AGRICULTURAL DEVELOPMENT IN THE WEST OF IRELAND: A MARGINAL PRODUCTIVITY STUDY

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ABSTRACT

AGRICULTURAL DEVELOPMENT IN THE WEST OF IRELAND:
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This paper focuses on the impact of economic and demographic variables on agricultural productivity. The purpose of this study was to examine resource productivity on farms in selected areas of County Mayo. The returns to land, labor, livestock investment, and variable nonlabor costs were examined for possible resource misallocation. The impacts of age of decision maker and family size on gross output were also studied. Knowledge of the productivity of resources used in the production processes of farmers in County Mayo should be of interest to the farming community, extension agents, banks and lending agencies, policy makers, and all concerned with the development of agriculture in the west of Ireland.

Estimates of the marginal value productivity of various inputs were calculated by fitting multilinear production functions to data from random samples of farms in three distinct topographical areas of County Mayo.

Four separate regression equations were fitted to the data for each area. The livestock investment categories were disaggregated in the first regression fit. The demographic variables were included in the first and second regression fits. Variable nonlabor costs, farm size, total livestock investment, and labor units were considered in the third regression equation. The data used in the third function were converted into logarithms for the fourth regression fit.

Tentative conclusions were that farm output declined as farmers grew older. Farm output increased as family size increased. Investment in dairy cows and pigs showed high returns in all areas. The marginal value products for the aggregated livestock investment category were not significantly different from marginal factor costs in two of the three areas. The marginal value products for variable nonlabor costs were significantly different from marginal factor costs in two areas. The marginal value products of labor and land were significantly less than marginal factor costs in all regions. The broad conclusions given the limitations of the study were that farmers should increase expenditure on variable costs and livestock investment. Farmers should also try to complement their agricultural incomes with earnings from off-farm employment where available. However, for a long run attempt at solving the low farm income problem dramatic changes in agricultural structure were proposed.

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CHAPTER I

INTRODUCTION

Specific regions in many countries lag behind in the development process. The retarded development of these regions is related to physical, economic, social, political, and historical factors. In less developed regions, usually the greater proportion of the active population is engaged in agriculture and resource productivity is low.

In the west of Ireland over 55 percent of the active population is engaged in agriculture. Subsistence income levels prevail in many areas. Few off-farm employment opportunities are available. Young active members of the farm community have emigrated leaving a residual, change-resistant, aging population. The related retarded development and low farm income problems persist indefinitely over time. Economic growth and development in the west of Ireland is hindered by low productivity in the agricultural sector.

The agricultural sector in a region or country is considered by many as a "powerful engine of growth."[1]

Most countries entered the stage of self-sustained growth only after they experienced a period of increasing agricultural productivity that preceded or accompanied industrial expansion.[2]

Knowledge of the productivity of resources used in the production processes of farmers in County Mayo should be of interest to the farming community, extension agents, policy makers, and all concerned with the development of agriculture in the west of Ireland. Farmers and those concerned with agricultural development need to know if it pays to increase variable costs. They need to know if labor can be withdrawn from agriculture and if livestock investment can be increased. They also need to know if the present allocation of resources on farms is efficient (in the Pareto sense),[3] and what institutional adjustments are necessary to improve productivity and to increase farm incomes.

The present study originated as a farm account survey of a random sample of farms chosen from three selected topographical areas in County Mayo. The topographical areas selected were lowland dry, lowland wet, and mountain [Figure 1 and Table 2, Chapter II].

The current study concerns itself mainly with the problem of low resource returns on farms in the west of Ireland. The study focuses on the impact of economic and demographic variables on agricultural productivity. More specifically, the objectives of the study are:

1. To establish estimates of gross output and resource productivity on farms in selected areas of County Mayo. The returns to labor, land, livestock investment, and variable nonlabor costs are examined.

2. To examine farm firm and farm household relationships. The impacts of age of decision maker and family size on gross output are examined.

3. To search for possible resource misallocation on the farms surveyed.

4. To make recommendations showing possible directions of reorganization, both in a static and dynamic sense (reallocation of resources on farms given the ceteris paribus conditions and also change in the ceteris paribus conditions).

The role of agriculture in the Irish economy, the costs of adjustment during the development process, the historical background to the low farm income, and retarded development problems in the west of Ireland and the economic, physical, demographic, and institutional conditions existing in County Mayo are discussed in Chapter II.

The theoretical background and related concepts of static production economics underlying the present study are outlined in Chapter III. A discussion on the functions used in this study and some of the statistical problems involved in their estimation is included.

Chapter IV contains a description of the farm account survey conducted in County Mayo and of the variables used in fitting the functions.

The production function fits and the evaluation and interpretation of the statistical results are described in Chapter V. The study focuses on the estimates of the productivity of land, labor, livestock investment, and variable nonlabor costs.

The implications of the statistical findings are discussed in Chapter VI. On the basis of the statistical results, economic theory and a knowledge of the institutional factors involved short- and long-term recommendations are tentatively outlined.

NOTES--CHAPTER I

[1]T. W. Schultz, Transforming Traditional Agriculture (New Haven: Yale University Press, 1964), pp. 4-5.

[2]Simon Kuznets, Modern Economic Growth (New Haven: Yale University Press, 1966), pp. 72F and 115.

[3]William J. Baumol, Economic Theory and Operations Analysis (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1961), p. 376.

CHAPTER II

BACKGROUND TO RETARDED DEVELOPMENT AND LOW FARM INCOME PROBLEMS IN THE WEST OF IRELAND

Introductory Remarks on Agriculture in the Irish Economy

As a nation develops, there is an increase in the per capita amount of goods and services consumed by its population. The development process also requires an equitable distribution of total product. Per capita G.N.P. increased by 3.1 percent annually in Ireland between 1961 and 1968.[1] Agriculture plays a major role in the economic development of most countries. During the course of economic development the agricultural sector provides increased food and fibre, a market for nonfarm goods and services, labor for nonfarm production, and capital for the industrial and service sectors. In 1966 agriculture, forestry, and fishing accounted for almost 19.0 percent of G.N.P. (Table 1). Industry accounted for 31.5 percent of G.N.P. in the same year. In Ireland, as in most developing countries, the percentage contributed by agriculture is declining. This declining percentage is

TABLE 1. Percentage G.N.P. Originating in the Agricultural and the Industrial Sectors at Constant 1958 Prices

	1958	1959	1960	1961	1962	1963	1964	1965	1966
Agriculture, Forestry, and Fishing as a Percent of G.N.P.	24.4	24.8	23.7	23.0	22.0	20.5	21.1	20.1	18.6
Industry as a Percent of G.N.P.	27.2	27.3	28.1	29.0	30.2	31.0	30.2	30.9	31.5

Source: Central Statistics Office, National Income & Expenditure, 1966 (Dublin: The Stationery Office, 1967).

compensated for in part by the growth in industries dependent upon agriculture.

Exports of farm products are a principal source of payment for capital imports. In 1968 agricultural exports accounted for 50 percent of total Irish domestic exports. The import content of agricultural exports is considerably less than that of industrial exports. For this reason, the real contribution of farm exports to foreign exchange earnings is substantially higher than the figures indicate.

In 1961 agriculture accounted for 22.9 percent of national income and for 34.2 percent of the labor force. The corresponding figures for 1968 were 18.7 percent and 27.8 percent, respectively.[2] From 1961 to 1968 the total number of persons working in agriculture, forestry, and fishing declined by 66,500 or by 17.5 percent. According to the third Programme for Economic Expansion, 36,000 people were expected to leave agriculture between 1969 and 1972 (an estimated annual decline of 2.8 percent). The numbers engaged in nonagricultural activities have increased but the increase has not been sufficient to absorb all those leaving agriculture. Between 1956 and 1966 estimated net emigration from the twenty-six counties was 292,608. The population of the twenty-six counties increased by 2.33 percent during the 1961-66 intercensal period. The only other intercensal period showing an

increase this century was that of 1946-51.[3] Since the end of the eighteenth century, the Irish agricultural sector has supplied labor not only for the benefit of Irish industry but also for the benefit of industry in the United Kingdom, United States of America, and elsewhere.

State Aid to Agriculture

State aid to agriculture for direct income assistance has risen from approximately 10 percent of the income arising in agriculture in 1960 to approximately 30 percent of the income arising in agriculture in 1968. Direct state aid to agriculture includes product and input subsidies, livestock headage grants, and relief of rates and annuities. It excludes other state expenditures in relation to agriculture. Approximately 45 percent of direct state aid to agriculture accrued to dairy farmers in 1968.

Economic Growth and Adjustment to Change

Economic growth brings both progress and pain to agriculture. Most farm policies in democratic societies are related either to the problem of increasing agriculture's contribution to growth or to the problems that growth brings to farm people. The benefits of economic growth are not obtained without some costs. Very often the benefits do not necessarily accrue to those who bear the costs. The unique economic structure within which agriculture operates causes growth in that sector to have

adverse effects on some members of the farming community. Adjustment to change in agriculture is especially difficult because of a combination of related characteristics. The characteristics as summarized by Hathaway are outlined in the following section.

> The inelastic demand for farm products leads to fluctuating market prices as a result of unplanned changes in output. The inelastic demand for farm products results in very low farm prices if over time the rate of increase in farm output slightly exceeds the rate of increase in the demand for farm products.
>
> Since the rate of growth in demand for farm products is low in developed countries, only slight rates of increase in the demand for farm products can be absorbed without creating serious adjustment problems in agriculture.
>
> . . . . . .
>
> Mistakes of over commitment of productive resources require a long period of correction because of the slow growth in demand for farm products.
>
> Rapid technical and economic change in agriculture means that new output increasing practices which are profitable at present or lower prices are constantly becoming available for farmers adoption. Even though some of the resources already in agriculture are not receiving satisfactory incomes, it will still pay to adopt many of the new techniques. Thus, unless some of the existing resources in agriculture turn to other production, prices and incomes will be even further depressed due to demand conditions.
>
> The competitive structure of the industry has several implications. First, the individual farm operators cannot control total output, price or the rate of adoption of new technology. All they can do is make the changes they believe will be individually profitable. Second, it is difficult for the individual farmer to judge what the aggregate effect of a given technical change will be; thus, the problem of obtaining accurate expectations regarding future income and earnings is great in an industry with many firms, inelastic demand, and rapid technical change.
>
> The fixity of resources in agriculture causes people and resources to continue to produce farm products even though they find their expectations of future earnings were badly in error. As long as the salvage value of resources outside the agricultural industry is substantially below the expected earnings

> of resources in the industry, current earnings are likely to remain unsatisfactory for much of the industry.[4]

Many farmers have lower incomes and lower returns on their investments than were expected when their occupational and investment decisions were made. When real incomes and returns to investment in agriculture fall below those in the nonfarm economy, the difference represents the cost of progress to farm people. Some of the benefits of progress in agriculture are foregone when resources cannot move freely from farm production to nonfarm production. Farm people who leave agriculture have to bear the cost of moving to nonfarm locations or to another country. During the course of progress and change, misallocation of resources has occurred in the production, storage, and disposal of farm surpluses.

