A_1} = \frac{pGR_1}{A_1(1-p)}$$

$$k_{N_2} = k_{N_1} + \frac{pGR_1}{A_1(1-p)}$$

Similarly,

$$k_{N_3} = k_{N_2} + \frac{pGR_1}{A_1(1-p)^2} = k_{N_1} + \frac{pGR_1}{A_1(1-p)} + \frac{pGR_1}{A_1(1-p)^2}$$

$$= k_{N_1} + \frac{pGR_1}{A_1}\left[(1-p)^{-1} + (1-p)^{-2} \quad \text{, and} \right]$$

$$k_{N_i} = k_{N_1} + \frac{pGR_1}{A_1}\left[(1-p)^{-1} + (1-p)^{-2} + \ldots + (1-p)^{-(i-1)}\right]$$

Substituting k_{R_1} for $\frac{GR_1}{A_1}$,

$$k_{N_i} = k_{N_1} + pk_{R_1}\left[(1-p)^{-1} + (1-p)^{-2} + \ldots + (1-p)^{-(i-1)}\right]$$

(b) Assuming a constant straight line downward trend in input prices, when p is not constant but is different every period, it can be shown that

$$k_{N_i} = k_{N_1} + k_{R_1}\left[\frac{p_1}{1-p_1} + \frac{p_2}{(1-p_1)(1-p_2)} + \ldots + \frac{p_{i-1}}{(1-p_1)(1-p_2)\ldots(1-p_{i-1})}\right]$$

Input and output price-trends together:

If the trends are not "flat", that is, price levels of both inputs and outputs are changing, the adjustments for both can be applied to k_{N_1} at the same time, e.g., assume an upward trend in output prices and a downward trend in input prices at constant percentages.

Then:

$$k_{N_i} = k_{N_1} + pk_{R_1}\left[1 + (1+p) + (1+p)^2 + \ldots + (1+p)^{i-2}\right]$$

$$+ pk_{R_1}\left[(1-p)^{-1} + (1-p)^{-2} + \dots + (1-p)^{-(i-1)}\right]$$

where the p-value in the second term on the right-hand side of the equation is for output prices and the p-value in the third term is for input prices. Similarly the adjustments may be combined in various ways, depending on the price trends.

3. Deriving R_i to allow for a changing ratio of living costs to net income in projecting total capital for year i.

Let $R_i = \frac{L_i}{N_i}$, i.e., substitute R for k_L.

When $L = cN + d$ or

$L = dN^c$,

R_i changes with N_i, according to $R_i = c^{N_i}$, an exponential.

When R_i is changing it is necessary to project R_i beforehand, for the period for which total capital is being projected. When R_i is changing, then, assuming k_N to be constant:

Year 1: Total Capital = A

$N_1 = k_N A$

$L_1 = R_1 N_1 = R_1(k_N A)$

$P_1 = k_N A - R_1(k_N A) = k_N A(1-R)$

Year 2: Total Capital $= A + P_1 = A + k_N A(1-R_1) = A\left[1+k_N(1-R_1)\right]$

$N_2 = k_N A\left[1 + k_N(1-R_1)\right]$

$L_2 = R_2 k_N \left[1 + k_N(1-R_1)\right]$

$P_2 = N_2 - L_2 = k_N A \left[1 + k_N(1-R_1)\right] \left[1-R_2\right]$

Year 3: Total Capital $= A + P_1 + P_2 = A + k_N(1-R_1) + k_N A(1-R_2)\left[1 + k_N(1-R_1)\right]$

$$N_3 = k_N \text{ (Total Capital)}$$

$$L_3 = R_3 N_3$$

$$P_3 = k_N A(1-R_3) \left[1 + k_N(1-R_1)\right] \left[1 + k_N(1-R_2)\right]$$

Similarly:

Year i: $\text{Total Capital} = A \left[1 + k_N(1-R_1)\right] \left[1 + k_N(1-R_2)\right] \ldots \left[1 + k_N(1-R_{i-1})\right]$

$$N_i = k_N \times \text{Total Capital}_i$$

$$L_i = R_i N_i$$

$$P_i = k_N A(1-R_i) \left[1 + k_N(1-R_1)\right] \left[1 + k_N(1-R_2)\right] \ldots \left[1 + k_N(1-R_{i-1})\right]$$

4. <u>Deriving the equation for projecting total capital, net income, living costs and "plow back" for the year i in the future, given present total capital = A and the following empirical relationships between capital, net income, and living costs:</u>

$$N = bA + a$$

$$L = cN + d$$

Year 1: $TC_1 = A$, Total Capital at beginning of year 1.

$$N_1 = bA + a$$

$$L_1 = c(ba + a) + d$$

$P_1 = bA + a - c(ba + a) - d$. Let this quantity $= \theta$ for ease of writing.

Year 2: $TC_2 = A + P_1 = A + \theta$

$$N_2 = b(A + \theta) + a = ba + b\theta + a = (bA + a) + b\theta$$

$$L_2 = c\left[(bA + a) + b\theta\right] + d = c(bA + a) + bc\theta + d$$

$$P_2 = (bA + a) + b\theta - c(bA + a) - bc\theta - d = \theta + b\theta - bc\theta$$

$$= \theta\left[1 + b(1-c)\right].$$ Let $1-c = \phi$ for ease of writing.

$$P_2 = \theta(1 + b\phi)$$

Year 3: $TC_3 = A + \theta + \theta(1 + b\phi) = A + \theta\left[1 + (1 + b\phi)\right]$

$$N_3 = bA + b\theta(2 + b\phi) + a = (bA + a) + b\theta(2 + b\phi)$$

$$L_3 = c\left[(bA + a) + b\theta(2 + b\phi)\right] + d = c(bA + a) + cb\theta(2 + b\phi) + d$$

$$P_3 = (bA + a) + b\theta(2 + b\phi) - c(bA + a) - cb\theta(2 + b\phi) - d$$

$$= \theta + b\theta(2 + b\phi)(1 - c) = \theta\left[1 + b\phi(2 + b\phi)\right] = \theta(1 + b\phi)^2$$

Year 4: $TC_4 = A + \theta + \theta(1 + b\phi) + \theta(1 + b\phi)^2$

$$= A + \theta\left[1 + (1 + b\phi) + (1 + b\phi)^2\right]$$

$$N_4 = (bA + a) + b\theta(3 + 3b\phi + b^2\phi^2)$$

$$L_4 = c(bA + a) + cb\theta(3 + 3b\phi + b^2\phi^2) + d$$

$$P_4 = (bA + a) + b\theta(3 + 3b\phi + b^2\phi^2) - c(bA + a) - cb\theta(3+3b\phi+b^2\phi^2) - d$$

$$= \theta + b\theta(3 + 3b\phi + b^2\phi^2)(1-c) = \theta\left[1 + b\phi(3+3b\phi+b^2\phi^2)\right]$$

$$= \theta(1 + b\phi)^3$$

Year i: $TC_i = A + \theta\left[1 + (1 + b\phi) + (1 + b\phi)^2 + \dots + (1+b\phi)^{i-2}\right]$

$$N_i = (bA + a) + b\theta\left[1 + (1+b\phi) + (1+b\phi)^2 + \dots + (1+b\phi)^{i-2}\right]$$

$$L_i = c(ba+a) + cb\theta\left[1 + (1+b\phi) + (1+b\phi)^2 + \dots + (1+b\phi)^{i-2}\right] + d$$

$$P_i = \theta(1+b\phi)^{i-1}$$

5. <u>Derivation of equation for calculating the income stream for investment P if each annual net income from P is invested back into the firm</u>, and if the relationship between the net income and the investment is $N = bP + a$, where b is the regression coefficient and a is the y-intercept:

Year 1: $TC_1 = P$

$N_1 = bP + a$

$P_1 = N_1$

Year 2: $TC_2 = P + N_1 = P + bP + a$

$N_2 = b\left[P + (bP+a)\right] + a = bP + a + b(bP+a) = (bP+a)(1+b)$

$P_2 = N_2$

Year 3: $TC_3 = P + N_1 + N_2 = P + (bP+a) + (bP+a)(1+b)$

$N_3 = (bP+a) + b(bP+a) + b(bP+a)(1+b)$

$= (bP+a)\left[1 + b + b(1+b)\right] = (bP+a)(1+b)^2$

Similarly,

Year 4: $N_4 = (bP+a)(1+b)^3$

and

Year i: $N_i = (bP+a)(1+b)^{i-1}$

6. Derivation of adjustments to apply to b_1 (using equation N = bA + a in the model for projecting capital accumulation) for changing trends in prices of inputs and outputs.

It is first necessary to realize that as prices change the relationship between N and A will change, so it seems logical to apply the adjustments to the regression coefficient, b. To do this it is necessary to express the equation N = bA + a in the form $b = \frac{N-a}{A}$. Thus, where N = GR - GE (gross receipts minus gross expenses), $b = \frac{(GR-GE) - a}{A}$.

The assumptions regarding constant inputs, outputs and prices are the same as for the development of the adjustments for k_N, in Appendix A2. Also assume price trends to be changing at the rate of p percent per period.

Output price-trend increase:

(a) Assume the increase to be a constant rate of p percent per period.

$$b_1 = \frac{(GR_1 - GE_1) - a}{A}$$

$$b_2 = \frac{(GR_2 - GE_1) - a}{A} = \frac{(GR_1 + pGR_1) - GE_1 - a}{A}$$

$$b_2 - b_1 = \frac{GR_1 + pGR_1 - GE_1 - a}{A} - \frac{GR_1 - GE_1 - a}{A} = \frac{pGR_1}{A}$$

$$b_2 = b_1 + \frac{pGR_1}{A}$$

$$b_3 = \frac{(GR_3 - GE_1) - a}{A} = \frac{(GR_2 + pGR_2) - GE_1 - a}{A}$$

$$= \frac{GR_1 + pGR_1 + p(GR_1 + pGR_1) - GE_1 - a}{A}$$

$$= \frac{GR_1 + 2pGR_1 + p^2 GR_1 - GE_1 - a}{A} = \frac{GR_1(1+p)^2 - GE_1 - a}{A}$$

$$b_3 - b_2 = \frac{GR_1(1+p)^2 - GE_1 - a}{A} - \frac{GR_1(1+p) - GE_1 - a}{A}$$

$$= \frac{GR_1\left[(1+p)^2 - (1+p)\right]}{A} = \frac{GR_1(1+p)(1+p-1)}{A} = \frac{pGR_1(1+p)}{A}$$

$$b_3 = b_2 + \frac{pGR_1(1+p)}{A} = b_1 + \frac{(pGR_1)}{A} + \frac{pGR_1(1+p)}{A}$$

Similarly,

$$b_4 = b_3 + \frac{pGR_1(1+p)^2}{A} = b_1 + \frac{pGR_1}{A} + \frac{pGR_1(1+p)}{A} + \frac{pGR_1(1+p)^2}{A}$$

$$= b_1 + \frac{pGR_1}{A}\left[1 + (1+p) + (1+p)^2\right]$$

and

$$b_i = b_1 + \frac{pGR_1}{A}\left[1 + (1+p) + (1+p)^2 + \dots + (1+p)^{i-2}\right]$$

Substituting $GR_1 = gA + k$, the regression equation used to estimate GR_1 from empirical data,

$$b_i = b_1 + \frac{p(gA+k)}{A}\left[1 + (1+p) + (1+p)^2 + \dots + (1+p)^{i-2}\right]$$

(b) When the trend is estimated by a straight line, p will not remain constant but will change each period. The adjustment developed in (a) will not apply, since for it p has the same value throughout. By substituting p_1, p_2, p_3, etc. for p, in (a), where appropriate, the following equation for calculating b_i can be developed:

$$b_i = b_1 + \frac{GR_1}{A}\Big[p_1 + p_2(1+p_1) + p_3(1+p_1)(1+p_2) + \dots + p_{i-1}(1+p_1)$$
$$(1+p_2)\dots(1+p_{i-2})\Big]$$

Substituting $GR_1 = gA + k$:

$$b_i = b_1 + \frac{gA + k}{A}\Big[p_1 + p_2(1+p_1) + p_3(1+p_1)(1+p_2) + \dots + p_{i-1}$$
$$(1+p_1)(1+p_2)\dots(1+p_{i-2})\Big]$$

<u>Output price-trend decrease:</u>

(a) At a constant rate of p percent per period, b_i can be determined by using the same method detailed in (a) above, but in this case $GR_2 = GR_1(1-p)$, $GR_3 = GR_1(1-p)^2$ and so on. The following equation is derived to calculate b_i:

$$b_i = b_1 - \frac{p(gA + k)}{A}\left[1 + (1-p) + (1-p)^2 + \dots + (1-p)^{i-2}\right]$$

(b) Assuming a straight line trend, where p changes each period, it can be shown by the same logic that

$$b_i = b_1 - \frac{gA + k}{A}\left[p_1 + p_2(1-p_1) + p_3(1-p_1)(1-p_2) + \dots + p_{i-1}\right.$$
$$\left.(1-p_1)(1-p_2)\dots(1-p_{i-2})\right]$$