Nearly all developing countries have regions where progress and change lag behind that of the rest of the country. The slow rate of development of specific regions in developing economies is usually related to physical, economic, social, political, demographic, and historical factors. These regions are characterized by a high percentage of the population engaged in agriculture and by low resource productivity. Normally, the majority of farmers in these areas are subsistence or near subsistence farmers. Farm incomes are rarely sufficient to provide anything more than the subsistence requirements of the farm population.

Young active members of these communities emigrate leaving behind a residual aging population which is not change-conscious. This aging population lacks the initiative and organizational ability to become community development oriented. In areas like the west of Ireland the problem of retarded development persists indefinitely over time.

Historical Perspective to the Retarded Development Problem in the West of Ireland

In order to understand the conditions prevailing in the west of Ireland during the nineteenth century, it is necessary to go back to the plantations of Munster, Ulster, and Connacht. During these colonial times, Irish occupiers of land were dispossessed of their fertile holdings and were driven westward to the moors and bogs of counties along the west coast of Ireland. They became tenants at will to the landlords already in the west of Ireland or to new British landlords who had been granted estates there. With very few exceptions, tenants were regarded only as occupiers from whom the highest possible rents should be extracted.[5] In 1783 when an electoral law was introduced by which all occupiers owning or renting holdings valued at 40 shillings or more were given the franchise landlords divided their grazing lands into small farms thereby increasing their rents and political influence.[6] By 1829 when the law was revised, it became

necessary to have land valued at 200 shillings in order to have a vote. Small farms became less desirable. Many farmers were evicted and became squatters on marginal land reclaimed from mountain or bog. Many of the landlords were absentee landlords employing agents to collect their rents. Most of the landlord's agents had no interest in improving land or farm practices. From 1767 to 1841 the population of Ireland increased from 2.5 million approximately to over 8 million.[7] The population increase in Ireland, especially in the twenty-six counties, was not accompanied by an industrial revolution. In 1841 the density of the rural population per square mile was 247 in Leinster, 332 in Munster, and 386 in Connacht. Counties Mayo, Kerry, and Donegal along the west coast had population densities of over 400 per square mile. The counties with the worst farmland and with very little industrial development had the highest population densities. Relative differences between east and west rural population densities persist even to the present time. According to the 1841 census there were 685,309 agricultural holdings over one acre supporting 952,631 families in Ireland. Problems related to microscopic farm sizes were more acute in the west of Ireland particularly in counties Mayo and Donegal where adverse soil and topographic conditions exist. In the provinces of Leinster and Munster, approximately 36 percent of the holdings were between one and five acres. The

corresponding figure for Connaught was 64 percent and for County Mayo, 73 percent. Some writers of the period state that the desirable farm size needed to support a family ranged from seven acres upwards depending on the ability of the farmer and the productivity of the land.[8]

Radical changes in population and in farming patterns were observed after the "Great Famine" of the 1840's. These changes cannot be ascribed to the events of the 1840's; however, the "Great Famine" hastened the adjustments that began soon after the Battle of Waterloo in 1815. Although the corn laws operated until 1846 once hostilities between European countries and Britian ceased corn importation from Europe become more attractive than from Ireland. Also, as living standards in Britain improved, the emphasis of demand swung from cereals to livestock products causing cattle, sheep, and butter prices to raise further relative to cereal prices. Corn prices in Ireland began falling. The economic attractiveness of pastoral farming helped to bring about adjustments in the structure of Irish agriculture and in Irish demographic patterns well before the "Great Famine." The effects of these adjustments in terms, especially of population size and tillage acreage could not become evident immediately and in fact did not become so until after the "Great Famine." In the west of Ireland, where there was a

relatively high proportion of small farms supporting a high population, acute adjustment problems arose.

A falling labor supply and a relative worsening in corn prices powerfully oriented Irish agriculture towards pastoral activities in the years between the Great Famine and the First World War. Beef cattle production expanded while dairying stagnated. The volume of total agricultural production changed little. The Irish rural population, having declined drastically, changed from predominantly proletariat to predominantly bourgeois after the Great Famine.[9] The bourgeoisie opposing the tenure system and assisted by a changed political climate in Britain succeeded in overthrowing the landlord-tenant system of tenure. Occupying farmers were given ownership on exceedingly favorable terms. Land reform proper began with the establishment of the Congested Districts Board under the Purchase of Land (Ireland) Act 1891.[10] The Act of 1891 empowered the Board to take all necessary steps to promote agriculture, forestry, fishing, and industrial development. Following the dissolution of the Congested Districts Board responsibility for land reform was transferred to the Irish Land Commission under the Land Act of 1923. This act effected the purchase of all outstanding tenancies from landlords. Currently, the Irish Land Commission purchases and redistributes land for the relief of rural congestion and the enlargement of holdings. The

Commission also leases land on the so-called "eleven months" system. Most of the purchase and enlargement of holdings occurs in the west of Ireland.

Factors Related to the Retarded Development of the West of Ireland

The minister for agriculture and fisheries appointed John J. Scully[11] as Western Regional Officer of his department in 1965. The duties assigned to him were the planning and coordination of the pilot area development program in the twelve western counties, the study of the low farm income problem in the west of Ireland and the factors contributing to it, the assembly of basic statistical data and the formulation of recommendations for alleviation of the problems associated with agriculture in the west of Ireland. Primary data for the study of the low farm income problem in the twelve western counties were collected in 1967. The remainder of this chapter draws heavily from the 1967 survey (The Western Farm Survey).[12] The difficult physical conditions of production combined with problems relating to land tenure, demographic, economic, and institutional factors as well as the historical factors considered in the previous section contribute to and help to prolong the retarded development of the western region. There are few urban industrial centers in the region. Off-farm employment opportunities are relatively scarce. As a result, 55 percent of the active population is engaged in farming.

Physical Factors

Approximately 18 percent of all holdings in County Mayo are located in mountain or hill areas (see Table 2 and Figure 1). In County Mayo as throughout the western region, less than 25 percent of all holdings are suited to intensive crop and livestock husbandry. The remaining holdings are in mountaneous areas or areas where drainage is impeded. A little over 6 percent of the crop and pasture land in County Mayo is tilled. The general picture in the western region is one of rugged terrain or wet farmlands. The topographical features together with the soil conditions present serious limitations to the development of farming in the west of Ireland.

Land Tenure Factors

Approximately 51 percent of farms are 30 acres or less in the western region while in the eastern region the corresponding figure is 36 percent. Almost 65 percent of farms in County Mayo are 30 acres or less. When small farms are associated with adverse topographical and soil conditions, the problem of increasing farm productivity becomes critical. Farm size tends to be lower than average in mountain and lowland wet areas.

When small farms are fragmented into two or more contiguous parcels of land sometimes miles apart, the problem of increasing agricultural productivity becomes even more acute. Approximately 47 percent of all farms

TABLE 2. Percentage Distribution of Farms according to Topographical Region, by County

	Topographical region							
	Mountain	Hill	Drumlin		Lowland			Total
			Wet	Dry	Wet	Intermediate	Dry	
Cavan	8.7	2.6	59.2	13.8	--	3.9	11.8	100.0
Clare	--	22.7	6.2	--	52.8	--	18.3	100.0
Donegal	46.1	17.5	--	9.7	--	5.9	20.8	100.0
Galway	19.4	2.9	--	--	22.6	--	55.1	100.0
Kerry	48.3	15.4	--	--	11.5	--	24.8	100.0
Leitrim	37.7	--	58.1	--	3.5	0.7	--	100.0
Longford	--	--	31.7	--	12.2	19.1	37.0	100.0
Mayo	14.6	3.4	2.3	2.4	13.5	37.5	26.3	100.0
Monaghan	3.0	--	38.2	58.8	--	--	--	100.0
Roscommon	--	--	25.5	--	27.9	22.2	24.4	100.0
Sligo	21.1	--	13.5	--	48.6	--	16.8	100.0
West Cork	28.0	34.0	3.0	--	--	12.9	22.1	100.0
All Counties	19.8	7.6	15.3	5.6	17.4	9.5	24.8	100.0

Source: John J. Scully, Agriculture in the West of Ireland (Dublin: The Stationery Office, 1971).

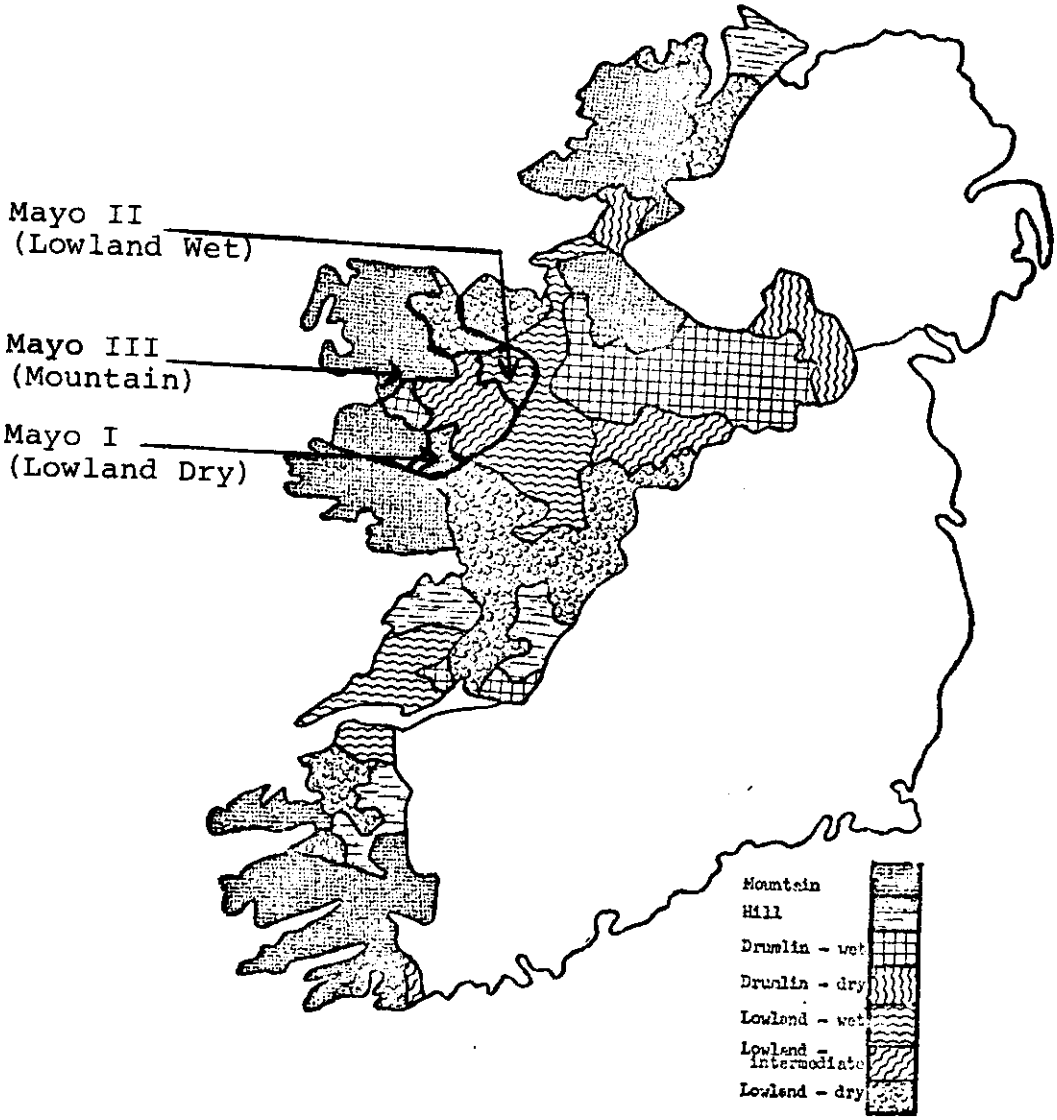

Figure 1. Simplified Diagrammatic Representation of Topographical Regions in the West of Ireland. Source: John J. Scully, Agriculture in the West of Ireland (Dublin: The Stationery Office, 1971), p. 20.

in the western region are fragmented while in the 5 to 30 acre farm size group slightly over 42 percent are fragmented. Almost 51 percent of all farms in County Mayo are fragmented.

Farmers in hill and mountain areas usually have communal grazing rights on the mountains and hills. Approximately 20 percent of all farmers in County Mayo have communal grazing rights. Only 26 percent of farmers with commonage in County Mayo make full use of their grazing rights. The number of animals kept on the commonages is determined, on the majority of small farms, not by the extent of the grazing rights as such, but by the availability of lowland for the production of winter feed and early spring grazing. Aging farmers do not like to keep mountain sheep. Very little fertilizer, if any at all, is applied to mountain and hill commonages. With regard to commonages, it can be said that every man's property is no man's property.

Without fully registered titles, it is almost impossible to borrow capital on a long-term basis through the normal channels. In County Mayo approximately 40 percent of farm titles are either part registered or not registered at all.

These various land tenure problems inhibit the adoption of new technology and many of the more profitable farm enterprises, curtail the farmer's incentive for

improvement and limit the availability of capital. As a result, economic development of region is retarded. Also, traditional methods of production are perpetuated and subsistence farming persists over time.

Demographic Factors

The rate of industrialization in the west of Ireland is not sufficient to absorb all those people leaving farming. Large masses of the population emigrate to other regions or other counties. Usually it is the young adults who leave. The residual population is an aging one with a particularly high dependency ratio. Dependent members of the farm population are those of 14 years of age or less plus those of 65 years of age and over. In the western region, the dependency ratio or the number of dependents per 100 people in the working age groups is 81.0. Also there is a relatively high ratio of males to females, particularly in the 20 to 44 year age groups. Marriage prospects for young farmers are not very favorable. There is an obvious decrease in the total number of farm births in the region each year due to falling numbers in the reproductive age groups and to celebacy on behalf of many farmers. Migration and the failure of farmers to marry bring about a situation where there are no prospective heirs on many farms. Almost 30 percent of all farmers who are over 50 years of age in County Mayo have no prospective heirs.

A little over 3 percent of farmers in the western region have had an adequate post primary education. Farmers who live and work continuously in a low income environment generally lack the finances necessary for post primary education. Low income farmers rarely seek the help of the agricultural advisory service. Over time the aging of farmers and the out migration of young people leave a residual farm population which is not very change conscious. As population declines, the financial burden of providing essential services will fall on fewer members of the community. Such a burden will become too heavy to bear unless the trend is reversed and as a result the quality of services will deteriorate.

Farming Systems

The main topographical regions of Table 2 have been traditionally associated with particular systems of farming. Black face mountain sheep and store cattle production are the usual farm enterprises in mountain and hill areas. Usually the extent of each farmer's share of communal grazing rights on the mountain is proportional to the size of the fenced-in area of his farm. The fenced-in area consists of a few acres of mineral or peaty soils around the farm yard. This part of the farm supports a few cows and their calves and provides spring grazing for mountain ewes and their lambs.

Dairying and store cattle raising, both on a relatively unintensive basis, are the most important farm enterprises in lowland areas where drainage is impeded. Most farms in the dry lowland areas can be adapted to the usual farm enterprises incorporating livestock and crop production. In the dry lowland areas of County Mayo, store cattle, sheep, and some tillage crops are produced. During the 1960's creamery milk production gained a foothold in the lowland areas. By and large, the systems of livestock production in the west of Ireland are very unintensive and totally unsuited to many small farms. The levels of intensity could be improved by a substantial increase in fertilizer use and in the production of adequate winter feed.

An inadequate market structure exists in the west of Ireland. Cooperative organizations have not developed. As a result, economies of scale in purchasing and selling are foregone. High transport costs to remote areas also help to reduce farmers' profits.

When some or all the various factors contributing to low farm incomes are associated as they are on small farms in the west of Ireland, the retarded development problem deserves prompt attention.

Categorization of Farms in the Western Region

The viability status of farms was considered in the Western Farm Survey. There is little consensus as to

what constitutes a viable farm. However, it is generally agreed that the current level of gross margin, labor availability, and the demographic structure of the farm family should be considered in determining viability. Farms operated by full-time farmers are categorized into three groups: viable or potentially viable, problem and nonviable farms. According to the Western Farm Survey viable or potentially viable farms are those with one or more labor units, having a gross-margin of 701 pounds or more operated by farmers under 50 years of age or by farmers over 50 years of age where prospective heirs are present.

All farms having gross margins of less than 700 pounds are considered problem or nonviable farms. Farms with between 701 and 1,000 pounds gross margins are also considered problem farms when the labor and demographic requirements for viability are lacking. Where the labor and demographic requirements are present, farms with gross margins of 400 pounds or less are categorized as problem farms. Farms having gross margins of 700 pounds or less operated by farmers over 50 years of age who have no prospective heirs are considered nonviable.

According to the Western Farm Survey, 32.6 percent of farms operated by full-time farmers are viable or potentially viable, 42.8 percent are problem farms, and 24.6 percent are nonviable farms. The situation is more

acute in County Mayo where only 17.8 percent of the farms operated by full-time farmers are viable or potentially viable and approximately 31 percent are nonviable.

The Current Study

The present study is based on a farm account survey of a random sample of farms in three distinct topographical areas in County Mayo: lowland dry (Mayo I), lowland wet (Mayo II), and mountain (Mayo III). It is hoped that the farm account survey and resulting analysis and recommendations complement Scully's work in the development field. Marginal productivity analysis as used in this study is discussed in the following chapter.

NOTES--CHAPTER II

[1]International Bank for Reconstruction and Development, World Bank Atlas (Washington, D.C.: International Bank for Reconstruction and Development, 1970).

[2]Government Publications Office, Review of 1969 and Outlook for 1970 (Dublin: The Stationery Office, 1970), pp. 119 and 129.

[3]Central Statistics Office, Statistical Abstract of Ireland, 1967 (Dublin: The Stationery Office, 1968), Section II.

[4]Dale E. Hathaway, Problem of Progress in the Agricultural Economy (Glenview, Ill.: Scott, Foresman and Company, 1964), pp. 18 and 28.

[5]W. L. Micks, History of the Congested Districts Board (Dublin: Eason and Son Limited, 1925), p. 10F. (Hereinafter referred to as Congested Districts Board.)

[6]Raymond D. Crotty, Irish Agricultural Production: Its Volume and Structure (Cork: Cork University Press, 1966), p. 18. (Hereinafter referred to as Irish Agricultural Production.)

[7]T. W. Freeman, Pre-Famine Ireland (Manchester: Manchester University Press, 1957), p. 18.

[8]The Devon Commission, Digest of Evidence Taken Before Her Majesty's Commissioners of Inquiry Into the State of Law and Practice in Respect to the Occupation of Land in Ireland (Dublin: The Devon Commission, 1847).

[9]Crotty, Irish Agricultural Production, p. 83.

[10]Micks, Congested Districts Board, p. 18.

[11]J. J. Scully, Agriculture in the West of Ireland (Dublin: The Stationery Office, 1971), p. 3. (Hereinafter referred to as Agriculture.)

[12]Ibid., Chapter 9.

CHAPTER III

MARGINAL PRODUCTIVITY ANALYSIS-- THE THEORETICAL FRAMEWORK

The usual procedure in a production function study is to estimate the total output curve or surface as a regression equation. Researchers use various type functions in a regression study depending on logic, the economic theory involved and computational manageability. Marginal value products for individual resource inputs can be estimated by computing the derivative of total value product in respect to the particular resource. When all units of output and input are measured in pounds the technical relationships are the same as if observations are in physical units. This statement holds true only when price is a constant as it usually is given the competitive conditions under which individual farms operate. The production function is usually expressed in the following form:

$$Y = f(X_1, X_2/X_3 \ldots X_n)$$

where Y is the value or quantity of output, X_1 and X_2 variable inputs, and $X_3, X_4 \ldots X_n$ fixed inputs.

From a strictly theoretical point of view output becomes a linear function of the inputs when all factors are variable. When some inputs are held constant the law of diminishing returns operates. The law of diminishing returns states that the addition of a variable input to fixed inputs results first in total returns which increase at an increasing rate, second in total returns which increase at a decreasing rate, and finally total returns which decrease with increases in the variable inputs.[1]

In analyzing the farm business costs and returns can be figured at different levels of refinement. Very often extension agents use bench marks arrived at by selecting data from farms above average--usually the top 33 1/3 percent. Those farms are considerably different from the average farm and do not necessarily represent a farming system which a below average farmer would be able to attain. Comparative analysis would be improved if efficiency is defined by the extent to which farm profit exceeds average profit for a given level of inputs.[2] Studies based on averages and simple comparisons have value for decision-making purposes, however, for many problems they are inferior to those based on marginal productivity analysis.

The law of diminishing returns can also be stated in terms of the marginal and average product. In general production functions derived from real world data are

assumed to conform to the law of diminishing returns. The classical production function shown in Figure 2 in value terms demonstrates the operation of the law of diminishing returns. Since prices of factors bought and sold by individual farmers are not functions of quantities, physical and value production functions are identical. Added returns and added costs are referred to as marginal value products and marginal factor costs to include cases where prices are functions of quantities transacted.

The marginal value product of a factor is the change in value of total product resulting from using one more unit of that factor. It is equal to the marginal physical product of the factor multiplied by the market price of the product plus or minus change in the value of total physical product. It can be expressed algebraically as $MVP_{X_i} = \frac{d(TVP)}{d\ X_i}$ where $\frac{d(TVP}{d\ X_i}$ is the derivative of total value product with respect to the factor X_i. The marginal factor cost of an input is the cost of an additional unit plus or minus the change in the original total cost. It can be expressed in algebraic terms as $MFC_{X_i} = \frac{d(TC)}{dX_i}$ where $\frac{d(TC)}{dX_i}$ is the derivative of total cost with respect to the factor X_i.