<u>Input price-trend increase:</u>

(a) Assuming the trend changes at a constant rate of p percent per period and that inputs, output and output prices are constant:

$$b_1 = \frac{GR_1 - GE_1 - a}{A_1}$$

$$b_2 = \frac{GR_1 - (GE_1 + pGE_1) - a}{A_1 + pA_1} = \frac{GR_1 - GE_1 - pGE_1 - a}{A_1(1+p)}$$

$$b_2 - b_1 = \frac{GR_1 - GE_1 - pGE_1 - a}{A_1(1+p)} - \frac{GR_1 - GE_1 - a}{A_1}$$

$$= \frac{GR_1 - GE_1 - pGE_1 - a - GR_1 + GE_1 + a - pGR_1 + pGE_1 + pa}{A_1(1+p)}$$

$$= \frac{-pGR_1 + pa}{A_1(1+p)} = \frac{-p(GR_1 - a)}{A_1(1+p)}$$

$$b_2 = b_1 - \frac{p(GR_1-a)}{A_1(1+p)}$$

$$b_3 = \frac{GR_1 - GE_3 - a}{A_1+pA_1+p(A_1+pA_1)} = \frac{GR_1 - (GE_2+pGE_2) - a}{A_1(1+p)^2}$$

$$= \frac{GR_1 - \left[GE_1 + pGE_1 + p(GE_1+pGE_1)\right] - a}{A_1(1+p)^2} = \frac{GR_1 - GE_1(1+p)^2 - a}{A_1(1+p)^2}$$

$$b_3 - b_2 = \frac{GR_1 - GE_1(1+p)^2 - a}{A_1(1+p)^2} - \frac{GR_1 - GE_1(1+p) - a}{A_1(1+p)}$$

$$= \frac{GR_1 - GE_1(1+p)^2 - a - (1+p)\left[GR_1 - GE_1(1+p) - a\right]}{A(1+p)^2}$$

$$= \frac{GR_1 - GE_1(1+p)^2 - a - GR_1(1+p) + GE_1(1+p)^2 + a(1+p)}{A_1(1+p)^2}$$

$$= \frac{GR_1 - GR_1(1+p) - a + a + pa}{A_1(1+p)^2} = \frac{GR_1(1-1-p) + pa}{A_1(1+p)^2}$$

$$= \frac{-p(GR_1-a)}{A_1(1+p)^2}$$

$$b_3 = b_2 - \frac{p(GR_1-a)}{A_1(1+p)^2} = b_1 - \frac{p(GR_1-a)}{A_1(1+p)} - \frac{p(GR_1-a)}{A_1(1+p)^2}$$

$$= b_1 - \frac{p(GR_1-a)}{A_1}\left[(1+p)^{-1} + (1+p)^{-2}\right]$$

Similarly,

$$b_4 - b_3 = -\frac{p(GR_1-a)}{A_1(1+p)^3}$$

$$b_4 = b_1 - \frac{p(GR_1-a)}{A_1}\left[(1+p)^{-1} + (1+p)^{-2} + (1+p)^{-3}\right] \text{ and}$$

$$b_i = b_1 - \frac{p(GR_1 - a)}{A_1}\left[(1+p)^{-1} + (1+p)^{-2} + \dots + (1+p)^{-(i-1)}\right]$$

Substituting $GR_1 = gA_1 + k$

$$b_i = b_1 - \frac{p(gA_1 + k - a)}{A_1}\left[(1+p)^{-1} + (1+p)^{-2} + \dots + (1+p)^{-(i-1)}\right]$$

(b) Assuming a straight line trend, where p changes each period, it can be shown that

$$b_i = b_1 - \frac{gA_1 + k - a}{A_1}\left[\frac{p_1}{1+p_1} + \frac{p_2}{(1+p_1)(1+p_2)} + \dots + \frac{p_{i-1}}{(1+p_1)(1+p_2)\dots(1+p_{i-1})}\right]$$

Input price-trend decreases:

(a) For a trend changing at a constant rate of p percent per period by the same logic developed above:

$$b_i = b_1 + \frac{p(gA_1 + k - a)}{A_1}\left[(1-p)^{-1} + (1-p)^{-2} + \dots + (1-p)^{-(i-1)}\right]$$

(b) When the trend best described by a straight line, results in p changing each period:

$$b_i = b_1 + \frac{gA_1 + k - a}{A_1}\left[\frac{p_1}{1-p_1} + \frac{p_2}{(1-p_1)(1-p_2)} + \dots + \frac{p_{i-1}}{(1-p_1)(1-p_2)\dots(1-p_{i-1})}\right]$$

Input and output price-trends together:

In any application of these adjustments, trends in both input and output prices must be considered. As with k_N, adjustments for both trends can be applied to b_1 at the same time, to give b_i.

7. Development of equation for estimating total capital for year i when $N = bA + a$ and $L = cN + \gamma S + d$, and S increases at the rate of s percent per year.

Year 1: $TC_1 = A$

$$N_1 = bA + a$$

$$L_1 = c(bA + a) + \gamma S + d$$

$$P_1 = (bA + a) - c(bA + a) - d - \gamma S = \theta - \gamma S$$

(Let $\theta = (bA + a) - c(bA + a) - d$ and $\phi = 1-c$ for ease of writing.)

Year 2: $TC_2 = A + \theta - \gamma S$

$$N_2 = bA + a + b\theta - b\gamma S$$

$$L_2 = c(bA+a) + d + bc\theta - cb\gamma S + \gamma S(1+s)$$

$$P_2 = (bA+a) - c(bA+a) - d + b\theta(1-c) - b\gamma S(1-c) - \gamma S(1+s)$$

$$= \theta(1+b\phi) - b\phi\gamma S - \gamma S(1+s)$$

Year 3: $TC_3 = A + \theta + \theta(1+b\phi) - \gamma S - b\phi\gamma S - \gamma S(1+s)$

$$= A + \theta\left[1+(1+b\phi)\right] - \gamma S(1+b\phi) - \gamma S(1+s)$$

$$N_3 = bA + a + b\theta\left[1+(1+b\phi)\right] - b\gamma S(1+b\phi) - b\gamma S(1+s)$$

$$L_3 = c(bA+a) + d + cb\theta\left[1+(1+b\phi)\right] - cb\gamma S(1+b\phi) - cb\gamma S(1+s) + \gamma S(1+s)^2$$

$$P_3 = (bA+a) - c(bA+a) - d + b\theta\left[1+(1+b\phi)\right](1-c) - b\gamma S(1+b\phi)(1-c) - b\gamma S(1+s)(1-c) - \gamma S(1+s)^2$$

$$= \theta + \theta b\phi\left[1+(1+b\phi)\right] - b\phi\gamma S(1+b\phi) - b\phi\gamma S(1+s) - \gamma S(1+s)^2$$

$$= \theta(1+b\phi)^2 - b\phi\,\gamma S(1+b\phi) - b\phi\,\gamma S(1+s) - \gamma S(1+s)^2$$

Year 4: $$TC_4 = A + \theta + \theta(1+b\phi) + \theta(1+b\phi)^2 - \gamma S - b\phi\,\gamma S$$

$$- \gamma S(1+s) - b\phi\,\gamma S(1+b\phi) - b\phi\,\gamma S(1+s) - \gamma S(1+s)^2$$

$$= A + \theta\left[1+(1+b\phi)+(1+b\phi)^2\right] - \gamma S(1+b\phi)^2 - \gamma S(1+s)(1+b\phi)$$

$$- \gamma S(1+s)^2$$

Similarly,

$$TC_5 = A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+(1+b\phi)^3\right] - \gamma S(1+b\phi)^3$$

$$- \gamma S(1+s)(1+b\phi)^2 - \gamma S(1+s)^2(1+b\phi) - \gamma S(1+s)^3$$

$$= A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+(1+b\phi)^3\right] - \left[\gamma S(1+b\phi)^3\right.$$

$$\left. + \gamma S(1+s)(1+b\phi)^2 + \gamma S(1+s)^2(1+b\phi) + \gamma S(1+s)^3\right]$$

and $$TC_i = A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+\ldots+(1+b\phi)^{i-2}\right]$$

$$- \left[\gamma S(1+b\phi)^{i-2} + \gamma S(1+s)(1+b\phi)^{i-3} + \gamma S(1+s)^2\right.$$

$$(1+b\phi)^{i-4} + \ldots + \gamma S(1+s)^{i-4}(1+b\phi)^2 + \gamma S(1+s)^{i-3}$$

$$\left.(1+b\phi) + \gamma S(1+s)^{i-2}\right]$$

where for the first year, TC_1, the terms inside the square brackets, $[\;\;]$, have a value of zero and, for year 2, the term inside the first square bracket has a value of unity.

It will be noticed that the portions of the model involving each independent variable, N and S, develop independently of each other. The first half of the left side of the equation develops exactly the same as the model involving N = bA + a and L + cN + d (Appendix A4).

8. Development of an adjustment to the model to take income tax into account.

Reviewing:

$$N = bA + a$$

$$L = cN + d$$

$$P = N-L$$

Let T_i represent income tax for a particular year, i. Then

$$P_i = N_i - L_i - T_i$$

Year 1: $TC_1 = A$

$$N_1 = bA + a$$

$$L_1 = c(bA+a) + d$$

$$T_1 = T_1$$

$$P_1 = (bA+a) - c(bA+a) - d - T_1 = \theta - T_1$$

(Let $\theta = (bA+a) - c(bA+a) - d$ and $\phi = 1-c$, for ease of writing.)

Year 2: $TC_2 = A + \theta - T_1$

$$N_2 = bA + a + b\theta - bT_1$$

$$L_2 = c(bA+a) + cb\theta - cbT_1 + d$$

$$T_2 = T_2$$

$$P_2 = (bA+a) - c(bA+a) - d + b\theta(1-c) - bT_1(1-c) - T_2$$

$$= \theta(1+b\phi) - b\phi T_1 - T_2$$

Year 3: $TC_3 = A + \theta + \theta(1+b\phi) - T_1(1+b\phi) - T_2$

$$= A + \theta\left[1+(1+b\phi)\right] - T_1(1+b\phi) - T_2$$

$$N_3 = bA + a + b\theta + b\theta(1+b\phi) - bT_1(1+b\phi) - bT_2$$

$$L_3 = c(bA+a) + cb\theta + cb\theta(1+b\phi) + d - cbT_1(1+b\phi) - cbT_2$$

$$T_3 = T_3$$

$$P_3 = (bA+a) - c(bA+a) - d + b\theta(1-c) + b\theta(1+b\phi)(1-c) - bT_1$$
$$(1+b\phi)(1-c) - bT_2(1-c) - T_3$$
$$= \theta\left[1+b\phi+b\phi(1+b\phi)\right] - b\phi T_1(1+b\phi) - b\phi T_2 - T_3$$
$$= \theta(1+b\phi)^2 - b\phi T_1(1+b\phi) - b\phi T_2 - T_3$$

Year 4: $$TC_4 = A + \theta + \theta(1+b\phi) + \theta(1+b\phi)^2 - T_1 - b\phi T_1 - T_2$$
$$- b\phi T_1(1+b\phi) - b\phi T_2 - T_3$$
$$= A + \theta\left[1+(1+b\phi)+(1+b\phi)^2\right] - T_1(1+b\phi)^2 - T_2(1+b\phi)-T_3$$

$$N_4 = bA + a + b\theta\left[1+(1+b\phi)+(1+b\phi)^2\right] - bT_1(1+b\phi)^2$$
$$- bT_2(1+b\phi) - bT_3$$

$$L_4 = cN_4 + d$$

$$T_4 = T_4$$

$$P_4 = (bA+a) - c(bA+a) - d + b\theta\left[1+(1+b\phi)+(1+b\phi)^2\right](1-c)$$
$$-bT_1(1+b\phi)^2(1-c) - bT_2(1+b\phi)(1-c) - bT_3(1-c) - T_4$$
$$= \theta + b\phi\theta\left[1+(1+b\phi)+(1+b\phi)^2\right] - b\phi T_1(1+b\phi)^2 - b\phi T_2(1+b\phi)$$
$$- b\phi T_3 - T_4$$
$$= \theta(1+b\phi)^3 - b\phi T_1(1+b\phi)^2 - b\phi T_2(1+b\phi) - b\phi T_3 - T_4$$

Year 5: $$TC_5 = A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+(1+b\phi)^3\right] - T_1 - b\phi T_1 - T_2$$
$$- b\phi T_1(1+b\phi) - b\phi T_2 - T_3 - b\phi T_1(1+b\phi)^2 - b\phi T_2(1+b\phi)$$
$$- b\phi T_3 - T_4$$
$$= A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+(1+b\phi)^3\right] - T_1\left[1+b\phi+b\phi(1+b\phi)\right.$$
$$\left.+b\phi(1+b\phi)^2\right] - T_2\left[1+b\phi+b\phi(1+b\phi)\right] - T_3(1+b\phi) - T_4$$
$$= A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+(1+b\phi)^3\right] - \left[T_1(1+b\phi)^3\right.$$
$$\left.+T_2(1+b\phi)^2+T_3(1+b\phi)+T_4\right]$$

Year i: $TC_i = A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+\ldots+(1+b\phi)^{i-2}\right] - \left[T_1\right.$
$(1+b\phi)^{i-2}+T_2(1+b\phi)^{i-3}+\ldots+T_{i-3}(1+b\phi)^2$
$\left.+T_{i-2}(1+b\phi)+T_{i-1}\right]$

where for year 1 the bracketed terms $\left[\quad\right]$ have a value of zero and in year 2 the value of $\left[1+(1+b\phi)+\ldots+(1+b\phi)^{i-2}\right]$ is unity. Here again (compare with Appendix A7) it will be noticed that the portion of the model involving T develops independently of the portion involving net income and living expenditures. The latter is exactly the same as the development of model for TC_i using $N = bA + a$ and $L = cN + d$. (Appendix A4).

9. Estimating discounted income stream from P_1.

In the process of deciding whether to consume or invest the net income available for "plowback", some estimate of the future income to be derived from the investment must be made. Assume that the new investment, P, has the same productivity as the previous capital used in the farm business, that is, the annual income from P is $N = k_N P$, which allows for maintaining capital. The income from P_1 in production period one would be $N_1 = k_N P_1$. (P_1 comes from a previous production period.)