As long as a production process pays more per additional unit of input than the additional unit of input costs, it pays to expand production. Alternatively, as long as the marginal value product of a factor is greater

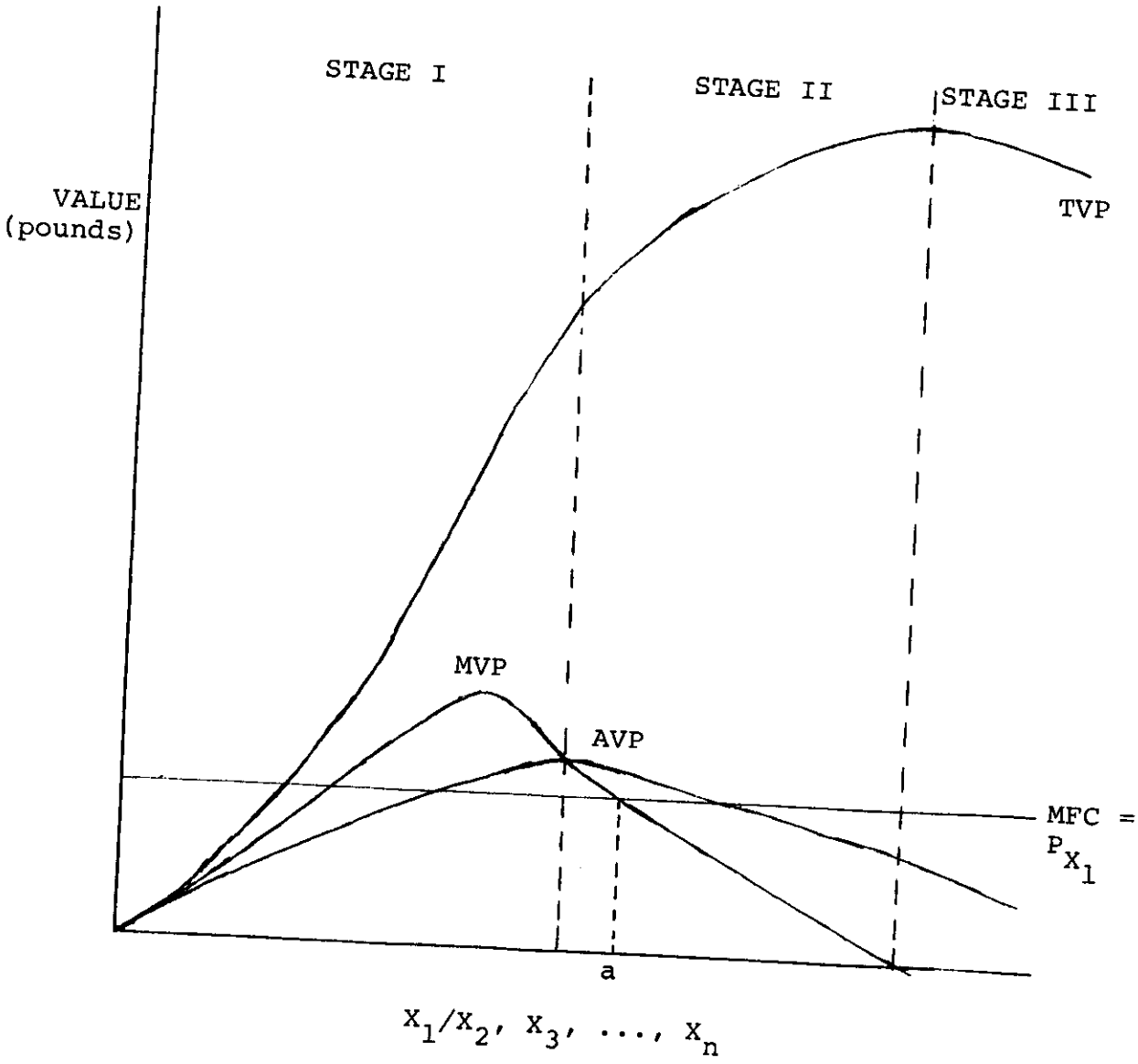

Figure 2. Illustration of the production function, showing the three stages of production and the operation of the law of diminishing returns.

than its marginal factor cost, it pays to use more of that factor. The condition for the optimal use of the variable X_1 in the production of Y is that[3]

$$MVP_{X_1Y} = MFC_{X_1Y} \text{ or } \frac{MVP_{X_1Y}}{MFC_{X_1Y}} = 1$$

On Figure 2 the optimal use of the input X_1 occurs at the point a. In practice more than one variable input is involved in the production process. Then the optimum combination, not the optimum level, is reached when the respective ratios between the marginal value products (MVP_{X_i}) are the same for each input used. The ratios are expressed as:[4]

$$\frac{MVP_{X_1Y}}{MFC_{X_1Y}} = \frac{MVP_{X_2Y}}{MFC_{X_2Y}} = \frac{MVP_{X_nY}}{MFC_{X_nY}}$$

where X_1, X_2 to X_n are the variable factors involved in the production process and where Y is the product. The optimum combinations of two variable inputs for given levels of output can be shown diagramatically. The circular lines on Figure 3 represent iso-product lines or the combinations of X_1 and X_2 which yield given levels of output. When constant returns to scale exist the iso-product lines are equal distances apart on any line drawn from the origin. If iso-product lines are measured in

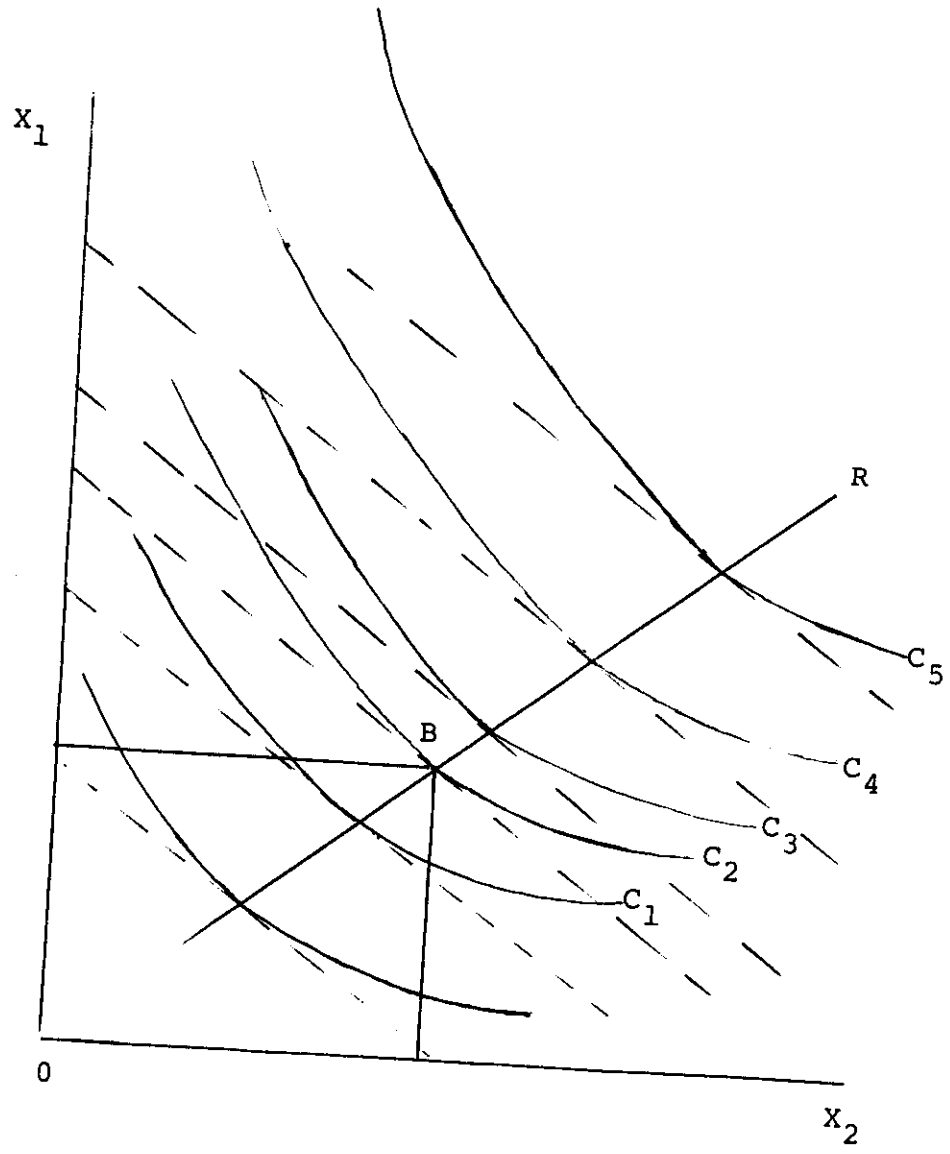

Figure 3. Iso value product lines (C_1, C_2, ... C_4) with iso-cost lines superimposed to locate scale line OR.

units of 10, 20, 30, 40 . . . pounds and if distances between them decrease at first and then increase the law of diminishing returns operates. Iso-cost lines (dotted on Figure 3), represent all combinations of X_1 and X_2 which can be purchased for a given outlay. The tangency point between an iso-cost line and the highest iso-value product line touched by it shows the greatest value of Y which can be produced for a given cost. The point B on Figure 3 shows the optimum combination of the inputs X_1 and X_2 to use in the production of that value of Y represented by the iso-value product line BC_2. The point B satisfies the equation,

$$\frac{MVP_{X_1Y}}{MFC_{X_1Y}} = \frac{MVP_{X_2Y}}{MFC_{X_2Y}}$$

for the optimum combination of the inputs X_1 and X_2. Similarly the equation is satisfied at other points where iso-cost lines are tangent to iso-value product lines. The line connecting points of tangency is called the line of optimum proportions or the line of least cost combinations.

When more than two variable inputs are involved in the production process they are being used in their optimum proportions when the ratios between marginal value products and respective marginal factor costs are the same. In practice the law of diminishing returns is conceived to hold regardless of the number of variables

involved. Marginal returns to single variable inputs or to groups of variable inputs ordinarily first increase, reach a maximum, then decrease and finally become negative. Marginal returns to inputs combined in their optimal proportions (along the least cost combination line) behave similarily.

The optimum amount of product (Y) to produce occurs when the following equation is satisfied:

$$\frac{MVP_{X_1Y}}{MFC_{X_1Y}} = \frac{MVP_{X_2Y}}{MFC_{X_2Y}} \cdot \cdot \cdot = \frac{MVP_{X_dY}}{MFC_{X_dY}} = 1$$

where d stands for the last input which happens to be variable in the particular planning span under consideration. The above equation states that all inputs are properly used when their marginal value products are precisely equal to their respective marginal factor costs. The use of an input should be expanded as long as its MVP is greater than its MFC and should be contracted in the reverse situation.

In the above discussion, salvage and acquisition prices are considered equal. Increasing and decreasing returns along least cost combination or expansion lines depend on the existence of fixed assets. Assets are fixed in static theory because they earn less in their present use than it costs to get more of them and as much or more than can be realized from them in alternative uses. The

existence of fixed assets can be largely explained by institutional and technical factors. When functions are fitted to data from a number of farms having a given asset fixed at various levels that asset is treated as variable and the fixities for individual farms create little difficultues,[5] e.g., land and labor in the current study.

Theory and Practice

Farmers do not always operate as the theory outlined above suggests. This does not indicate that marginality has no application in farming or that farmers do not understand marginal concepts even in a crude fashion. Farmers cannot always equate MFC's of inputs with their respective MVP's because they lack knowledge of the relevant input-output relationships and cost structures, because of uncertainty of future prices and yields, and because of the existence of severe capital restrictions.[6]

In a study of the managerial processes of midwestern farmers it was found that farmers generally understand and use marginal analysis and the processes associated with it, i.e., deductive and inductive reasoning.[7] The study showed that farmers generally considered an example of an analytical model utilizing marginal data more adequate for solving problems than a corresponding model employing average data. Estimates of marginal value productivities derived from the analysis of farm account records and survey data are useful to policy makers, farm managers,

research workers in agricultural economics, and to a wide variety of other persons.