The decision on whether to consume or invest P_1 is made at the beginning of the period. The present value of $k_N P_1$ at that time would be $k_N P_1(1+r)^{-1}$, where "r" is the interest rate which the farm family uses to discount future income[a]. As pointed out

a. The present quantity PV which in n years will accumulate to the amount S at the rate of interest r, compounded annually is, $PV = S_n(1+r)^{-n}$. See any text on interest and annuities.

in Chapter II (p. 33) P_1 can be used in three ways. The formulas for the present value of the income from P_1 are presented on the basis of these.

(a) Assuming that P_1 will remain intact while all of the future net income derived from P_1 is consumed, and that P_1 will produce the same annual net income each year, then the present value of this income stream at the beginning of the year when the decision is made, is:

$$PV = k_N P_1 \left[(1+r)^{-1} + (1+r)^{-2} + \dots + (1+r)^{-n}\right]$$

where "n" is the number of years in the period over which the future income stream accrues.

(b) Assuming that all of this net income is invested back into the business each year, then the income for the "ith" year is:

$$N_i = k_N P_1 (1+k_N)^{i-1}$$

Derivation:

$$N_1 = k_N P_1$$

$$N_2 = k_N(P_1 + k_N P_1) = k_N P_1 (1+k_N)$$

$$N_3 = k_N\left[P_1 + k_N P_1 + k_N P_1 (1+k_N)\right] = k_N P_1 (1+k_N)^2$$

$$\vdots$$

$$N_i = k_N P_1 (1+k_N)^{i-1}$$

The present value of this income would be:

$$\text{PV of } N_i = k_N P_1 (1+k_N)^{i-1}(1+r)^{-i} \tag{1}$$

The present value of the income stream for n years then would be:

$$\text{PV of } N_1 + N_2 + \ldots + N_i + \ldots + N_n$$
$$= k_N P_1 \Big[(1+r)^{-1} + (1+k_N)(1+r)^{-2} + \ldots + (1+k_N)^{i-1}(1+r)^{-i} + \ldots + (1+k_N)^{n-1}(1+r)^{n-1}\Big] \tag{2}$$

To "plow back" all of the net income each year the family must hold its living costs at the current level and invest all of the incremental income stream. In this case each annual income is not discounted and summed because the income stream will not be available for spending. The comparison to be made is the spending of P_1 now compared with the present value of the income available from P_1 in the n^{th} year. The latter can be estimated by Equation (1), substituting n for i. (Note that Equation (2) would not be used because the income stream would not be available for spending.)

(c) Assuming that the future periodic incomes from P_1 are to be partly consumed and the remainder invested back into the business and that the rate of consuming is k_L, then Equations 6 and 7 (pages 30, 31) may be used by substituting P_1 for A. Each annual net income may be discounted and summed over n years, in order to compare its present value with P_1. To illustrate, the present value of such an income stream, assuming part of N to be consumed each year, would be

$$PV \text{ of } N_1 + N_2 + \ldots + N_i + \ldots + N_n$$
$$= k_N P_1(1+r)^{-1} + \left[1+k_N(1-k_L)\right](1+r)^{-2} + \left[1+k_N(1-k_L)\right]^2 (1+r)^{-3} + \ldots + \left[1+k_N(1-k_L)^{i-1}\right](1+r)^{-i} + \ldots + \left[1+k_N(1-k_L)\right]^{n-1}(1+r)^{-n}$$

The most likely assumption is that living costs will continue to rise so that part of the income stream from P_1 is consumed and part is "plowed back". Here it is necessary to look at the difference between net income stream available from the total input capital over the next n years with and without "plow back". Without, the annual income each year would be equal to the current income, N_1. With "plowback" the annual income would be estimated by Equation 7 (p. 31).

Presumably the family would be interested in the income available for spending, although the increase in Assets due to accumulations of P would enter the decision. (The accumulated assets are given by Equation 6 (p. 30). The present value of the income stream available for spending, assuming no "plow back", is

$$PV_{na} = k_N A\left[(1+r)^{-1} + (1+r)^{-2} + \ldots + (1+r)^{-n}\right]$$

since each annual income remains the same as that currently available. Total input capital is maintained and all income is spent on living. PV_{na} represents "present value with no accumulation" and A is the total input capital available at the time of decision, including P_1. The present value of the income stream available for spending, assuming "plow back" is

$$PV_a = k_L k_N A(1+r)^{-1} + \left[1+k_N(1-k_L)\right] (1+r)^{-2} + \left[1+k_N(1-k_L)\right]^2 (1+r)^{-3} + \dots + \left[1+k_N(1-k_L)\right]^{n-1} (1+r)^{-n}$$

where PV_a represents "present value with accumulation". This is obtained by discounting L for each year, estimated by Equation 8 (p. 31).

The effect of "plow back" on the present value comparison of income stream available for spending is estimated by $PV_a - PV_{na}$. Comparisons can be made for various sizes of P_1 as a proportion of N_1 by varying k_L. (The proportion of net income invested back into the business is $1 - k_L$.) The gain in assets would be $A\left[1+k(1-k_L)\right]^{n-1} - A$.

Replacing k_N and k_L with regression equations:

Similar estimates of the discounted income stream from P_1 can be made when the regression equations $N = bA + a$ and $L = cN + d$ replace k_N and k_L for estimating net income and living expenditures in the capital accumulation model.

(a) Assuming that the future annual net incomes from P_1 are spent on consumer goods but P_1 is maintained intact, the income from P_1 will not accumulate, so that for each future year the income will be $N = bP_1 + a$, where b and a have been determined empirically. The PV (present value) of net income from P_1 at the end of the year (call it Year 1) will be $(bP_1+a)(1+r)^{-1}$. At the end of Year 2 it will be $(bP_1+a)(1+r)^{-2}$, and so on, where r is the interest rate used by the farm family to discount future income.

Thus the present value of the income from P_1 for n years hence is

$$PV = (bP_1+a)\left[(1+r)^{-1}+(1+r)^{-2}+\ldots+(1+r)^{-n}\right]$$

(b) Assuming that each of the annual incomes from accumulated capital is invested back into the firm, which means that the farm family will keep its living costs at the current level, starting the current year with P_1, the income at the end of Year i will be $N_i = (bP_1+a)(1+b)^{i-1}$ (See Appendix A5 for the development of this equation). The present value of N_i is

$$PV_{N_i} = (bP_1+a)(1+b)^{i-1}(1+r)^{-i}$$

There is no stream of annual incomes from P_1 to be discounted and summed because each annual income, except the one for the last year of the projection period, will be invested back into the firm and therefore will not be available for spending.

(c) On the assumption that living costs will increase and at the same time some net income will be invested back into the business, the decision as to whether or not to "plow back" some net income requires a comparison of present value of income streams available for spending on living, with and without "plow back". Without "plow back" the present value of the income stream for n years hence is $PV_{na} = (bA+a)\left[(1+r)^{-1}+(1+r)^{-2}+\ldots+(1+r)^{-n}\right]$ where na refers to "no accumulation" of capital and A refers to total capital accumulated to date, including P_1. With "plow back" for n years hence the present value of the income stream is:[a]

a. PV_a is obtained by summing the discounted value of $L_1, L_2, L_3, \ldots L_n$ from Equation 19 (p. 49). See Appendix A4 for details of L_i.

$$
\begin{aligned}
PV_a = {} & c(bA+a)\left[(1+r)^{-1}+(1+r)^{-2}+\ldots+(1+r)^{-n}\right] \\
& + d\left[(1+r)^{-1}+(1+r)^{-2}+\ldots+(1+r)^{-n}\right] + bc\theta\Big\{(1+r)^{-2} \\
& + \left[1+(1+b\phi)\right](1+r)^{-3} + \left[1+(1+b\phi)+(1+b\phi)^{2}\right](1+r)^{-4} + \ldots \\
& + \left[1+(1+b\phi)+(1+b\phi)^{2}+\ldots+(1+b\phi)^{n-2}\right](1+r)^{-n}\Big\}
\end{aligned}
$$

where the third term does not enter the calculation until Year 2 and where PV_a refers to PV with accumulation of capital

$\theta = (bA+a) - c(bA+a) - d$

$\phi = 1 - c$

Then the effect of capital accumulation on the present value comparison of the income stream available for spending is estimated by $PV_a - PV_{na}$. Comparisons can be made for assumed alternative values of c and d in the function $L = cN + d$. The gain in total capital, due to accumulation would be:

$$
\begin{aligned}
& A + \theta\left[1+(1+b\phi)+(1+b\phi)^{2}+\ldots+(1+b\phi)^{n-2}\right] - A \\
& \quad = \theta\left[1+(1+b\phi)+(1+b\phi)^{2}+\ldots+(1+b\phi)^{n-2}\right]
\end{aligned}
$$

where the value inside the brackets $[\quad]$ is equal to zero at the beginning of Year 1 and one at the beginning of Year 2.

APPENDIX B

1. Converting livestock enterprises costs from a basis of animals to a per acre basis[a] for use in typing farms in the sample: To find the number of acres required to support the animals costed in the enterprise sheets[b] it is necessary to convert the animals to animal units. Also it is necessary to determine the acres of land required per animal unit.

Calculating animal units for grazing grazing animals:

Using Morrison's feeding standards (52, p. 1004-1008) the following annual feed intake in terms of therms may be calculated:

	Daily requirement (therms)		Period (days)	Annual requirement (therms)
1,000 lb. dairy cow (9,000 lb. of 3.5% milk):				
maintenance requirements last	5.95	x	365	2,171.25
2½ months of pregnancy	4.90	x	75	367.50
milk production: 9,000 lbs x .27 therms per lb.				2,430.00
				4,969.25
Total annual requirement				
1,200 lb. beef cows:				
pregnant wintering	7.7	x	255=	1,963.50
nursing calf	12.0	x	110=	1,320.00
Total annual requirement				3,283.50

continued

---

a. These costs per acre are not accurate enough nor are they intended to be used for income calculations. They are satisfactory for weighting purposes, however.

b. Oregon State University, Agricultural Extension Service. Unpublished enterprise cost sheets, 1955-57. Corvallis, 1957. (Mimeographed)

	Daily requirement (therms)		Period (days)	Annual requirement (therms)
800 lb. Dairy heifer	8.8	x	365=	3,102.50
500 lb. Dairy heifer	6.65	x	365=	2,427.25
800 lb. beef heifer	8.80	x	365=	3,212.50
500 lb. beef heifer	6.85	x	365=	2,500.25
300 lb. calf	5.0	x	185=	925.00
110 lb. Ewe:				
dry period	1.30	x	84=	109.20
pregnant: until 5 weeks before lambing	1.45	x	111=	160.95
5 weeks before lambing	1.85	x	35=	64.75
nursing	2.15	x	135=	290.25
Total annual requirement				625.15
Lambs:				
growing period	1.0	x	135=	135.00
fattening period	1.6	x	100=	160.00
Total annual requirement				295.00

Using, as a basis, the annual requirements of a 1,000 lb. dairy cow producing 9,000 lbs. of 3½ per cent milk, the following "animal unit" conversion ratios are derived:

one 1,000 lb. cow	1.00 animal unit
one 800 lb. dairy heifer, growing	.62 animal unit
one 1,200 lb. beef cow	.67 animal unit
one 800 lb. beef heifer, growing	.65 animal unit
one 500 lb. beef heifer, growing	.50 animal unit
one 300 lb. calf	.19 animal unit
one ewe	.13 animal unit
one lamb, growing	.06 animal unit

It takes about .75 acres of irrigated tame grass pasture plus 15 per cent more for feed from other sources to feed one dairy animal unit for 6 months during the growing season (28, p. 9). Assuming "other sources" produce feed with equal efficiency, 1 animal unit requires .75 x 1.15 = .8625 acres for 6 months. Assuming that winter feed (for the other 6 months) can also be produced with the same efficiency, 1 animal unit requires 1.725 acres of irrigated land for a year. Such land may be compared favorably with Willamette Valley tame pasture.

<u>Dairy enterprise costs per acre</u>:

The dairy enterprise (Enterprise sheets) is based on 25 cows averaging 9,000 lbs. of milk per year. Assume the following herd:

Cows	25	25.00 animal units
Replacements:		
Heifers 800 lb.	4	2.48 animal units
heifers 500 lb.	4	1.96 animal unit
calves 300 lb.	4	.76 animal unit
		30.20

(Assume the other calves were all sold.)

Acres required are 30.20 x 1.725 = 52.10

Cost (inputs) per acre = $8,473   52.10 = <u>$162.63</u>

<u>Beef enterprise costs per acre</u>:

This enterprise is based on 30 cows, selling calves at 450 lb. in the fall.

Cows	30	20.10 animal units
Replacements:		
heifers 800 lb.	3	1.95 animal unit
heifers 500 lb.	3	1.50 animal unit
calves 300 lb.	3	.57 animal unit
Calves sold (450 lb.)	20	3.80 animal units
		27.92

Acres required are 27.92 x 1.725 = 48.16

Cost (inputs per acre: $3,055   48.16 = <u>$63.43</u>

Sheep enterprise costs per acre:

Based on 40 ewes:

Ewes	40	5.20 animal units
Bucks	2	.20 animal unit
Replacements	10	1.30 animal unit
Lambs	26	1.56 animal unit
		8.26

Acres required are 8.26 x 1.725 = 14.3

Cost (inputs) per acre: \$869 ÷ 14.3 = \$60.77

Hog enterprise costs per acre:

Based on 7,000 ÷ 200 = 35 hogs marketed, 3 brood sows. This complement requires about 30 tons of grain. Replacements and a boar would require some additional. Allow a requirement of 30 acres.

Cost per acre is \$1,317 ÷ 30 = \$43.90

2. Evaluating cropland in cases of non-response. Most of the farms in the sample were located on soils that were predominantly Willamette, Amity or Woodburn series (Table 5, p. 133). A statistical test was made to assist in deciding whether soil made a difference in values. It showed that on the basis of the sample, these three soil series had the same average value per acre of cropland (Table 1). The hypothesis of equality in value between any two of the soils could not be rejected on the basis of the t-values, even at the .10 level of significance, so the estimates were pooled to give a weighted average of \$336.31 per acre[a]. The standard error was \$12.315 compared with \$59.45, \$17.98 and \$23.37 for the T_1, T_2 and T_3 mean values, respectively. Better estimates of

a. The 1959 census shows the average value of land and buildings in Marion County to be \$356.34 (79, p. 144).

Table 1. Mean value of cropland (without buildings) on three predominant soil series, 66 sample farms, Marion County, 1957

	Soil Series		
	Willamette (T_1)[a]	Amity (T_2)	Woodburn (T_4)
Mean value per acre	$376.67	$305.75	$346.15
Number of estimates	15	24	13

Testing differences:

Hypothesis[b]	Calculated t-values	d.f.	t-values at .10 level of significance
$T_1 = T_2$	1.3602	37	1.684
$T_2 = T_4$	1.3151	35	1.692
$T_1 = T_4$	0.4494	26	1.706

a. These alphabetical designations were given these soil series in the preliminary mapping of the new soil survey.

b. These abbreviated equations are used to designate the following hypotheses: "The mean value per acre of T_1 soil series is equal to the mean value per acre of T_2 soil series" in the case of the first equation, with a similar meaning for the other two equations.

cropland values were available for 1958 from James's study (41, p. 292) so where it was necessary to give an office evaluation to the land, because of non-response, these 1958 values were used if a clear description of the soil was available. In four cases, because of soil mixtures, these values could not be used so the mean value calculated from the estimates in Table 1 was used.

3. Estimating gross income for cases of non-response.

Where yields were not recorded, the average usual yield reported on woil of the same type by other respondents, was used. Where yields of a certain crop were reported by only one or two respondents, the data were supplemented by data from a survey in Marion County a year later (41, p. 74, 75)[a].

Where sales of livestock or livestock products were not reported by respondents who otherwise reported a usual complement of livestock, the annual sales were estimated on the basis of the complement of breeding stock or laying hens reported. Because farmers were busy when the enumeration was carried out, it was very difficult to probe for exact figures on sales of livestock and livestock products. Later editing of the questionnaires revealed a few cases where reported sales were inconsistent with breeding or laying stock to such an extent as to cause serious doubts about their accuracy. Rather than reject the record, the sales were adjusted to a more reasonably consistent figure. Each case was adjusted individually on the basis of judgment rather than formula, taking into consideration replacement age, reproduction rate and the closeness with which the respondent's estimates approached these[b]. Any "across the board" adjustment according to a set formula based on a constant per cent reproduction rate, number of breeding

a. For yields used see Appendix D, Table 4.

b. For example, one farm reported 15 sows that averaged 4 litters each, over their productive life. If these litters occurred every 6 months, the sows were replaced at an age of 2½ - 3 years. If they occurred only once a year, the sows were replaced at an age of at least 4 years. So the farmers report of 4 old sows sold per year could be accepted as reasonable for "usual" sales. However, most of the records having 10-12 sows reported usual sales of 150 market hogs per year, whereas the respondent in the example reported selling only 75. So his usual sales of market hogs were adjusted upward to 100, which is still considerably below what would be expected. It was not adjusted to a higher figure because other factors (e.g., investment in feed, housing, etc.) may have made the respondent a below average producer.

females, etc., would tend to artificially increase the correlation between capital investment (in livestock, in this case) and income. Therefore, such a method was not used.

4. Methods used for estimating and calculating gross expenses.

The items that are included in gross expenses are: farm share of machinery operating costs; repairs on fences, buildings and other real estate improvements; livestock purchases; the value of paid and unpaid labor; custom work hired; taxes; crop expenses such as seed, fertilizer, sacks, twine, weedicides, insecticides and other sprays, water charges, etc.; livestock expenses such as veterinary services and supplies, feeds purchases, pasture rent, breeding and registration fees, bedding purchased, etc.; rent of equipment; fees and commission paid; farm share of telephone and electricity; farm share of fire insurance; hauling. Depreciation was also included here, although it is not an operating expense and consists of the farm share of depreciation on machinery, the "usual" depreciation on buildings and the perennial crop "overhead". Interest on debt was omitted. Social Security payments for the operator were considered negligible by most respondents so they were not included.

The details of these expenditure items and methods for arriving at some of them are as follows:

(1) Machinery: Fuel costs for power equipment were calculated from the annual hours of use reported, the hourly rate of fuel consumption and the average price of fuel in the locality.[a] The cost of

a. See Appendix D, Table 1 for fuel prices.

lubricants was taken as reported, but where it was not enumerated the following charges were made: trucks, $.002 per mile of annual use; car, $.003 per mile; tractors and other special equipment, $.022 per hour of annual use. A flat charge of $5.00 per record was made for grease for general equipment. Licenses and insurance costs were tabulated and, where not enumerated, the following rates were calculated from the tabulation: car, $70.00; ½-ton trucks, $46.00; larger trucks, $65.00.

Machinery repairs present a problem. Some repairs are annual while some are required less frequently. In any given year an operator may be fortunate and require only the annual repairs. On the other hand, unforeseen breakages may require repairs that last longer than one year. Over the life of the machine both types must be met out of income. The problem is that in a one-call survey the reported repair costs for an individual farm are likely to distort the normal association between capital invested and net income. To overcome this problem an annual average of the repairs for that farm should be charged against income.

It is not realistic to charge an average annual repair cost for all farms in the survey to each individual farm because the farms vary in the size and annual use of equipment items. To take into account this variation a formula was applied to each of the following categories of machinery for each farm: half-ton trucks, other trucks, balers, combines, automobiles, forage harvesters, cane choppers, general equipment and irrigation equipment. The formula for all but the last two was: annual use x present value x an adjusting factor for the category. The adjusting factor for a category was calculated thus:

$$\frac{\text{average repairs for the category}}{\text{average annual use x average present value}}$$

The averages in the calculation were for all sample farms reporting the item. Zero repairs were included. Care must be taken in the first formula to apply the same annual use unit as used in the calculation of the adjusting factor for the category.

The adjusting factor for general equipment and for irrigation equipment was: "repairs per dollar of present value." A weighted average was calculated for the whole sample. The factor was then applied directly to the present value of this equipment for each farm[a].

Tractor repairs were handled differently because they were prejudged to be relatively more important than repairs on other equipment. The problem discussed above, concerning annual and more enduring repairs and what to charge to a particular farm in a one-call survey analysis, applied in the case of tractors. It was desired to use a formula for normal repairs that recognized inter-farm variations. Size of tractor, age of tractor and annual use were all deemed important influences on repairs so it was decided to use multiple regression to associate these with annual repairs reported. The following equation was derived from the data for 100 tractors reporting repairs (zero repairs were included).

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a. See Appendix D for the average annual use, average present values and adjusting factors. (Table 5.)

$$Y = 2.9471X_1 - 1.3302X_2 + 0.0232X_3 - 12.272$$

where Y is estimated annual repairs in dollars

X_1 is size of tractor in drawbar horsepower

X_2 is age of tractor in years

X_3 is annual use in hours.

$$R^2 = .1122$$

The F-value is shown in the following analysis of variance:

Variation due to	Sum of squares	d.f.	Mean squares	F
Regression	67505.79	3	22501.93	4.04
Residual	534324.65	96	5565.88	
Total	601830.44	99		

It was therefore concluded that the overall regression was significant at the .01 level.

The following t-values were calculated for each regression coefficient:

b_1	$t = 2.95$
b_2	$t = .77$
b_3	$t = .80$

b_1 was significant at the .01 level and b_2 and b_3 were not significant at the .10 level of significance.

Thus it was concluded that only tractor size influenced repairs significantly.

To test whether or not the relationship of repairs and size was linear the following analysis of variance was applied to five size groups stratified by drawbar horsepower, 5-14, 15-19, 20-24, 25-29, 30-44:

Table 2. Analysis of variance of tractor repairs[a] for five tractor size groups from sample farms, 1957

Variation due to	Sum of squares	Degrees of freedom	Mean square	F	Remarks
Among sample	68731.75	4	17182.94	3.06	(4,95 df)
Linear regression	58636.54	1	58636.54	10.45	(1,95 df)
Deviation from linearity	10095.20	3	3365.07	.60	(3,95 df)
Error	533098.69	95	5611.57		
Total	601830.44	99			

a. Zero repairs are included.

The F-value of .60 is not large enough at the .10 level of significance to reject the hypothesis that the population regression is linear so the conclusion is that the regression is linear.

On this basis and on the basis of the multiple regression analysis it was decided to use a simple linear regression equation to estimate annual repairs. The following equation was fitted to the data:

$$Y = 3.185X - 18.804$$

Where Y is the estimated annual repairs in dollars and X is the size of tractor in drawbar horsepower.

$b = 3.18475$ was found to be significant at the .01 level ($F = 10.5789$ with 1 and 98 degrees of freedom) and $r = .3121$. (The true correlation is greater than .15 with 1 chance in 20 of being wrong (21, p. 294).

On the basis of this equation the following annual repairs were charged according to the drawbar-horsepower group into which a tractor was categorized:

D-b horsepower	Annual repairs
5-14	$ 11.50
15-19	35.50
20-24	51.00
25-29	67.00
30-44	99.00

The farm share of machinery costs was calculated for cars and trucks only. The following shares were used according to the conditions indicated:

Farm shares for cars on farms:

With half-ton truck	25 per cent
Without truck (any type)	40 per cent

Farm share for trucks on farms:

With car	- half-ton truck	75 per cent
	- other trucks	100 per cent
Without car	- half-ton truck	67 per cent
	- other trucks	90 per cent

These values are judgment estimates based on the author's experience in previous farm surveys.

Machinery depreciation was calculated by the straight-line method. The price paid by the farmer (when he acquired the item) converted to 1957 dollars (use 75) was depreciated. The time period used was the period from the time of acquiring to the time of the survey plus the respondent's estimate of the remaining life at the time of the survey. For trucks and cars only the farm business share of the depreciation was included.

(2) Buildings: Annual charges for repairs and depreciation on buildings is even more difficult to estimate than for machinery. There is

a certain amount of repairing occurring at uneven intervals, some of which last a short time and some for several years. In any single year it is difficult to determine, from a brief survey, the repairs necessary to charge annually against the business, yet it is necessary to make some allowance for them in a budget for capital accumulation over time. The response on repairs in the survey was too unreliable to provide data to calculate a formula to apply to every farm or building. So it was necessary to develop a reasonable formula on other bases.

Annual repairs depend mainly upon the age of the building, its size, the quality of its construction and the use to which it is put. The writer was unable to obtain data or analyses from previous studies in Oregon or elsewhere so it was necessary to resort to the following assumptions based on his experience in farm surveys: (a) as the age of a building increases, the annual cost of repairs on that building as a percentage of construction costs, increases; (b) with fairly new buildings of a given type, e.g., houses, repairs are about proportional to the construction costs of the building, but (c) with older buildings repairs are a smaller proportion of the construction cost for higher cost buildings; (d) the repairs as a proportion of construction costs are lower for dwellings than for other farm buildings.

Since depreciation on a straight line basis is an annual expression of the value being depreciated, it was decided to calculate depreciation first and then apply the repair rates to the annual depreciation. The practical lifetimes used for the various buildings are shown in Appdendix D, Table 6 along with a table of repair rates used[a]. These rates were applied to each building. The repairs on the dwelling are allocated to living cost so that only the repairs on the remaining buildings are charged against farm income in determining net income.

A building whose age exceeded the practical life allowed[b] was considered to be fully depreciated so that no depreciation was charged. However, repairs for these buildings were calculated on the annual depreciation rate arrived at on the straight line basis. The maximum ages in the lifetime[c] were used to apply the repair rates[a]. The straight line method considerably over-estimates the usual depreciation on old buildings, especially on large old buildings having a high replacement cost. To calculate usual annual repairs on these buildings only half of the calculated straight line depreciation was used.

Although it would be much better for purposes of this study to have empirical historical data on repairs for various types of buildings under conditions found in the sample area, without those data it is more realistic to assume a formula based on logic and experience than to ignore the problem or to choose repair costs at random. Because of the logic the repairs are in reasonable relative magnitude and the experience basis will considerably reduce the absolute magnitude of the error in annual repairs.

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a. See Appendix D, Table 8.
b. See Appendix D, Table 6.
c. ibid.

The survey data on fence repairs were adequate for calculating a repair rate, based on replacement cost, to apply to those farms for which data were not obtained.

No repair cost was charged for wells or drainage. It was assumed that only replacements would occur so that annual depreciation was sufficient.

(3) **Taxes:** The fundamental projection of capital accumulation is based on a farm business for which the resources are fully owned. Consequently taxes were charged for the real estate of every sample farm used in the study, and rent, where paid, was ignored.

In cases where the respondents were renting all or some of their real estate, they usually did not know what the taxes were on the rented portion. Also, a number of respondents' replies when later checked, were unreasonable for the real estate and chattels owned by the respondent[a]. The taxes for these cases and for renters were estimated by applying to their cropland acreage the weighted average taxes per cropland acre reported by the remaining respondents with the same type of farm[b]. The average tax rates are listed in Appendix D, Table 9.