A Brief Review of the Literature

The Cobb/Douglas is the most popular production function used by agricultural economists to estimate marginal value products. This function has been used because of computational manageability and because it allows for the law of diminishing returns to come into operation without the loss of many degrees of freedom.[8] Only one regression coefficient for each resource category is needed. Degrees of freedom become critical when sample sizes are small and the functional form contains power and interaction terms. The Cobb/Douglas function can be expressed algebraically as $Y = aX_1^{b_1}X_2^{b_2} \cdots X_n^{b_n}$ where $b_1, b_2, \cdots b_n$ are the elasticities of production. When $\sum_{i=1}^{n} b_i$ is < 1 decreasing returns to scale exist and when $\sum_{i=1}^{n} b_i > 1$ increasing returns to scale are indicated. The function is linear and homogeneous when $\sum_{i=1}^{n} b_i = 1$.

Previous studies fitting Cobb/Douglas functions to cross-sectional data are outlined in works by Heady, Johnson, and others.[9] Rasmussen and Sandilands fitted Cobb/Douglas functions to six groups of randomly selected farms in Ireland.[10] Data from the six groups were available for

three successive years making it possible to calculate regressions for each year and for the average of the three years. They emphasize "the importance of the managerial variance, in other words the great importance of many detailed husbandry decisions in comparison with the allocation of resources about which the production function as such can give information." They also warn against extrapolating from data based on a single year's accounting. In their study they show that when accounts are averaged over three years "Managerial" variation remained the same while "random" variation was substantially reduced. In some regression fits based on one year's data, the random variation was three times as large as it was for the regression fits based on averaged data. Rasmussen and Sandilands estimated that with the exception of the subsistence group of farms, very close to constant returns to scale existed on Irish farms. They recommend increases in livestock investment and variable expenses, and reductions in family labor on most farms. In a study of Pilot area farms Higgins[11] found that similar adjustments were necessary. Heady, Back, and Peterson[12] have studied relationships between the farm business and the farm household using quadratic and linear functions.

Functions Used in the Current Study

In the current study a linear function is used to estimate the effects of farm business and farm household

variables. Marginal value productivities of resources are estimated using multilinear regression analysis. The Cobb/Douglas function is used to estimate returns to scale.

Production function analysis attempts to predict in a broad manner, the factor-product, product-product, and factor-factor relationships. From these relationships one can derive the added return using one more unit of the resource or can predict how far resources can be added before added cost becomes greater than added returns. The current study is concerned solely with factor product relationships.

Linear functions ignore the physical law of diminishing marginal returns. The marginal productivities of linear functions are not meaningful in economic terms. It is unlikely that marginal productivities are constant over all ranges of inputs. Linear functions yield rather easily, first approximation of the nature and magnitude of MVPs and related parameters. In budgeting and linear programming studies the input output coefficients are assumed constant, i.e., production functions or segments of production functions are assumed linear. In the current study the segment of the production function within the range of the data is assumed linear. This means that constant marginal productivity is assumed over the range of inputs represented by the data. When a function is

linear and it pays to produce one unit of output then resources can be used indefinitely. The high profit point can be calculated only when the law of diminishing returns operates, i.e., where the function being fitted can represent Stage II of the classical production function. The linear assumption may not present a major problem where one only wishes to estimate the marginal value productivity of resources. The estimates of MVPs derived at the mean values of inputs, from Cobb/Douglas, quadratic and linear functions might be similar for the data of the current study. Estimates of MVPs for non-mean values may differ greatly especially when the scale lines of the respective functions are curved in one case and linear in the other.[13]

In this study multilinear regression analysis is preferred because some sociological together with economic factors are examined. A Cobb/Douglas function is fitted to the farm firm variables to determine returns to scale and possibly to help confirm the linearity assumption. The main disadvantage of the linear function is that it does not allow for the law of diminishing returns and thereby is less meaningful economically than other functions such as the quadratic or Cobb/Douglas. The main shortcomings of the Cobb/Douglas function are:[14]

(a) that constant elasticities of production not only with respect to specific X_i's but also in respect to all variables X_1, X_2, X_n collectively exist;

(b) the inability of the function to describe simultaneously any two relationships such as increasing positive, decreasing positive, and negative marginal returns; and

(c) that the combination of resources which gives the lowest cost for one level of output must also give the lowest cost for all other levels of output.

Problems Related to Estimating MVPs from Cross-sectional Data

The most frequent problems related to production function analysis based on cross-sectional data encountered by researchers are those concerning multicollinearity, measurement error, and aggregation.[15] The multicollinearity problem arises when high intercorrelations between input categories exist. When random sampling, there is a tendency to collect data from perfectly or near perfectly adjusted firms of varying size. Farms selected at random or from the better adjusted farms which tend to cooperate in record-keeping projects tend to cluster along expansion lines in the factor-factor dimensions and around the high profit point or the expansion lines.[16] Estimates derived from an analysis of such farms can be erroneous. Marginal value products of small amounts of inputs considered both singly and jointly are likely to be underestimated while estimates of MVPs for large amounts of inputs considered

both singly and jointly are likely to be overestimated.[17] Purposive sampling techniques allow for the selection of farms over wide ranges in proportions and quantities of inputs. This enables a reduction in the intercorrelation between input categories and reduces the standard errors of the regression coefficients.

The problem of finding a method to estimate MVPs for input and investment categories on multienterprise farms is related to the aggregational problem. The conditions set forth in static economic theory for multienterprise firms to be in optimum adjustment are: (a) that the MVP of each particular input or investment category be the same in all its various uses, and (b) assuming that the farmer can acquire additional resources, that the MVPs of each factor or input category must be equal to the cost of acquiring another unit of that factor or input category.[18] In the present study problems created by the existence of more than one enterprise are circumvented by aggregating gross output regardless of the enterprise from which it arose and by aggregating inputs and investments regardless of the enterprises to which they were applied. Problems relating to multicollinearity, measurement error, and aggregation in the current study are referred to in Chapters V and VI.

NOTES--CHAPTER III

[1]Glenn L. Johnson and Lawrence A. Bradford, Farm Management Analysis (New York: John Wiley and Sons, Inc., 1953), p. 113. (Hereinafter referred to as Farm Management.)

[2]C. J. Black, "Premium Averages for Farm Management Purpose," Farm Economist, X, No. 3 (1963), 268-81.

[3]Johnson and Bradford, Farm Management, p. 117.

[4]Ibid., p. 132.

[5]Glenn L. Johnson, "Problems in Studying Resource Productivity and Size of Business," in Resource Productivity, Returns to Scale and Farm Size, ed. by Earl O. Heady, Glenn L. Johnson, and Lowell S. Hardin (Ames, Iowa: The Iowa State College Press, 1956), p. 17. (Hereinafter referred to as "Resource Productivity.")

[6]E. O. Heady, Economics of Agricultural Production and Resource Use (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1952), p. 115.

[7]D. Woods Thomas and Dale Knight, "Analytical Processes in Farm Management," in A Study of Managerial Processes of Midwestern Farmers, ed. by Glenn L. Johnson, Albert N. Halter, Harold R. Jensen, and D. Woods Thomas (Ames, Iowa: The Iowa State University Press, 1962), p. 83.

[8]E. O. Heady, "Technical Considerations in Estimating Production Functions," in Resource Productivity and Returns to Scale, ed. by E. O. Heady, G. L. Johnson, and L. S. Hardin (Ames, Iowa: Iowa State University Press, 1956), p. 14. (Hereinafter referred to as "Technical Considerations.")

[9]Ibid.

[10]K. Rasmussen and M. M. Sandilands, Production Function Analyses of British and Irish Farm Accounts (Nottingham, England: University of Nottingham, 1962), pp. 23 and 58. (Hereinafter referred to as Production Function Analyses.)

[11]P. J. Higgins, "A Marginal Productivity Study of Farms in Selected Western Pilot Areas in Ireland, 1966-1968" (unpublished Master's thesis, Michigan State University, 1971). (Hereinafter referred to as "Marginal Productivity Study.")

[12]E. O. Heady, W. B. Back, and G. A. Peterson, Interdependence Between the Farm Business and the Farm Household with Implications on Economic Efficiency, Bulletin 398, Agricultural Experiment Station (Ames, Iowa: Iowa State College, June, 1953), p. 384F. (Hereinafter referred to as Interdependence Between Farm Business and Farm Household.)

[13]Heady, "Technical Considerations," p. 13F.

[14]H. O. Carter, "Modifications of the Cobb-Douglas Function to Destroy Constant Elasticity and Symmetry," in Resource Productivity and Returns to Scale, ed. by E. O. Heady, G. L. Johnson, and L. S. Hardin (Ames, Iowa: Iowa State University Press, 1956), p. 168F.

[15]Glenn L. Johnson, "Classification and Accounting Problems in Fitting Production Functions to Farm Record and Survey Data," in Resource Productivity and Returns to Scale, ed. by E. O. Heady, G. L. Johnson, and L. S. Hardin (Ames, Iowa: Iowa State University Press, 1956), Chapter 9.

[16]Ibid., p. 95.

[17]Johnson and Bradford, Farm Management, p. 145.

[18]C. Beringer, "Problems in Finding a Method to Estimate Marginal Value Productivities for Input and Investment Categories on Multi-Enterprise Farms," in Resource Productivity and Returns to Scale, ed. by E. O. Heady, G. L. Johnson, and L. S. Hardin (Ames, Iowa: Iowa State University Press, 1956), p. 106F.

CHAPTER IV

DESCRIPTION OF SURVEY AND VARIABLES

Three different topographical areas in County Mayo were selected for this study. The areas are lowland dry, lowland wet, and mountain,[1] and are named Mayo I, Mayo II, and Mayo III, respectively, for the remainder of the study. In 1967/68 a farm account survey was conducted in each region. The district electoral divisions selected for survey in each region were:

Mayo I: Balbinrobe, Cong. and the Neale

Mayo II: Aughomore, Coolnaha, Kilbeagh, Urlaur, and Kilmovee

Mayo III: Croughmoyle, Glanhest, Newport East, Newport West, and Shromore

A 5 percent random sample was chosen for each area. Farmers who dropped out of the initial selection were substituted for. During the year six farmers declined to participate further in the survey. Finally, thirty-two farmers in Mayo I, fifty-five farmers in Mayo II, and twenty-seven farmers in Mayo III kept farm records for one year from May 1, 1967.

Variables Considered in this Study

The variables are:

X = gross output in pounds

X_3 = variable nonlabor costs in pounds

X_4 = unemployment benefit measured as a zero/one variable

X_5 = labor units in man equivalents

X_6 = sheep livestock investment in pounds

X_7 = cattle livestock investment in pounds

X_8 = dairy cow livestock investment in pounds

X_9 = pig livestock investment in pounds

X_{10} = age of decision-makers in years

X_{11} = total livestock investment in pounds

X_{12} = number of dependent children living on the farm

X_{13} = farm size measured in adjusted acres

Gross Output

Gross Output consisted of total cash sales of farm products less purchases, plus or minus the value of inventory changes, plus the value of produce consumed in the farmhouse. Gross output also included receipts from farm hire work and subsidies from various government schemes.