(4) **Other expenses:** No depreciation was allowed on breeding stock so that usual livestock purchases were included in expenses.

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a. They were checked against per acre tax rates reported in the survey made a year later by S.C. James (41, p. 5).

b. The taxes reported by these latter respondents were taken to be correctly reported.

Labor charges included paid and unpaid labor at the going rates, without board and room[a].

Custom work paid out including hauling costs, was taken as reported by the respondent[a].

Fire insurance for all buildings but the dwelling was included. Respondents reported total insurance, which was allocated according to present values of the dwelling and other buildings.

Cost of seed was calculated by acreage seeded, usual rate of seeding and the price of the seed, which was taken to be the selling prices reported. Bedding plants and new caneberry plants were calculated the same way. In some cases it was necessary to resort to published bulletins for planting rates[b].

Fertilizer costs were taken as reported. An occasional respondent reported the rate of application or the total tonnage. Current prices from the survey were applied to these cases[c].

The remaining expense items were taken as reported and are as follows: sacks, twine, weedicides, insecticides, fungicides, livestock sprays and disinfectants, medicines, veterinary charges, bedding fees, feed purchases, pasture rental, registration fees, bedding costs, rent for equipment, commissions paid, water charges, telephone and electricity (farm share), other.

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a. See Appendix D, Table 10, for these rates.

b. See Appendix D, Tables 11 and 12, for rates on planting and for prices.

c. See Appendix D, Table 12, for fertilizer prices.

(5) Overhead for perennial crop[a]: No charge was made for newly planted perennial "crops" but an annual overhead was charged to those perennial "crops" for which the returns were included in the gross income for the farm. The original cost of establishing the plantings was divided by the years of estimated economic bearing life of the "crops".[b] For the main components of gross operating expenses by individual farms in the sample see Appendix C, Table 3.

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a. Crops here include berries, orchards, nut groves, grasses, etc.

b. See Appendix D, Table 13, for schedule of annual depreciation charged to perennial crops.

APPENDIX C

Table 1. Components of total input capital values on 66 sample farms, Marion County, 1957

Type of farm & farm no.		Service buildings	Cropland	Lvstk. inventory	Mach. and Equip.	Operating expenses	Perennial crops	Total
				-dollars-				
E1	2	3,393	19,000	105	6,240	2,390	90	31,218
	7	8,794	69,300	365	10,555	4,914	--	93,928
	32	4,483	31,350	666	9,195	2,709	64	48,467
	35	4,376	25,500	850	2,251	2,727	511	36,215
	41	11,067	14,000	--	16,796	2,522	--	44,485
	44	11,764	67,200	284	8,037	5,528	336	93,149
	53	3,810	44,400	2,208	6,315	4,165	--	60,898
	61	1,786	10,700	545	2,673	1,571	--	17,275
	64	5,331	35,181	2,735	17,436	6,923	1,547	69,153
	65	9,747	71,400	205	12,675	7,888	3,415	105,330
	66	1,875	34,625	--	1,821	5,319	345	43,985
	69	1,093	14,500	--	2,980	1,380	--	19,953
	74	2,181	10,312	--	758	1,326	36	14,613
	86	9,097	36,438	886	15,525	7,075	830	69,851
	89	2,237	20,350	400	2,789	1,632	--	27,408
E2	26	4,968	65,325	2,600	5,576	5,289	--	83,758
	43	3,680	30,600	1,245	9,692	4,181	278	49,676
	48	1,747	11,100	1,110	5,710	1,745	--	21,412
	52	6,903	17,875	2,204	1,556	8,867	3,903	41,308
	81	7,362	55,200	4,840	5,849	17,841	--	91,092
	96	7,037	32,400	650	7,329	4,478	--	51,894
D	1	3,275	43,050	10,175	22,397	16,825	14,861	110,583
	12	13,725	64,000	7,710	19,481	15,804	479	121,199
	31	4,887	17,316	4,815	13,229	6,863	268	47,378
	33	3,641	28,650	3,180	10,845	5,325	--	51,641
	37	6,019	21,600	5,625	6,538	7,683	136	47,610
	38	8,877	17,200	9,405	10,382	6,266	678	52,808
	39	12,410	55,570	10,200	13,887	10,409	128	102,784
	42	2,800	14,250	6,500	3,133	6,593	272	38,553
	50	13,673	17,250	5,525	6,045	8,494	162	51,149
	51	6,116	11,120	1,140	2,287	2,699	157	23,519
	54	5,374	18,725	5,445	7,948	10,641	437	48,570
	99	17,222	27,300	10,444	19,487	12,061	1,416	87,930

continued

Table 1. Components of total input capital values on 66 sample farms, Marion County, 1957 (continued)

Type of farm & farm no.		Service buildings	Cropland	Lvstk. inventory	Mach. and equip.	Operating expenses	Perennial crops	Total
		- dollars -						
I	3	1,350	10,650	320	3,104	3,084	582	19,075
	4	438	3,500	--	1,111	4,071	633	9,753
	5	3,592	7,500	598	7,746	3,595	297	23,328
	6	3,237	20,500	100	10,873	6,605	1,823	43,138
	8	1,343	13,600	294	6,922	2,737	9,612	34,508
	9	2,514	26,750	134	3,762	4,610	2,385	40,155
	10	1,995	16,800	150	2,474	6,192	1,237	28,848
	11	1,228	16,875	--	5,276	5,565	771	29,715
	13	2,745	17,085	3,450	2,821	8,011	2,001	36,113
	14	499	23,056	--	1,752	4,334	2,025	31,666
	15	8,727	35,550	3,354	23,389	25,512	3,818	100,350
	16	2,780	7,500	370	7,527	5,451	3,920	27,548
	17	1,281	12,250	--	4,488	6,451	1,686	26,516
	18	5,055	7,875	75	7,403	2,262	359	23,029
	19	5,097	15,000	--	7,458	12,868	3,102	43,525
	30	3,334	18,750	993	6,605	11,080	2,088	42,850
	36	16,565	33,300	2,360	6,357	19,466	4,762	82,810
	49	3,076	3,675	370	6,477	4,000	585	18,183
	63	670	7,800	--	245	914	54	9,683
	67	1,830	7,800	16	5,268	5,601	1,829	22,344
	70	2,095	14,125	175	3,186	4,737	730	25,048
	72	2,483	5,900	188	6,001	6,182	1,418	22,172
	73	1,415	11,212	522	3,678	3,480	1,202	21,509
	82	2,175	6,750	795	2,316	5,283	1,500	18,819
	83	2,001	16,000	2,735	6,597	15,716	13,972	57,021
	84	7,458	29,100	987	8,235	11,931	1,267	58,978
	87	6,099	11,880	--	3,246	4,813	1,033	27,071
M	27	3,928	18,626	790	7,432	3,686	284	34,746
	28	2,889	20,400	2,350	1,910	3,621	416	31,586
	34	9,184	45,750	585	15,711	14,083	2,914	88,227
	40	2,220	14,600	1,513	5,319	4,460	659	28,771
	68	4,028	41,100	1,740	4,606	6,100	946	58,520
	98	11,056	35,674	2,050	20,055	8,680	2,339	79,854

Table 2. Usual gross income[a] and components for 66 sample farms, Marion County, 1957.

Farm type & no.		Improved acres[b]	Crop sales	Lvstk. sales	Sales of lvstk. products	Custom work	Perquisites	Total
E1	2	76.0	5,195	--	--	15	371	5,581
	7	198.0	9,399	353	108	--	117	9,977
	32	104.5	5,316	535	901	--	169	6,921
	35	85.0	7,883	348	1,000	--	34	9,265
	41	47.0	4,770	--	--	--	--	4,770
	44	224.0	10,326	1,425	--	--	84	11,835
	53	120.0	8,016	1,075	161	1,500	165	10,917
	61	53.5	1,740	250	450	--	213	2,652
	64	108.2	8,554	2,472	150	600	398	12,174
	65	238.0	23,734	261	59	--	64	24,118
	66	138.5	11,802	--	--	--	--	11,802
	69	58.0	3,371	--	--	159	188	3,718
	74	27.5	2,211	--	--	--	262	2,473
	86	132.5	9,047	2,289	2,682	3,000	895	17,913
	89	55.0	2,826	971	--	--	218	4,016
E2	26	201.0	5,801	6,774	1,800	--	160	14,535
	43	102.0	2,043	6,922	230	283	82	9,561
	48	30.0	844	728	445	--	132	2,149
	52	71.5	2,375	2,134	8,271	275	307	13,362
	81	138.0	10,032	1,147	18,122	--	72	29,373
	96	108.0	3,696	6,952	--	--	82	10,731
D	1	143.5	4,020	4,758	24,000	--	337	33,115
	12	160.0	532	1,965	18,652	850	519	22,418
	31	111.0	3,991	1,000	9,140	--	657	14,788
	33	191.0	1,799	2,183	4,300	--	313	8,595
	37	48.0	510	1,540	11,523	--	270	13,843
	38	43.0	427	1,133	14,921	--	210	16,691
	39	111.5	1,481	1,925	12,775	--	698	16,879
	42	38.0	--	940	11,059	--	340	12,339
	50	57.5	934	900	11,080	800	383	14,097
	51	34.8	1,280	475	1,908	--	358	4,021
	54	53.5	2,000	805	11,275	--	818	14,898
	99	78.0	--	1,280	17,885	15	609	19,789

continued

Table 2. Usual gross income[a] and components for 66 sample farms, Marion County, 1957 (continued).

Farm type & no.		Improved acres[b]	Crop sales	Lvstk. sales	Sales of lvstk. products	Custom work	Perquisites	Total
1	3	35.4	5,197	492	100	--	423	6,212
	4	8.8	7,808	--	--	--	130	7,938
	5	18.8	2,837	911	600	10	15	4,372
	6	42.0	10,134	--	--	--	15	10,149
	8	34.0	5,692	--	--	--	334	6,026
	9	82.0	9,797	--	--	--	147	9,944
	10	48.0	11,106	--	--	10	210	11,326
	11	11.2	5,894	--	--	--	400	6,294
	13	34.2	7,836	7,601	--	--	731	16,168
	14	29.8	6,957	692	--	--	96	7,745
	15	118.5	36,780	4,430	86	100	747	42,142
	16	25.0	11,448	302	--	--	234	11,984
	17	24.5	11,713	--	--	--	75	11,788
	18	21.0	2,661	--	--	--	447	3,108
	19	30.0	23,400	--	270	1,900	--	25,570
	30	62.5	15,898	1,825	1,120	--	589	19,432
	36	111.0	15,328	8,129	4,360	--	--	27,818
	49	10.5	2,344	122	1,248	--	229	3,944
	63	19.5	1,104	--	--	--	411	1,515
	67	19.5	9,667	--	--	--	35	9,702
	70	19.5	7,162	--	--	--	111	7,273
	72	14.8	9,582	50	--	125	239	9,997
	73	34.5	5,168	147	600	--	222	6,137
	82	22.5	4,920	290	1,750	335	137	7,432
	83	40.0	18,970	4,498	156	--	285	23,909
	84	97.0	10,900	9,087	--	--	146	20,133
	87	24.0	8,396	--	--	--	85	8,481
M	27	55.6	2,507	461	1,120	400	386	4,874
	28	68.0	3,982	4,450	60	--	173	8,665
	34	183.0	17,571	6,883	--	--	123	24,577
	40	36.5	4,136	689	2,618	--	376	7,818
	68	82.2	8,703	3,224	1,600	--	286	13,813
	98	170.0	11,440	2,175	27	--	240	13,882

a. Off-farm receipts other than for custom work have been omitted. Since this is usual income, based on annual output, no change in inventory is included.

b. Includes improved pasture, cropland acres, summerfallow, orchards, etc., but does not include the farmstead.

Table 3. Components of usual annual expenses, 66 sample farms, Marion County, 1957

Farm type and no.		Machinery op. costs (farm share)	Improvement repairs[a]	Livestock purchases	Labor (paid & unpaid)	Custom work	Taxes	Other[b]	Total expenses
E1	2	542	269	--	432	--	520	627	2,390
	7	1,217	686	--	48	298	1,600	1,065	4,914
	32	637	214	142	--	240	682	784	2,709
	35	345	104	--	1,120	--	525	633	2,727
	41	1,006	43	--	100	475	365	533	2,522
	44	692	303	375	225	1,338	1,500	1,095	5,528
	53	725	478	25	99	136	955	1,747	4,165
	61	277	246	18	60	200	488	282	1,571
	64	1,453	322	1,024	1,880	125	933	1,186	6,923
	65	1,329	486	46	828	1,000	1,842	2,357	7,888
	66	972	67	--	1,292	408	1,071	1,509	5,319
	69	432	281	--	--	166	403	98	1,380
	74	210	353	--	--	382	170	211	1,326
	86	2,299	219	226	1,353	194	600	2,184	7,075
	89	235	301	150	96	318	400	132	1,632
E2	26	1,137	221	--	20	75	1,295	2,541	5,289
	43	799	144	98	350	128	650	2,012	4,181
	48	456	68	145	--	305	318	453	1,745
	52	674	200	522	1,215	179	569	5,508	8,867
	81	656	241	289	600	430	827	14,798	17,841
	96	740	225	--	100	145	860	2,408	4,478

continued

Table 3. Components of usual annual expenses, 66 sample farms, Marion County, 1957 (continued)

Farm type and no.	Machinery op. costs (farm share)	Improvement repairs[a]	Livestock purchases	Labor (paid & unpaid)	Custom work	Taxes	Other[b]	Total expenses
D 1	1,737	274	1,000	4,360	1,450	1,119	6,885	16,825
12	1,287	336	1,986	5,148	989	1,248	4,810	15,786
31	674	313	760	2,408	80	647	1,981	6,863
33	1,232	234	600	600	--	1,200	1,459	5,325
37	850	212	900	35	1,002	374	4,310	7,683
38	895	153	1,254	--	1,188	380	2,396	6,266
39	1,188	640	2,500	3,264	852	780	1,185	10,409
42	651	184	1,000	100	726	296	3,641	6,598
50	579	324	845	1,053	762	448	4,483	8,494
51	313	207	195	560	171	300	953	2,699
54	527	349	918	2,600	1,235	430	4,582	10,641
99	1,580	358	--	3,530	750	570	5,273	12,061
I 3	287	305	13	1,615	175	293	396	3,084
4	187	117	--	3,371	40	97	259	4,071
5	888	77	--	1,216	72	156	1,186	3,595
6	884	118	--	3,810	114	350	1,329	6,605
8	536	146	168	1,200	90	250	347	2,737
9	793	47	--	2,600	35	680	455	4,610
10	471	59	--	4,600	140	398	524	6,192
11	626	6	--	4,290	78	156	409	5,565
13	449	187	--	3,786	35	236	3,318	8,011
14	387	14	--	3,294	101	189	349	4,334
15	2,189	446	2,386	16,187	--	961	3,343	25,512
16	738	71	225	2,930	20	358	1,109	5,451
17	620	52	--	4,746	48	203	782	6,451
18	555	63	--	1,121	85	196	242	2,262
19	875	94	--	10,334	--	250	1,315	12,868

continued

Table 3. Components of usual annual expenses, 66 sample farms, Marion County, 1957 (continued)

Farm type and no.	Machinery op. costs (farm share)	Improvement repairs[a]	Livestock purchases	Labor (paid & unpaid)	Custom work	Taxes	Other[b]	Total expenses
30	569	327	231	7,360	75	540	1,978	11,080
36	907	359	122	11,042	85	917	6,034	19,466
49	450	62	63	980	80	200	2,165	4,000
63	59	142	—	256	164	75	218	914
67	351	45	—	4,765	50	162	228	5,601
70	457	80	—	3,650	72	190	288	4,737
72	435	—	27	4,890	—	110	720	6,182
73	376	400	34	1,730	188	214	538	3,480
82	475	268	90	1,950	37	200	2,263	5,283
83	716	328	1,697	11,325	143	340	1,167	15,716
84	1,578	211	—	6,526	418	700	2,498	11,931
87	776	276	—	3,167	29	274	291	4,813
M 27	678	468	84	1,230	90	405	731	3,686
28	340	125	17	2,008	100	432	2,599	3,621
34	1,906	681	—	6,100	120	1,162	4,114	14,083
40	399	336	—	2,391	180	276	878	4,460
68	913	56	—	2,780	165	500	1,686	6,100
98	1,557	113	458	3,166	—	1,100	2,286	8,680

a. Repairs to buildings, fences, wells, drainage, etc.

b. Includes farm share of fire insurance, seed and plants, fertilizer, weedicides, insecticides, sprays, sacks, twine, fungicides, disinfectants, feed purchases, breeding fees, veterinary charges, registration fees, pasture rental bedding costs, equipment rental, commissions and fees paid, water charges, telephone, electricity and miscellaneous.

Table 4. Components of depreciation, 66 sample farms, Marion County, 1957

Farm type & no.		Buildings[a]	Machinery	Perennial crops	Total
E1	2	249	576	30	855
	7	505	1,082	--	1,587
	32	315	1,383	16	1,714
	35	236	649	340	1,225
	41	499	1,848	--	2,347
	44	932	897	112	1,941
	53	662	1,322	--	1,984
	61	244	395	--	639
	64	315	1,143	173	1,631
	65	605	2,015	729	3,349
	66	130	527	68	725
	69	137	821	--	958
	74	295	114	7	416
	86	525	1,627	324	2,476
	89	311	178	--	489
E2	26	318	900	--	1,218
	43	144	1,097	92	1,333
	48	88	436	--	524
	52	366	322	267	955
	81	631	396	--	1,027
	96	417	800	--	1,217
D	1	425	2,285	1,883	4,593
	12	654	2,628	140	3,422
	31	518	1,305	66	1,889
	33	248	930	--	1,177
	37	294	733	34	1,061
	38	431	995	198	1,624
	39	799	1,570	32	2,401
	42	263	727	68	1,058
	50	717	977	64	1,778
	51	292	380	31	703
	54	497	905	105	1,507
	99	1,035	2,241	414	3,690

continued

Table 4. Components of depreciation, 66 sample farms, Marion County, 1957 (continued)

Farm type & no.		Buildings[a]	Machinery	Perennial crops	Total
I	3	147	476	208	831
	4	67	98	171	336
	5	182	775	131	1,078
	6	238	1,259	1,187	2,684
	8	115	602	820	1,537
	9	124	--	549	673
	10	135	399	392	926
	11	55	469	519	1,043
	13	208	313	882	1,403
	14	31	89	690	810
	15	1,034	2,305	2,077	5,416
	16	172	1,025	386	1,583
	17	70	623	772	1,465
	18	202	696	110	1,008
	19	220	810	1,359	2,388
	30	245	882	546	1,691
	36	829	1,154	982	2,965
	49	160	468	126	754
	63	110	6	11	127
	67	90	735	773	1,598
	70	217	374	486	1,077
	72	73	613	945	1,631
	73	199	419	329	947
	82	307	161	334	802
	83	267	618	979	1,864
	84	357	1,075	312	1,744
	87	348	418	566	1,332
M	27	503	644	123	1,270
	28	221	415	144	780
	34	621	1,502	980	3,103
	40	280	684	246	1,210
	68	142	698	370	1,210
	98	457	2,100	939	3,496

a. Includes buildings normally used in the operation of the farm. The house is excluded.

Table 5. Disposable net income, living costs and household size, 64 sample farms, Marion County, 1957[a]

Farm no.	Net income[b]	Living costs[c]	House-hold size[d]	Farm no.	Net income	Living costs	House-hold size
	-dollars-				-dollars-		
2	3,623	3,136	5.7	10	5,834	1,548	2.0
7	5,771	1,507	3.0	11	4,169	3,270	4.9
32	4,242	1,740	2.0	13	9,712	2,796	5.4
35	6,568	1,548	2.0	14	3,411	1,295	1.0
41	4,348	3,650	4.3	15	16,630	4,264	4.0
44	7,031	1,971	2.0	16	7,073	3,444	2.8
53	7,102	2,269	3.0	17	8,673	2,213	4.4
61	1,111	795	2.0	18	5,213	3,624	5.2
64	6,229	3,130	4.1	19	12,822	3,051	4.6
65	17,730	4,217	2.0	30	9,562	3,780	4.4
69	2,338	1,067	2.0	36	10,108	4,386	5.4
74	1,467	2,289	2.0	49	434	1,941	2.0
86	16,841	4,717	6.7	63	916	1,009	1.0
89	2,480	1,230	2.0	67	6,101	735	2.0
26	9,246	2,034	3.8	70	7,478	5,689	4.9
43	5,512	1,409	1.0	72	5,250	2,699	2.8
48	1,144	2,214	2.0	73	2,857	1,484	2.8
52	5,440	1,616	3.3	82	3,347	2,190	2.5
81	11,557	1,428	2.0	84	8,368	1,898	2.0
96	6,253	1,222	2.0	87	4,161	2,696	2.0
27	2,313	2,045	3.6	1	18,390	3,770	3.6
28	5,044	2,347	4.8	12	6,714	3,362	3.0
34	12,054	4,853	4.1	31	11,555	2,915	4.0
40	4,524	2,392	2.8	33	3,470	1,270	2.0
68	8,413	3,022	4.5	37	6,310	3,127	3.6
98	5,742	3,270	3.3	38	10,825	2,317	2.0
3	3,878	2,440	4.4	39	10,784	4,100	5.7
4	4,530	3,751	4.6	42	5,841	2,476	3.3
5	767	749	1.0	50	6,906	3,511	5.2
6	3,754	3,747	4.9	51	1,372	1,739	2.0
8	3,314	1,260	2.8	54	6,167	3,937	3.5
9	6,482	2,417	4.0	99	11,518	4,495	6.8

a. Both disposable net income and living costs contain farm perquisites.

b. The allowances for unpaid family labor and depreciation have been added. It also includes income from non-farm sources.

c. Depreciation charge for furniture and equipment has been subtracted.

d. In adult equivalents.

APPENDIX D

PRICES, AVERAGE YIELDS, RATES USED IN CALCULATING INCOME AND EXPENSES

1. Prices:

Table 1. Fuel prices[a] for power equipment on 66 sample farms, Marion County, 1957

Type of fuel	Unit	Price
		-dollars-
Tractor	gallon	.197
Tractor diesel fuel	gallon	.155
Combine gasoline	gallon	.197
Truck gasoline	gallon	.197
Automobile gasoline	gallon	.298

a. Source: Tabulation of survey data.

Table 2. Livestock and livestock products prices and weights[a] for 66 sample farms, Marion County, 1957

Livestock sold				Livestock inventory		
Type	Unit	Weight	Price	Type	Unit	Price
		(lbs.)	-dollars-			-dollars-
Cows	each		135.00	Cows	lb.	.13
15 days calves	each		6.00	Dairy cows	each	209.00
Heifers	lb.	926	.165	Breeding Bulls	each	166.00
Steers	lb.	926	.168	Bulls	lb.	.15
Calves	lb.	213	.195	Heifers	lb.	.145
Bulls	lb.		.125	Dairy heifers	each	86.00
Market hogs	lb.	200	.205	Steers	lb.	.175
Feeder hogs	lb.		.13	Calves	lb.	.165
Brood sows	lb.	409	.158		or	
Boars	lb.		.035		each	16.00
Lambs	lb.	88	.193	Young calves	each	7.00
Ewes	lb.	148	.054	Ewes	lb.	.112
Bucks	each		17.50		or	
Feeder lambs	each		15.50		each	15.00
Chickens	lb.	5	.14	Bucks	each	24.00
Broilers	lb.	3	.24	Market lambs	lb.	.194
				Feeder lambs	lb.	.17
				Sows	lb.	.174
				Boars	each	63.00
				Market hogs	lb.	.21
				Feeder hogs	lb.	.226
				Weaner hogs	each	11.60
Livestock Products Sold:						
Wool	lb.	10 per ewe	.612	Chickens	each	1.05
Eggs	doz.		.40	Broilers	each	.50
Fluid milk	cwt.		5.11	Turkeys	each	2.25

a. Source: tabulations of data from the survey.

Table 3. Selling prices of crops sold (in dollars) on 66 sample farms, Marion County, 1957

Crop	Unit	Price	Crop	Unit	Price
Wheat	ton	65.57	Broccoli	ton	152.20[b]
Oats (grain)	ton	40.60	Beans	ton	131.80[c]
Barley (grain)	ton	39.58	Onions	ton	36.00[c]
Mixed grain	ton	48.58[d]	Mint oil	lb.	4.35[b]
Rye (grain)	ton	45.00	Loganberries	lb.	.12
Austrian peas	ton	49.00	Boysenberries	lb.	.10
Vetch (grain)	ton	100.00	Ev. Gr. Bl.berries	lb.	.08
Oats and Vetch (grain)	ton	42.00	Chehalis Bl.berries	lb.	.12
Oats and Aust. peas	ton	45.95	Santiam Bl.berries	lb.	.20
Red Clover seed	lb.	.28	Strawberries	lb.	.08
Crimson Clover seed	lb.	.172[a]	N.W. Strawberries	lb.	.21
Alta Fescue seed	lb.	.093[a]	Black Cap Raspberries	lb.	.157[a]
Red Fescue seed	lb.	.37	Red Raspberries	lb.	.153[a]
Chewings Fescue seed	lb.	.295	Gooseberries	lb.	.065
Squash seed seed	lb.	.35	Walnuts	lb.	.20
Hay-in field	ton	15.00	Filberts	lb.	.15
-in delivered	ton	20.90	Cherries	lb.	.15
Sweet corn	ton	29.30[c]	Prunes	ton	37.20[a]
Potatoes	ton	32.40[c]	Onion seed	lb.	1.00
Cucumbers	ton	64.60[c]			

a. Source: Index of Prices Received by Oregon Farmers and Oregon Farm Product Prices (57).
b. Source: Season Average Price, Oregon (1950-57) (58).
Note: the price series for peppermint is shown here in \$/cwt. In a release September 17, 1957, the same series, to that date, was shown in \$/lb. For the 1958 release the \$/cwt. was taken to be an error on the basis that no farmer in Marion County would use expensive land to raise mint, yielding 55-60 lbs. of oil per acre, at \$4.35 per lb. or \$2.39 gross per acre.
c. Source: Season Average Farm Prices and Yields in Oregon of Specified Farm Products (59).
d. Source: Average of wheat, oats and barley. Source of all other prices: tabulations of data from the survey.