Variable Nonlabor Costs

Variable Nonlabor Costs included all costs directly incurred in production with the exception of rent and rates,

machinery depreciation, labor hire, and that portion of telephone, car, and electricity not directly attributable to farming. The major costs included in this category are feed, seed, and fertilizer costs. Livestock maintenance, transport, and other miscellaneous costs are also included.

Unemployment Benefit

Information on unemployment benefit received by farmers was obtained from government officials. For many years unemployment benefit given to small farmers or the so-called "dole" has been blamed for lack of agricultural progress in the poorer regions of the west of Ireland. Many small farmers believed and still believe despite institutional refinements that if they improve their farming unemployment benefit may be withdrawn. This variable was included to find out if there was a difference in output between the farmers who received unemployment benefit and those who did not receive it.

Livestock Investment

The variables X_6, X_7, X_8, and X_9 are the averages of the beginning and ending inventory figures for each of the livestock investment categories. Cattle and sheep are the two largest livestock investment categories in Mayo I and Mayo III. In Mayo II cattle and cows are the two largest livestock investment categories. The sheep,

cattle, cow, and pig livestock investment figures are aggregated and added to investment in horses and poultry to give the figure for total livestock investment (X_{11}). Investment in horses and poultry is a very small percentage of total livestock investment.

Age of Decision-Maker

The normal aging of farmers reduces their capacity to exercise the managerial function. As farmers get older they are less likely to change cultural practices and adopt new methods of production. Older farmers use smaller amounts of capital than middle-aged farmers. Even so, capital productivity tends to be low because it is directed into less productive uses. The physical abilities of the older operator decline with age and since labor and capital are complements in many ways capital productivity tends to decline with labor productivity. With a limited life span before him the older farmer is reluctant to make investments involving large risks even though they may appear profitable.[2]

Family Size

The farm business goes through phases of a life cycle much like the farm family. There is a shortage of capital in the beginning stages of farming. The family is also beginning; marriage and the birth of children take place. The farm and the family compete for funds which are needed both to raise the children and increase

the size of the farm operation. During the second phase of the family cycle, the family increases, thus furnishing added labor. Capital and land are combined with this relatively inexpensive labor to achieve an efficient combination of resources.[3] The children leave the household during the third phase of the family cycle. The quantity and quality of labor decreases. Eventually the cycle repeats itself again with the farm being acquired by one of the children remaining or returning home.

In the west of Ireland, however, as in all declining rural communities, there is often a missing link which prohibits the continuation of the process described above. Many farmers' sons never marry for a variety of reasons, the main one being that in the age groups over 18 years, male children of the decision-maker on farms outnumber females on farms by three to one.[4] Many farm children prefer occupations other than farming. The western farm survey showed that only 58.7 percent of farms had dependent children in 1967.[5] Farmers with no prospective heirs (i.e., single farmers, childless farmers, and farmers whose children will not return to farming) may become passive in their attitudes towards increasing productivity.

Farm Size

Land was measured in adjusted acres. Total farm area was adjusted using the most productive acre of land in the area as the common denominator. All farms were

adjusted by the author. This subjective method of land measurement can be objected to. Still it is considered more practical than measuring land input by its market value. Farmers usually do not know the market value of their land since very few farms come on to the market in these areas. Even though each area selected is relatively homogeneous with respect to land quality great differences occur between farms and even within farms. This is especially true in the mountainous region. Most farmers in the Mayo III area have communal grazing rights on the mountains and hills. Some farmers make very little use of their grazing rights. It can be a difficult task trying to find a common denominator to measure farm size in such an area.

Problems Related to Measurement Error in the Independent Variables

Where there is a high degree of measurement error in the independent variables the estimated regression coefficients and hence the marginal value products will be inconsistent.[6] For all microeconomic studies based on cross-sectional survey data there will usually be quality differences within single input cagegories no matter how finely they are defined. Labor should be measured in constant quality units. The labor input category should only include the labor actually used in the production process. Work performance varies with age, weather conditions, and attitudes of individuals concerned. An

accurate measure of farm family labor actually used is difficult to achieve. Failure to properly take account of quality differences in land leads to measurement error in the farm size variable. Errors may occur in the collection and transcription of data. Errors in measuring livestock investment occur when taking inventories. In the mountainous area sheep losses are very high. In many cases sheep are counted only four or five times a year. Very often farmers have no correct estimate of sheep numbers. As a result, erroneous sheep livestock investment figures can be collected.

Very often errors occur because a satisfactory conceptual basis of measurement is not available. This leads to the problem of aggregation which arises whenever the input or output under consideration is not homogeneous either within or between observations.[7] Ignoring quality differences within a factor is equivalent to omitting several variables plus including the imperfectly specified variable. The result of the former tends to bias the coefficients of the included variables upwards. The inclusion of the misspecified variable may complement or counteract this bias.[8] The direction of the bias in the estimated coefficients due to aggregation over different inputs is unpredictable. However, bias is minimized by treating resource categories that are near perfect complements as well as resource categories that are near perfect substitutes as single inputs.

Management, although a crucial factor of production, is very difficult to measure. Entrepreneurship has not been included as a variable in this study. It is reasonable to assume that the managerial input is positively correlated with other factors of production. It is also likely that entrepreneurial talent increases less than proportionately with changes in other inputs. Omission of the management factor may lead to overestimation of regression coefficients of some of the other inputs. There is no way of knowing the extent of the bias caused by the omission of the management factor.

All researchers engaged in microeconomic studies have problems with inadequate data. Due to low levels of education among farmers in poorer rural areas, over reliance on memory on behalf of farmers, and administrative inefficiency, even the most carefully designed and conducted survey can hardly procure sufficiently polished primary data. Problems arising from working with inadequate data can often only be overcome by imputation based on liberal compromise of techniques. Purists will have little confidence in the results of the analysis of such data. However, although imperfect, this analysis provides a better aid in formulation of economic policies than some alternatives widely used.

NOTES--CHAPTER IV

[1]Scully, Agriculture, p. 20.

[2]Heady, Back, and Peterson, Interdependence Between Farm Business and Farm Household, pp. 384-86.

[3]Everett M. Rogers, Social Change in Rural Society (New York: Appleton-Century Crofts, Inc., 1960), pp. 202-03.

[4]Scully, Agriculture, pp. 38-39.

[5]Ibid., pp. 38-39.

[6]Jan Kmenta, Elements of Econometrics (New York: The Macmillan Co., 1971), p. 309. (Hereinafter referred to as Econometrics.)

[7]Earl O. Heady and John L. Dillon, Agricultural Production Functions (Ames, Iowa: Iowa State University Press, 1961), p. 127. (Hereinafter referred to as Agricultural Production.)

[8]Ibid., pp. 212-17. Also see Z. Griliches, "Specification Bias in Estimates of Production Functions," Journal of Farm Economics, XXXIX (February, 1957), 1-20.

CHAPTER V

ANALYSIS AND INTERPRETATION OF RESULTS

The analysis in this chapter relies heavily on marginal productivity techniques to determine returns to resources. There are four regressions for each area. Three regressions are fitted for each area using the functional form:

$$y = a + b_1X_1 + b_2X_2 \ldots + b_nX_n$$

The data are converted into logarithms and the Cobb-Douglas function:

$$y = aX_1^{b_1}X_2^{b_2} \ldots X_n^{b_n}$$

is used for the fourth regression. The regression coefficients and related statistics are studied. Recommendations and implications for reorganization of farming in the regions are outlined.

The first regression is fitted to all the variables described in the previous chapter with the exception of total livestock investment (X_{11}). In the second aggression sheep (X_6), cattle (X_7), cow (X_8), and pig (X_9) livestock

investment are aggregated. While discussing the first regression fit, emphasis is placed on the individual livestock investment variables X_6, X_7, X_8, and X_9. The variables, unemployment benefit (X_4), age of decision maker (X_{10}), and number of dependent children (X_{12}) are considered in the discussion on the second regression fit. The economic factors only are studied in the third and fourth regressions. Variable nonlabor costs (X_3), labor units (X_5), total livestock investment (X_{11}), and farm size (X_{13}) are used in fitting the third regression. The fourth regression using the same four inputs is considered mainly to determine returns to scale.

Marginal Value Product

The marginal value product of a factor X_i is obtained by taking the partial derivative of the production function with respect to that factor. In the regression equations where the function is:

$$Y = a + b_1X_1 + b_2X_2 \ldots + b_iX_i \ldots b_nX_n$$

the marginal value product of X_i (MVP_{X_i}) is $\frac{dy}{dX_i} = b_i$. The marginal value product of the Cobb-Douglas function is calculated thus:

$$Y = aX_1^{b_1}X_2^{b_2} \ldots X_i^{b_i} \ldots X_n^{b_n}$$

$$MVP_{X_i} = \frac{dy}{dX_i} = aX_1^{b_1}X_2^{b_2} \ldots b_iX_i^{b_i-1} \ldots X_n^{b_n}$$

$$= \frac{b_i\left[aX_1^{b_1}X_2^{b_2} \ldots X_i^{b_i} \ldots X_n^{b_n}\right]}{X_i}$$

$$MVP_{X_i} = \frac{b_iY}{X_i}$$

The usual economic organization of sample farms in the regions being studied is given in Table 3. The typical family structure is also shown in Table 3. The values in the table are the arithmetic means of all the variables in the study. A random sample of thirty-two farmers was taken in the Mayo I region, fifty-five farmers in the Mayo II region, and twenty-seven farmers in the Mayo III region.

Results of the First Regression

The regression equations and related statistics for each area are shown in Table 4. The expected value of gross output, E(Y), for Mayo I was 750.156 pounds when calculated at the arithmetic mean input values. The standard error of estimate, S, was 160.564 pounds. Under random sampling and given the conditions of the 1967/68 period, 67 percent of the time actual gross output would

TABLE 3. Usual Economic Organization of Sample Farms in Three Regions in County Mayo, 1967/68

Input Category	Mean Values		
	Mayo I	Mayo II	Mayo III
Gross Output	750.156	540.273	362.000
Variable Nonlabor Costs	179.969	142.036	100.740
Unemployment Benefit	0.031	0.418	0.296
Labor Units	1.097	1.095	0.844
Sheep Livestock Investment	156.125	9.455	93.481
Cattle Livestock Investment	474.750	355.527	398.037
Dairy Low Livestock Investment	85.906	153.763	24.074
Pig Livestock Investment	38.875	16.527	8.333
Age of Decision Maker	53.375	52.509	53.296
Total Livestock Investment	803.281	587.727	549.000
Number of Dependent Children	1.844	1.745	1.593
Farm Size	31.438	22.527	32.852

TABLE 4. Regression Equations for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68 (First Function)

	$EY = -70.024 + 1.044X_3 + 28.011X_4 + 183.096X_5 + 0.062X_6 + 0.444X_7$		
Mayo I	$+ 1.221X_8 + 0.499X_9 - 1.529X_{10} + 24.792X_{12} + 3.877X_{13}$		
	$E(Y) = 750.156$	$\bar{R}^2 = .901$	$S = 160.564$
	$EY = 122.512 + .736X_3 - 36.285X_4 + 42.656X_5 + 0.809X_6 + 0.519X_7$		
Mayo II	$+ 0.903X_8 + 1.150X_9 - 1.359X_{10} + 9.783X_{12} - .627X_{13}$		
	$E(Y) = 540.272$	$\bar{R}^2 = .920$	$S = 104.523$
	$EY = 65.649 + 1.918X_3 - 22.273X_4 + 68.307X_5 - 0.233X_6 - 0.257X_7$		
Mayo III	$+ 0.328X_8 + 0.243X_9 - 0.642X_{10} + 0.777X_{12} + 6.063X_{13}$		
	$E(Y) = 362.000$	$\bar{R}^2 = .921$	$S = 69.754$

fall within the range 750.156 $\pm$ 160.564 or between 590 pounds and 911 pounds.