Table 4. Average yields[a] for various crops and soil types, Marion County, 1957 and 1958

	Soil types													
	T_1 (Willam'te)		T_2 (Amity)		T_3 (Conc'd)		T_4 (Woodb'n)		X_1 (Cheh's)		X_4 (Wapato)		M (Mixed)	
Crop	n	yld	n	yld	n	yld	n	yld	n	yld	n	yld	n	yld
Spring Wheat	5	1.47	8	1.12	1	1.00	7	1.13	1	1.50	1	1.35		
Winter Wheat	17	1.32[b]	46	1.26[b]	3	1.40	76	1.44[b]	13	1.34[b]	3	1.32	14	1.26[c]
Spring Oats	2	1.11	20	1.12	5	0.94	10	1.08	3	1.81	4	0.88	1	1.00
Winter Oats	8	1.10	28	1.10			24	1.13	2	1.00	1	1.00	5	1.02
Spring Barley	17	1.46[b]	55	1.35[b]	10	0.98[b]	48	1.41[b]	19	1.52[b]	10	1.20[b]	12	1.27[c]
Winter Barley			1	1.00										
Oats and Peas	1	10.00[d]	1	1.30			4	1.38			2	1.50		
Peas	3	1.00	1	1.50	1	1.00							1	1.50
Oats and Vetch	7	1.03	22	1.40	2	0.90	22	1.12[b]	5	0.93			1	1.00
Oats and Barley														
Mixed Grain			1	0.75	1	1.25	2	1.12						
Field Corn Grain	14	1.44	11	1.97	1	1.96	12	1.76[b]	8	2.79[b]			2	1.70
Field Corn Silage			4	12.05	2	11.00	3	10.67			1	10.00		
Red Clover Hay	8	3.16	6	2.54			8	2.10	1	4.00	1	2.00	2	3.25
Red Clover Seed	4	3.50	11	3.00[b]			20	2.87[b]	3	3.00			1	4.00
Crimron Cl. Seed	5	6.60	8	4.94[b]			14	4.96[b]	5	5.00	3	3.33		
Alfalfa Hay	3	5.17	8	4.60[b]			12	5.30[b]	7	5.31	1	2.00	3	5.00
Ch. Fescue			11	4.32[b]			6	5.08[b]					2	3.80
Alta Fescue			5	7.12			1	5.00						
Red Fescue					1	4.00								
Other Hay			4	2.24			1	5.00					2	3.00
St. Berries	15	4.35	12	4.62[b]			37	4.20	2	4.00	1	3.00	4	3.62
Loganberries	2	3.80	3	3.57			5	2.26			1	3.00		
E.G. Blk.berries	11	4.87[c]	17	4.83			16	4.53	1	5.00	1	2.00	4	3.82

continued

Table 4. Average yields[a] for various crops and soil types, Marion County, 1957 and 1958, (continued)

Crop	Soil types: T_1 (Willam'te) n	T_1 yld	T_2 (Amity) n	T_2 yld	T_3 (Conc'd) n	T_3 yld	T_4 (Woodb'n) n	T_4 yld	X_1 (Cheh's) n	X_1 yld	X_4 (Wapato) n	X_4 yld	M (Mixed) n	M yld
Santiam Bl.berries	1	2.50					1	2.50						
Boysenberries	10	3.00[c]	5	3.11			9	2.30[b]	1	3.00			2	3.00
Gooseberries			2	3.50			2	2.95					1	6.00
Blackcaps	3	2.30					2	1.12	1	0.78				
Raspberries									1	3.00				
Prunes	1	8.00					3	5.67						
Cherries	6	4.01	2	4.00			2	3.08	3	4.78				
Walnuts	2	0.63	2	0.63			4	0.90	2	0.59			1	0.15
Filberts	5	0.62	3	0.57			8	0.65	5	0.84			4	0.37
Cucumbers	1	6.00											1	10.00
Cucumbers Seed			1	5.00			1	5.00	1	7.00				
Squash Seed			1	5.27										
Sweet Corn	4	5.13	5	5.50			16	6.38[b]	17	6.53[b]	1	5.00	1	6.00
Beans	2	9.25	4	8.88[b]			4	8.75[b]	3	10.40[b]				
Mint Oil			2	0.55[b]	1	0.45			13	0.55[b]	4	0.63		
Potatoes	1	7.50	1	5.00			1	4.50					1	3.00
Onions											1	15.00	2	18.75[e]
Onion Seed							1	2.50						

a. Yields of grains, silage, hay, berries, stone fruits, nuts, cucumbers, corn, beans, potatoes and onions are in <u>tons</u>. Yields of grass and clover seeds, mint oil and onion seed are in <u>pounds</u>.

b. Source: James, S. (41, p. 74, 75).

c. Source: This survey. All other yields in the table are weighted averages of observations from both surveys.

d. Silage.

e. On peat soils.

Table 5. Adjusting factors for calculating usual annual repairs for machinery and equipment, 66 sample farms, Marion County, 1957

Line	Item	No.	Total repairs[a]	Average repairs	No.	Total annual[b] use[a]	Average annual use
			(1)	(2)		(3)	(4)
			-dollars-			-hours-	
1	½-ton truck	23	672	29.21	23	90	3.93
2	Other trucks	47	2,328	49.54	46	158	3.45
3	Baler	6	308	51.33	6	735	122.50
4	Combine	29	1,374	47.36	28	2,608	93.14
5	Car	75	4,377	58.36	75	712	9.50
6	Forage harvester	5	267	53.40	5	418	83.50
7	Cane chopper	1	50	50.00	1	300	300.00
8	Gen. equipment	76	7,172	94.37			
9	Irrigation equip.	50	936				

Line	No.	Total present value[a]	Average present value	(4) x (6)	Special equipment factor (2) (7)	General & irrigation factor (1) (5)
		(5)	(6)	(7)		
		-dollars-				
1	20	7,203	360.17	1,415.47	.0206	
2	48	31,053	646.94	2,231.94	.0222	
3	7	7,369	1,052.66	128,950.85	.0004	
4	30	31,939	1,064.63	99,159.64	.0005	
5	73	83,933	1,149.76	10,922.72	.0053	
6	5	5,447	1,089.32	91,067.15	.0006	
7	1	694	693.75	208,125.00	.0002	
8	71	155,469				.046132
9	49	119,343				.007847

a. Tabulated from the survey data.

b. Annual use figures for trucks and cars are in '000 miles. Annual use for other items are in hours. To apply the factor to each truck and car the vehicle's annual use must first be divided by 1,000.

Table 6. Estimated[a] length of useful life of buildings and improvements typically occurring on sample farms, Marion County, 1957

Building	Life[b] (years)
House built 1947-1957	50
House built prior to 1947	40
Milking parlor	40
Milk house	40
Barn or hog house costing over $2,500	40
Loafing shed	25
Silos (upright)	25
Poultry buildings	25
Other outbuildings	25
Wells	40
Drainage tile	30

a. Published data were not available. Estimates were made from experience in other surveys in consultation with Professor G. R. Sitton, Farm Management, Department of Agriculture Economics, Oregon State College.

b. When a building was reported to be older than this it was considered to be fully depreciated. It was allowed the following present value: House 20 per cent of replacement cost. Other buildings 15 per cent of replacement cost.

Table 7. Replacement costs of improvements, 66 sample farms, Marion County, 1957

Fencing[a]:	
One strand electric	$ 27.69 per mile plus $ 34.95 for the complete fence.
Three strand barbed wire	$108.91 per mile.
Woven wire with one strand barbed wire	$429.50 per mile.
Wells:	
Drilled	$ 7.00 per foot with casing[b].
Dug	No cost.
Tile:	$ .06 per foot[b].

a. Assuming cedar posts 1 rod apart. Prices were used from Montgomery Ward and Sears-Roebuck Catalogs, 1957.

b. Source: Local prices at Corvallis, 1957.

Table 8. Rates[a] used to estimate usual annual repairs to buildings on 66 sample farms, Marion County, 1957

Replacement cost	Age: 5 years or less	6 - 10 years	11-20 years	21-40 years	Over 40 years
	- per cent of annual depreciation -				
Houses:					
$ 5,000 and less	10	20	30	40	50
5,001 - 10,000	10	20	30	40	50
10,001 - 15,000	10	15	25	35	45
15,001 - 20,000	10	10	20	30	40
20,001 and over	10	10	20	30	40
Other Buildings with replacement costs over $2,000:					
$ 2,001 - 4,000	20	40	60	80	100
4,001 - 6,000	20	30	40	60	80
6,001 - 10,000	20	25	30	40	60
10,001 and over	18	20	25	30	50

Other buildings: Replacement cost x rate x $\frac{\text{present age}^{b}}{\frac{1}{2}\text{ total life}}$

Rate: Replacement cost less than $1,000 — 3 per cent
Replacement cost $1,000 - $2,000 — 2 per cent

a. Estimated on the basis of experience and the following assumptions:
(1) The older the building the greater is "repairs" as a proportion of the construction costs;
(2) With fairly new buildings of any given type repairs are proportional to construction costs;
(3) With older buildings, for any given type the higher the construction costs the repairs are proportionally smaller;
(4) The repairs as a proportion of construction cost are lower for dwelling than for other farm buildings.
All of these assumptions are recognized in the system of rate above. Rates were tested for reasonableness on buildings reported in the survey.

b. The rate is an assumed annual average rate for all buildings of this age. Thus it is based on the average age, presumably one half of the total life of the building. However, newer buildings would have fewer repairs per $1,000 replacement cost and older buildings would have more than the average. This ratio adjusts for age. For a building for which present age equals half its life, the full rate is used. For older buildings, more than the full rate is used, and for younger buildings only a fraction is used. The adjustment may not be correct in quantity but it is in the right direction.

Table 9. Tax rates per cropland acre by type of farm, 66 sample farms, Marion County, 1957

Farm type	Predominant soil types[a]	Weighted[b] average taxes per cropland acre[c]
E1	T_1, T_2, T_4	$ 7.76
E2	T_2, T_4	7.96
D	T_2	7.80
I	T_1, T_2	8.30
M	T_2	6.40

a. See Table 5, Chapter IV, for the names of the soils indicated by these symbols.

b. Weighted for each farm by total cropland acreage.

c. Cropland included improved pasture and summerfallow.

Source: Tabulation of survey data.

Table 10. Labor[a] and custom rates on 66 sample farms, Marion County, 1957

		Rate (dollars)
Hourly labor		1.00 per hour
Picking:	Blackberries	70.00 per ton
	Logans	80.00 per ton
	Boysens	70.00 per ton
	Strawberries	85.00 per ton
	Black caps	133.00 per ton
	Prunes	.50 per cwt.[b]
	Cherries	4.00 per cwt.[b]
	Walnuts	.04 per lb. dry weight
	Filberts	.035 per lb. dry weight
	Beans	50.00 per ton
Custom rates:		
	Hauling milk	.26 per cwt.
	Combining: grain	5.50 per acre
	clover	10.00 per acre
	Baling	4.50 per ton

a. Board and room are not included in the labor rates.

b. Source: James, S. C. (41, p. 280, 284).
Other rates were from tabulations of survey data in the present study.

Table 11. Seeding and planting rates[a] on 66 sample farms, Marion County, 1957

Crop		Rate per acre
Wheat		106 lbs.
Oats and Vetch		70 lbs. and 30 lbs.
Barley		111 lbs.
Fall Oats		98 lbs.
Spring Oats		102 lbs.
Aust. Peas		100 lbs.
Corn		10 lbs.
Sweet Corn		8 lbs.
Mixed grain		100 lbs.
Aust. Peas and Coarse grain		50 lbs. and 50 lbs.
Rye		125 lbs.
Alfalfa		13.5 lbs.
Crimson clover:	Wapato woils	7 lbs.
	Other soils	16 lbs.
Red clover		9 lbs.
Seed canary grass		7 lbs.
Sweet clover		12.2 lbs.
Red Fescue		20 lbs.
Sudan Grass		25 lbs.
Chewings Fescue		14 lbs.
Masture Mixtures:		
Well drained :	6 lbs. orch. gr., 6 lbs. Alta fescue, 5 lbs. rye gr., 3 lbs. ladino, 15 lbs. orch. or Alta fescue, 2-3 lbs. ladino.	
Poorly drained:	6 lbs. Alta fesc., 6 lbs. meadow foxtail, 3 lbs. rye gr., 2-3 lbs. white clover.	
Prunes		85 trees
Cherries		65 trees
Walnuts		30 trees
Filberts		85 trees
Black-cap raspberries		1,200 plants
Gooseberries		865 plants
Strawberries		6,400 plants
Boysenberries		630 plants
Loganberries		700 plants
Blackberries		525 plants
Red raspberries		1,500 plants
Potatoes		600 lbs.
Beans		23 lbs.

a. Used where no estimates were given by respondents.
Source: Tabulation of survey data.

Table 12. Prices of seed, setting plants and fertilizer used[a] on 66 sample farms, Marion County, 1957

Item	Unit	Price (dollars)
Alfalfa seed	lb.	.31
Red Clover seed	lb.	.34
Kenland Clover seed	lb.	.34
Ladeno Clover seed	lb.	.36
Alsike Clover seed	lb.	.33
New Zealand White Clover seed	lb.	.65
Orchard Grass seed	lb.	.50
Alta Fescue seed	lb.	.20
Chewing Fescue seed	lb.	.32
Creeping Red Fescue seed	lb.	.42
Strawberry plants	each	.0185
Blackcap Raspberry plants	each	.04
Gooseberry plants	each	.05
Raspberry plants	each	.05
Boysenberry plants	each	.045
Santiam Blackberry plants	each	.25
Austrian Peas seed	ton	66.00
Vetch (hairy) seed	lb.	.14
Vetch (other)	lb.	.08
Squash seed	lb.	.10
Oats seed	ton	45.00[b]
Barley seed	ton	43.00
Wheat seed	ton	68.00
Fertilizer	**Unit**	**Price (dollars)**
8-16-16	ton	80.00
6-20-20	ton	70.00
10-20-20	ton	84.00
22% Superphophate	ton	50.00
Boron	ton	60.00
16-20-0	ton	80.00
Lime	ton	12.50
Ammonium sulphate	ton	64.00
Calcium nitrate	ton	68.00
Ammonium nitrate	ton	86.00

a. Used where necessary to extend quantity estimates given by respondents or where no estimate was given.

b. Bluestone treating oats (dollars) .67/cwt.
Cleaning and treating oats (dollars) .50/cwt.