The adjusted coefficient of multiple determination, $\bar{R}^2$, was .901 for the Mayo I regression equation. The coefficient of multiple determination, $\bar{R}^2$, is adjusted to correct for degrees of freedom. This is a necessary procedure when the number of parameters to be estimated is large and the number of observations is small.[1] The adjusted coefficient of multiple determination indicates that 90 percent of the variation in the thirty-two observed values of gross output is explained by the fitted regression equation for Mayo I. The unexplained 10 percent is probably due to unincluded independent variables such as management, weather conditions, institutional, and human behavioral factors.[2] The coefficient of determination should not always be interpreted as a determinant of goodness of fit.[3] The researcher may have some a priori evidence as to what exact form the model should take. The standard error of estimate, S, differs from $\bar{R}^2$ in that, S, is an absolute measure of goodness of fit whereas $\bar{R}^2$ is a relative measure.

The constant (a = -70.024) in Table 4, equation for Mayo I is the Y intercept when all X_i's are zero. It should be interpreted as an estimate of what would happen if all X_i's were zero only when the sample includes points where all X_i's are zero. The estimated parameters have

meaning only within the range of the data used. The sample point where all X_i's are zero is beyond the range of the data used in all three samples in this study.

Estimated Marginal Value Products

Since the regression is not in logarithmic form the marginal value products can be read directly from the equations. The marginal value product of X_i (MVP_{X_i}) is equal to the regression coefficient of X_i(b_i). The regression coefficient says that if one independent variable (X_i) is changed by one unit while all other X's are held constant the value of the dependent variable (Y) will change by the b_i value of the changed independent variable (X_i). Interpreting the equations in Table 4, one can say that the marginal pound spent on variable nonlabor costs (X_3) was estimated to be earning 1.044 pounds when other inputs were held constant at their arithmetic means. The last pound invested in cattle (X_7) was estimated to be earning 0.466 pounds. The return to the last acre (X_{13}) was estimated to be 3.877 pounds. Referring to the equation for Mayo II, if a farmer had been receiving unemployment benefit (X_4) his gross farm output was estimated to have fallen by 36.285 pounds, and if his age (X_{10}) was increased by one year output would fall by 1.359 pounds. The return to the last labor unit (X_5) was estimated to be 42.656 pounds and if the average

farmer had one extra child (X_{12}) his output was estimated to increase by 9.783 pounds. The coefficients for the Mayo III equation in Table 4 can be interpreted similarly.

The regression coefficients are of little use if reliable conclusions and predictions cannot be drawn from them. Regression coefficients are highly unreliable if they have large standard errors. The usual method to establish statistical significance is to hypothesize that a given regression coefficient is zero. The regression coefficients together with their standard errors and significance levels are given in Table 5.

The Mayo I column of Table 5 shows that the regression coefficient for dairy cow livestock investment (X_8) is significantly different from zero at less than the 1 percent level. The regression coefficients for variable nonlabor costs (X_3), labor units (X_5), and cattle livestock investment (X_7) are significantly different from zero at less than the 10 percent level.

The column for Mayo II shows that the coefficients for cattle (X_7) and dairy cow livestock investment (X_8) are significantly different from zero at less than the .05 percent level. The coefficients for variable nonlabor costs and pig livestock investment are significantly different from zero at less than the 10 percent level. The column for Mayo III shows that the coefficient for variable nonlabor costs is significantly different from

TABLE 5. Regression Coefficients and Significance Levels for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68 (First Function)

Input Category	Mayo I		Mayo II		Mayo III	
	b_i	Significance Level	b_i	Significance Level	b_i	Significance Level
Variable Nonlabor Costs (X_3)	1.044	.095	0.736	.057	1.918	.003
Unemployment Benefit (X_4)	28.011	.888	-36.285	.290	-22.273	.559
Labor Units (X_5)	183.096	.060	42.656	.223	68.307	.224
Sheep Livestock Investment (X_6)	0.062	.888	0.809	.328	-0.233	.341
Cattle Livestock Investment (X_7)	0.444	.070	0.519	.0005	-0.257	.082
Dairy Cow Livestock Investment (X_8)	1.221	.006	0.923	.0005	0.328	.152
Pig Livestock Investment (X_9)	0.499	.665	1.150	.095	0.243	.830
Age of Decision Maker (X_{10})	-1.529	.611	-1.359	.352	-0.642	.636
Dependent Children (X_{12})	24.792	.124	9.783	.177	0.777	.905
Farm Size (X_{13})	3.877	.432	-0.627	.845	6.063	.015

zero at less than the 1 percent level. The coefficient for cattle livestock investment is significantly different from zero at less than the 10 percent level. However, the coefficient has a negative sign contrary to expectations. The remaining regression coefficients in Table 5 are not significantly different from zero at the 10 percent level.

Signs of the Regression Coefficients

The regression coefficient for employment benefit (X_4) in the Mayo I column of Table 5 has little meaning because in the random sample of thirty-two farmers only one farmer received unemployment benefit. The negative signs associated with the coefficient for unemployment benefit in the Mayo II and Mayo III columns of Table 5 do not conflict with a priori knowledge of the institutional factors involved.[4] Young farmers are expected to be more receptive to change and new ideas than older farmers. The hypothesis is that overall productivity decreases with age hence X_{10} is expected to have a negative coefficient. Increasing numbers of dependent children are expected to induce farmers to increase farm output accordingly the coefficient for X_{12} is expected to have a positive sign.

Returns to sheep (X_6) and cattle livestock investment (X_7) were expected to be lower in the Mayo III region than in the Mayo I and Mayo II regions. However, returns were not expected to be negative. The reliability of the

regression coefficients and hence of the marginal value products is indicated by the size of their standard errors. High intercorrelations among the independent variables contribute to raising the size of the standard errors of the regression coefficients. The intercorrelation between sheep livestock investment (X_6) and farm size (X_{13}) is .87. The simple correlation coefficient between cattle livestock investment (X_7) and farm size (X_{13}) is .76 and between X_7 and variable nonlabor costs (X_3) it is .68 (Appendix Table 3). It can be inferred as the following section explains that some regression coefficients are overestimated while others are underestimated when high intercorrelations exist among independent variables. In the Mayo III column of Table 5, the coefficients for sheep and cattle livestock investment are probably underestimated and the coefficients for variable nonlabor costs and farm size may be overestimated.

The Reliability of the Regression Coefficients

The estimates of the regression coefficients are unreliable if they have large standard errors. The standard errors of the regression coefficients were calculated from the following formula:

$$Sbx_i = \frac{Sy \cdot x_1 x_2 \cdots x_n}{nS^2 x_i [1 - R^2 x_i, x_1 \cdots x_h, x_j \cdots x_n]}$$

As with simple regression coefficients the reliability of net regression coefficients (b_i) is affected by the number of cases in the sample (n) and the standard error of estimate $Sy \cdot x_1 x_2 \cdots x_n$. In addition, it is affected by how closely the given independent variable X_i can be estimated from other independent variables.[5] The $R^2 x_i, x_1 \cdots x_h, x_j \cdots x_n$, section of the equation determines the effect of multicollinearity on the standard errors of the regression coefficients. A high degree of multicollinearity means that in the matrix (X^1X), one colume is close to being a linear combination of one or more of the remaining columns.[6] The size of the standard error of X_i (Sx_i) also affects the standard error of the regression coefficients. To minimize the standard error of the regression coefficient one should try to maximize n and $S^2 x_i$ and to minimize $S^2 y \cdot x_1, x_2 \cdots x_n$ and $R^2 x_i, x_1 x_2 \cdots x_h, x_j \cdots x_n$. Ezekiel and Fox say "purposeful selection of extreme values of X_i's can reduce the standard error of the regression coefficients very substantially relative to the value that would be obtained if the X values were selected so as to follow a normal frequency curve."[7] This procedure may also help to reduce the degree of multicollinearity.[8] A purposive method of data collection was not undertaken for the current study.

The degree of multicollinearity involved is one of the most important factors to be considered when studying

Table 5. Tables 1, 2, and 3 of the Appendix show the intercorrelations between the independent variables. The degree of multicollinearity can be easily read from simple correlation tables when only two independent variables are involved. The simple correlation tables in the Appendix give one a rough guide to the degree of multicollinearity existing in the current study. When the estimated regression coefficients have large standard errors, the acceptance region for the hypothesis that a given regression coefficient is zero will be wide. The power of the test will be weak making it difficult to discriminate between true and false hypotheses.

Comments on Some of the Regression Coefficients in Table 5

The regression coefficients, in the Mayo I and Mayo II columns, for variable nonlabor costs (X_3) may be underestimated and for dairy cow livestock investment (X_8) may be overestimated. A high degree of multicollinearity is indicated from the intercorrelations between the two variables (Appendix Tables 1 and 2). When multicollinearity is indicated, Ezekiel and Fox say that "any deficiency in one coefficient may be compensated for by an excess in another."[9] The regression coefficients for all the livestock investment categories are probably underestimated in the Mayo III region. It can be said with reservations that differences in the marginal value productivities of the livestock investment categories in Table 5 suggest

investment in dairy cows and pigs was more profitable for the given conditions of the 1967/68 period. Recommendations based on the results of Table 5 should be suggested in conjunction with information available from farm management and extension experts in the field. The results from regression analysis should complement the knowledge of farm management and extension experts working in the regions being examined.

Results of the Second Regression Fit

Because the individual livestock investment figures were highly intercorrelated with variable nonlabor costs and with farm size, they were aggregated to form the independent variable total livestock investment (X_{11}). In the first regression fit the four livestock investment variables X_6, X_7, X_8, and X_9 were highly correlated with variable nonlabor costs (X_3) and farm size (X_{13}). In the second regression fit only one variable total livestock investment (X_{11}) was highly correlated with variable nonlabor costs and farm size. This aggregation procedure probably reduces the degree of multicollinearity a little. However, it narrows the researcher's ability to make recommendations on the basis of the results. A farmer gains little when told that he should invest in a broad category called "livestock." Further problems of aggregation arise which were discussed in a previous chapter.

The equations for the second regression fit are given in Table 6. The adjusted coefficients of correlation fell marginally indicating that the first fit may have been slightly better. Table 7 shows the regression coefficients with their standard errors and significance levels for the second regression fit. The coefficients for variable nonlabor costs in the Mayo I and Mayo II columns are more in line with those one would expect from a priori knowledge than the corresponding coefficients of the first regression fit. For all the columns of Table 7, the coefficients for variable nonlabor costs may be overestimated and the coefficients for farm size and livestock investment may be underestimated due to the high intercorrelations between the variables X_3, X_{11}, and X_{13} (Appendix Tables 1, 2, and 3).