Source: tabulation of survey data.

Table 13. Annual overhead charges[a] for perennial crops on 66 sample farms, Marion County, 1957

Crop	Estimated economic bearing life	Soil Series: Willamette (T_1)	Amity (T_2)	Woodburn (T_4)	Chehalis (X_1)	Wapato (X_4)	Mixed soils: T_1T_4	T_2T_4	Bottom	Other
		- dollars -								
Alta fescue	10		5.37							
Red fescue	10		4.81	4.81						
Chewings fescue	8							3.13		
Alfalfa	6	12.35	10.77	10.93	11.50	11.00	11.50		11.00	10.00
Irrigated pasture	7	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Strawberries	3	94.39	83.12	97.25		94.39	95.50	90.00	87.00	
Ev. gr. bl. berries	10	13.20	11.32	14.45	13.20	13.20	14.00	12.85		13.00
Boysenberries	6	28.17	28.62	24.16	28.17			26.35		
Loganberries	6	28.17	31.13	28.67		28.17				
Gooseberries	10		30.00	30.00				30.00		
Raspberries (blk.cps.)	7	34.00								
Cherries	20	46.90		46.00						
Prunes	20	46.00		46.00						
Walnuts	30	44.00	42.70						44.00	44.00
Filberts	20	30.95	30.40	30.40					31.40	31.00
Mint	6				10.00				10.00	

a. Excludes interest charge for land. A blank in the data indicates that the relevant soil-crop combination was not reported in the survey.

b. Sources: The information on all crops except irrigated pasture, gooseberries and black cap raspberries, was obtained from S. C. James doctoral thesis (41, p. 119-170). This applies to the unmixed soil series and economic bearing life. This information for the other crops was compiled from the following: Oregon State College Agricultural Extension Enterprise Sheets, 1955-1957; Oregon State College Agricultural Experiment Station bulletins on production of various crops; personal interview by the author with M. Becker, Farm Management Specialist, Agricultural Extension Service, Oregon State University; data from the survey for the present study. Mixed soil charges are averages of the other soils, weighted for the predominant soil in the mixture.

Table 14. Average replacement cost[a] of various types of buildings on twenty of the 66 sample farms, Marion County, 1957

Type of building	Average cost per square foot	Number of building for average
General purpose sheds	1.66	69
Low cost general purpose sheds	1.01	21
Machine sheds	.96	14
Low cost barns	2.15	9
Lean-to's	..85	8
Medium barns	2.48	8
Loafing sheds	1.29	3
Poultry houses	1.54	3
Silos (upright)	5.27	5
Milk cooling houses	2.82	2
Garages	1.49	2
Corn cribs	.23	2

a. Source: Building assessment records for twenty of the sample farms were available at the County Assessor's Office at Salem, Oregon. The appraisal for these particular farms was made in 1956 and 1957.

APPENDIX E

Table for projecting capital accumulation using Equation 24[a]

For easy reference Equation 24 is repeated here:

$$TC_i = A + \theta\left[1+(1+b\phi)+(1+b\phi)^2+\ldots+(1+b\phi)^{i-2}\right]$$
$$-\gamma S\left[(1+b\phi)^{i-2}+(1+s)(1+b\phi)^{i-3}+(1+s)^2(1+b\phi)^{i-4}+\ldots+(1+s)^{i-4}(1+b\phi)^2+(1+s)^{i-3}(1+b\phi)+(1+s)^{i-2}\right]$$
$$-\left[T_1(1+b\phi)^{i-2}+T_2(1+b\phi)^{i-3}+\ldots+T_{i-3}(1+b\phi)^2+T_{i-2}(1+b\phi)+T_i\right]$$

A 19-column table can be set up with the following column headings:

(1) A = Original total input capital for Year 1;

(2) $\theta = (bA+a) - c(bA+a) - d = (bA+a)(1-c) - d$;

(3) [First bracket], where $\phi = 1-c$;

(4) θ [First bracket];

(5) γS;

(6) [Second bracket];

(7) γS [Second bracket];

(8) TC_i without tax = (1) + (4) - (7);

(9) [Third bracket];

(10) TC_i with tax = (8) - (9);

(11) bTC_i;

(12) $N_i = bTC_i + a$;

(13) Federal tax exemptions;

(14) Federal taxable income = (12) - (13);

a. Chapter II, p. 56.

(15) Federal income tax;

(16) Social security tax, based on column (12);

(17) State taxable income = (12) - (15);

(18) State tax;

(19) T_i = (15) + (16) + (18).

The rows for the table are designated as Year 1, Year 2, etc. Year 1 is 1957.

With the values for A, b, a, c, γ, d and s the first eight column can be filled out without a knowledge of the values for the remaining eleven columns. The remaining columns require a knowledge of federal and state tax exemptions and rates and social security tax rates.

The quantities inside the first two brackets can be calculated for each year without reference to other columns in the table, but the quantity inside the third bracket must be calculated from year to year as it depends upon the values in columns (10), (12) and (19).

The federal tax exemptions for the estimations for which Equation 24 was used were:

Year 1: $1,200

Years 2-4: $1,800

Years 5-7: $2,400

Years 8-19: $3,000

The federal tax rates for 1957 were used. Only one rate was required as taxable income for no year exceeded $4,000. This rate was 20 per cent. Social Security tax was calculated as 3-3/8 per cent.

The state tax tables for 1956 were used to calculate state income tax.

APPENDIX F

Procedure for projecting capital accumulation allowing for projected changes in price trends of input and living expenditure items. (Since the trend of output prices is "flat", it is not necessary to adjust for it in the projection.)

It is first necessary to calculate the percent change in price trend for each year. The following table sets out these percentages for input prices and prices of items purchased for living:

	Input Prices			Living Item Prices		
Year	Trend index	Annual change	Percent change	Trend index	Annual change	Percent change
1957	258.8	--	--	278.2	--	--
1958	261.0	2.2	.850	281.5	3.3	1.186
1959	263.2	2.2	.843	284.8	3.3	1.172
1960	265.4	2.2	.836	288.1	3.3	1.159
1961	267.6	2.2	.829	291.4	3.3	1.145
1962	269.8	2.2	.822	294.7	3.3	1.132
1963	272.0	2.2	.815	298.0	3.3	1.120
1964	274.2	2.2	.809	301.3	3.3	1.111
1965	276.4	2.2	.802	304.6	3.3	1.095
1966	278.6	2.2	.796	307.9	3.3	1.083
1967	280.8	2.2	.790	311.2	3.3	1.072
1968	283.0	2.2	.783	314.5	3.3	1.060
1969	285.2	2.2	.777	317.8	3.3	1.049
1970	287.4	2.2	.771	321.1	3.3	1.038
1971	289.6	2.2	.765	324.4	3.3	1.028
1972	291.8	2.2	.760	327.7	3.3	1.017
1973	294.0	2.2	.754	331.0	3.3	1.007
1974	296.2	2.2	.748	334.3	3.3	.997
1975	298.4	2.2	.743	337.6	3.3	.987

The next step is to set up a table with row headings Year 1 (1957) to Year 19 (1975) and with the following column headings:

(1) $p_{i-1} \div (1+p_1)(1+p_2)\ldots(1+p_{i-1})$, where p is the decimal expression of the annual percent change in input price trend (p_1 for Year 2, p_2 for Year 3, etc.);

(2) $g + \frac{k+a}{A}$, where $A = TC_1$;

(3) The product of column (1) multiplied by column (2);

(4) $b_i = b_{i-1}$ - column (3);

(5) Total input capital (for Year 1, A and for each year thereafter, add plow-back);

(6) $b_i TC_i$, that is, the product of columns (4) and (5);

(7) N_i (net income): add the value of a to column (6);

(8) cN_i;

(9) S (household size);

(10) γS;

(11) L_i, which is the sum of columns (8) and (10) plus the value of d;

(12) 1 + annual percent change (expressed as a decimal) in the price index trend of living items for the relevant year;

(13) The product of columns (11) and (12);

(14) The federal income tax exemption for the members in the family;

(15) Federal taxable income, that is, column (7) minus column (14);

(16) Federal income tax, based on column (15);

(17) Social security tax, based on column (7);

(18) "Adjusted gross income" for state income tax, that is, column (7) minus column (16);

(19) State income tax;

(20) P_i (plow back), which is column (7) minus the sum of columns (13), (16), (17) and (19).

With this table, each step in the calculation can be done year by year, adding P_i to TC_i to get the following year's total input capital. Once A, beginning capital, is known, the values for b_i can be calculated for all of the years, without reference to the other components of the table.

APPENDIX G

Calculating b_i for each year when all other components of the model for capital accumulation are given[a]

$P_i = N_i - L_i(1+m)_i$ - federal income tax - social security tax
- state tax

where $N_i = b_i TC_i + a$ (TC_i being total input capital for year i);

$L_i = c(b_i TC_i + a) + \gamma S + d$;

m_i = annual percent increase in the trend of the cost of living price index, expressed as a decimal;

federal income tax = tax rate (N_i - exemptions)

(Let E_i represent exemptions.)

social security tax = tax rate x N_i

Under a taxable income of $4,000 the federal tax rate used was 20 percent and under a net income of $4,800 the social security tax rate used was 3-3/8 percent. Over the latter net income the social security tax is a flat $162.

So, up to these income levels,

$$P_i = (b_i TC_i + 609) - (1+m)_i \left[.09(b_i TC_i + 609) + \gamma S + 394\right] - .2\left[(b_i + TC_i + 609) - E_i\right] - .03375(b_i TC_i + 609) - \text{state tax} \quad (1)$$

Collecting terms:

$$P_i = b_i TC_i \left[1 - .09(1+m)_i - .2 - .03375\right] + 609\left[1 - .09(1+m)_i - .2 - .03375\right] - (1+m)_i(\gamma S + 394) + .2E_i - \text{state tax}$$

---

a. See Appendix F for the components.

$$= b_i TC_i \left[.76625 - .09(1+m)_i\right] + 609\left[.76625 - .09(1+m)_i\right]$$
$$- (1+m)_i(\gamma S+394) + .2E_i - \text{state tax.}$$

Transposing and collecting:

$$b_i = \left[P_i - 466.65 + 54.81(1+m)_i + (1+m)_i(\gamma S+394) - .2E_i + \text{state tax}\right]$$
$$\div\ TC_i\left[.76625 - .09(1+m)_i\right]$$

When net income exceeds $4,800 the term

$.03375\ (b_i TC_i+609)$ in Equation (1) above is replaced by 162 with the following result:

$$b_i = \left[P_i - 487.2 + 54.81(1+m)_i + (1+m)_i(\gamma S+394) - .2E_i + 162\right.$$
$$\left. + \text{ state tax}\right] \div TC_i\left[.8 - .09(1+m)_i\right]$$

Since b_i must be calculated year by year, a table is set up with Year 1, Year 2, etc. as row headings and the following column headings:

(1) P_i, which is $1,681 in the example in Table 23 (p. 198);

(2) $(1+m)_i$ (The values of m_i are given in Appendix F.);

(3) $54.81(1+m)_i$;

(4) Column (1) plus column (3) minus 467;

(5) $\gamma S + 394$;

(6) $(1+m)_i(\gamma S+394)$, i.e., column (2) x column (5);

(7) E_i;

(8) $.2E_i$;

(9) State tax;

(10) Column (4) plus column (6) minus column (8) plus column (9);

(11) $.9(1+m)_i$;

(12) $.76625 - .09(1+m)_i$;

(13) TC_i;

(14) Column (13) x column (12);

(15) b_i = column (10) divided by column (14);

It is necessary to estimate state tax, column (9), by judgment as closely as possible. To do this, estimate net income as follows:

$$N_i = P_i + L_i(1+m)_i + \text{federal tax} + \text{social security tax} + \text{state tax.}$$
$$= P_i + cN_i(1+m)_i + (\gamma S+d)(1+m)_i + .2(N_i-E_i) + .03375N_i$$
$$+ \text{state tax.}$$

Collecting all N_i terms and transposing:

$$N_i\left[1-c(1+m)_i - .2 - .03375\right] = P_i + (1+m)_i(\gamma S+d) - .2E_i + \text{state tax}$$
$$N_i = \left[P_i+(1+m)_i(\gamma S+d) - .2E_i + \text{state tax}\right] \div \left[.76625 - .09(1+m)_i\right]$$
$$= \left[\text{column (1)} + \text{column (6)} - \text{column (8)} + \text{state tax}\right]$$
$$\div \text{ column (12).}$$

For state tax for Year 1 substitute the value for Year 1 used in calculating Table 21 (p. 196; Appendix F). This will only be 3 or 4 dollars out, which will affect N_i relatively little. Now use the N_i thus estimated to go to the state tax tables for the state tax, after subtracting federal income tax from N_i. Federal tax = $.2N_i$ - column (8) above. Use the value thus obtained from the tax table for column (9) above to calculate columns (10) and (15).

Since net income must be estimated for each year, it will be noticed when it exceeds $4,800. At this point the following changes must be made in column headings:

Column (4): change to "Column (1) plus Column (3) minus 487".

Add a new column, (8a) after column (8). The value for every subsequent year in this column is 162.

Column (10): change to "column (4) plus column (6) minus column (8) plus column (8a) plus column (9)".

Column (12): change to "$.8 - .09(1+m)_i$".