As previously mentioned in this chapter, the regression coefficient for unemployment benefit (X_4) in the Mayo I column has little meaning. The coefficients of X_4 in the Mayo II and Mayo III columns of Table 7 are negative but not significantly different from zero at the 10 percent level. The coefficient for age of decision maker (X_{10}) is negative and small in all columns of Table 7. The coefficients for X_{10} are not significantly different from zero.

The regression coefficient of dependent children (X_{12}) is significantly different from zero at less than

TABLE 6. Regression Equations for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68 (Second Function)

Mayo I	$EY = -60.900 + 1.339X_3 + 8.218X_4 + 106.103X_5 - 0.749X_{10} + 0.458X_{11} + 29.417X_{12} + 2.275X_{13}$		
	$EY = 750.156$	$\bar{R}^2 = .891$	$S = 168.257$
Mayo II	$EY = 149.927 + 1.558X_3 - 51.106X_4 + 27.117X_5 - 1.734X_{10} + 0.448X_{11} + 5.794X_{12} - 0.967X_{13}$		
	$EY = 540.272$	$\bar{R}^2 = .893$	$S = 120.585$
Mayo III	$EY = 48.477 + 2.217X_3 - 36.852X_4 + 126.517X_5 - 0.891X_{10} - 0.175X_{11} + 2.470X_{12} + 4.074X_{13}$		
	$EY = 362.00$	$\bar{R}^2 = .884$	$S = 84.757$

TABLE 7. Regression Coefficients and Significance Levels for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68 (Second Function)

Input Category	Mayo I		Mayo II		Mayo III	
	b_i	Significance Level	b_i	Significance Level	b_i	Significance Level
Variable Nonlabor Costs	1.339	.0005	1.558	.0005	2.217	.0005
Unemployment Benefit	8.218	.968	-51.106	.180	-36.852	.393
Labor Units	106.103	.243	27.117	.504	126.517	.044
Age of Decision Maker	-0.749	.805	-1.734	.289	-0.891	.555
Total Livestock Investment	0.458	.051	0.448	.004	-0.175	.230
Dependent Children	29.417	.076	5.794	.487	2.470	.730
Farm Size	2.275	.613	-0.967	.793	4.074	.032

the 10 percent level in Mayo I and not significantly different from zero in Mayo II and Mayo III. The signs of the coefficients of X_4, X_{10}, and X_{12} do not conflict with expectations from prior knowledge. Further controlled purposive sampled surveys would need to be initiated to quantify the effects of the variables unemployment benefit, age of decision maker, and number of dependent children on gross output.

Results of the Third Regression Fit

The regression equations and related statistics are given in Table 8. Even though the variables unemployment benefit (X_4), age of decision maker (X_{10}), and number of dependent children (X_{12}) were dropped in the third regression fit the adjusted coefficient of determination $\bar{R}^2$ hardly changed at all. The difference between the $\bar{R}^2$'s of the second and third regression fits was .01 or less for all regions. The results of the regression analysis in this study suggest that the variables X_4, X_{10}, and X_{12} contributed little in explaining the variation in gross output. The regression coefficients with their standard errors and significance levels for the third regression fit are shown in Table 9.

The coefficient for variable nonlabor costs (X_3) is significantly different from zero at less than the .05 percent level in all regions. As indicated in the previous regression fit, the coefficient for X_3 may be overestimated.

TABLE 8. Regression Equations for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68 (Third Function)

Mayo I	$EY = -31.869 + 1.475X_3 + 104.752X_5 + 0.423X_{11} + 1.975X_{13}$	
	$\bar{R}^2 = .885$	$S = 172.980$
Mayo II	$EY = 30.152 + 1.674X_3 + 5.810X_5 + 0.469X_{11} - 0.435X_{13}$	
	$\bar{R}^2 = .894$	$S = 120.077$
Mayo III	$EY = 0.810 + 2.273X_3 + 107.424X_5 - 0.175X_{11} + 4.180X_{13}$	
	$\bar{R}^2 = .894$	$S = 80.746$

TABLE 9. Regression Coefficients and Significance Levels for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68 (Third Function)

Input Category	Mayo I		Mayo II		Mayo III	
	b_i	Significance Level	b_i	Significance Level	b_i	Significance Level
Variable Nonlabor Costs	1.475	<.0005	1.674	<.0005	2.273	<.0005
Labor Units	104.752	.201	5.810	.878	107.424	.046
Total Livestock Investment	0.423	.072	0.469	.001	-0.175	.194
Farm Size	1.975	.667	-0.435	.900	4.180	.018

The return to the last labor unit (X_5) employed is low in all regions when compared with minimum wages for agricultural workers. In the Mayo III column of Table 9, the coefficient for X_5 is significantly different from zero at less than the 5 percent level. The return to the last pound spent on livestock investment (X_{11}) was significantly different from zero at less than the 10 percent level in Mayo I, and at the 1 percent level in Mayo II. There was a low negative marginal value product for X_{11} in Mayo III. As mentioned previously in this chapter, multicollinearity may have contributed to underestimated and even negative coefficients. The marginal value product of farm size (X_{13}) is negative for the Mayo II Region but not significantly different from zero. It seems unlikely that production should actually decrease if certain factors of production are increased. Within the range of inputs on most farms, negative marginal value productivities are meaningless.[10]

A more desirable test economically would be to compare the marginal value products with their respective opportunity costs or marginal factor costs. This comparison is considered for each region in Tables 11, 12, and 13.

Comparison of Marginal Value Products with Marginal Factor Costs

Marginal factor costs may vary from farm to farm and from area to area depending on price differences,

uncertainty, and differences in managerial capacity. Reasonable estimates of marginal factor costs are shown in Table 10. In the case of variable nonlabor costs (X_3), labor units (X_5), and farm size (X_{13}), opportunity costs and marginal factor costs can be regarded as being the same. A reservation price is calculated for livestock investment (X_{11}). This is the expected minimum return the farmer hopes to receive on his investment. Variable nonlabor costs, depreciation, and interest charges are expected to be paid for by returns on investment.

TABLE 10. Opportunity Costs or Marginal Factor Costs for Factor Inputs

Input Category	Unit of Measurement	Value
Variable Nonlabor Costs - X_3	Pound/Per Pound	1.06
Labor Units - X_5	Pounds/Per Labor Unit Per Year	500
Livestock Investment - X_{11}	Pounds/Per 100 Pound	40

A return of one pound plus 6 percent interest on every pound spent was expected for input X_3. The opportunity cost of not working in off-farm employment in 1967/68 was estimated to be 500 pounds. The expected minimum return on livestock investment was based on the following charges; 12 percent for depreciation, 6 percent interest charge, and 22 percent for variable nonlabor

TABLE 11. Comparison of Estimated bi's with the b_i's Required to Equate Marginal Value Products and Opportunity Costs Mayo I (Third Regression Fit)

	b_i	Estimated b_i	b_i^* = Opportunity Costs	Difference $b_i - b_i^*$	Standard Error	t Value	Significance Level
Variable Nonlabor Costs	b_3	1.4752	1.060	.4152	.2714	1.5298	N.S.
Labor Units	b_5	104.7521	500.000	-395.2479	79.8393	4.9505	.001
Total Livestock Investment	b_{11}	0.4226	0.400	.0226	.2254	.1020	N.S.
Farm Size	b_{13}	1.9754	12.00	-10.0246	4.5368	2.2097	.05

TABLE 12. Comparison of Estimated b_i's with the b_i's Required to Equate Marginal Value Products and Opportunity Costs Mayo II (Third Regression Fit)

	b_i	Estimated b_i	b_i^* = Opportunity Costs	Difference $b_i - b_i^*$	Standard Error	t Value	Significance Level
Variable Nonlabor Costs	b_3	1.6741	1.060	.6141	.2616	2.3475	.05
Labor Units	b_5	5.8102	500.000	-494.1898	37.6191	13.1367	<.001
Total Livestock Investment	b_{11}	0.4692	.400	.0692	.1280	.5406	N.S.
Farm Size	b_{13}	-0.4352	9.000	-9.4352	3.4331	2.7484	.01

TABLE 13. Comparison of Estimated b_i's with the b_i's Required to Equate Marginal Value Products and Opportunity Costs Mayo III (Third Regression Fit)

	b_i	Estimated b_i	b_i^* = Opportunity Costs	Difference $b_i - b_i^*$	Standard Error	t Value	Significance Level
Variable Nonlabor Costs	b_3	2.2735	1.060	1.2135	0.3018	4.0192	.001
Labor Units	b_5	107.4239	500.000	-392.5761	50.7872	7.7298	<.001
Total Livestock Investment	b_{11}	-0.1746	0.400	-0.5746	0.1305	4.4030	.001
Farm Size	b_{13}	4.1795	7.000	-2.8205	1.6365	1.7235	.10

costs.[11] The rental value of one adjusted acre corresponds to the opportunity cost of using an acre of land for one year. Based on the author's familiarity with the regions being studied, the opportunity cost of using an acre of land in 1967/68 was estimated to be 12 pounds in Mayo I, 9 pounds in Mayo II, and 7 pounds in Mayo III.

Table 11 shows that sizable differences exist between marginal value products and marginal factor costs of labor units X_5 and farm size X_{13}, the differences being significant at the .1 percent and the 5 percent level, respectively. This suggests that adjustments are necessary in the use of resources in the Mayo I area given the conditions of the farms examined. Labor is under utilized and on the majority of farms there are low returns to labor.[12] Caution should be exercised in recommending reductions in farm size as suggested by the result in Table 11. As outlined earlier in this chapter, the coefficient for farm size, X_{13}, may be underestimated. A more efficient means of measuring land might help to produce a higher marginal value product. There is a large difference, though not significant between the MVP of variable nonlabor costs (X_3) and its MFC. Farmers should increase expenditure on variable nonlabor costs to the point where its MVP is equal to its MFC. Farm management experts would consider that if variable nonlabor costs are increased by way of improving pastures then investment in livestock should be increased also.

Table 12 shows maladjustments in the use of resources in the Mayo II region. Expenditure on variable nonlabor costs can be increased to the point where MVP_{X_3} is equal to its MFC. From a practical farm management point of view, increases in variable nonlabor costs should usually be accompanied by increases in livestock investment on most farms in the west of Ireland.

It can be argued that the opportunity cost figure of 500 pounds per labor unit is too high; however, even if farmers could find off-farm employment for as little as three months of the year the return to labor in farming would still be significantly less than in off-farm employment. Reductions in farm size can hardly be recommended given the political and institutional factors involved and for reasons already mentioned.

Large significant differences occur between all marginal value products and their respective opportunity or marginal factor costs in the Mayo III region as shown by Table 13. In the author's opinion a high degree of measurement error is more probable in the Mayo III figures than in the figures for Mayo I and II. Measurement error is discussed in the previous chapter. Because of measurement error together with the high degree of multicollinearity recommendations based on the results of Table 13 should be made with extreme caution. The coefficient for variable nonlabor costs appears overestimated

and for livestock investment appears underestimated. Even so increased expenditure on variable nonlabor costs can be recommended. Given the conditions of this particular area, most farm management experts would consider that expenditure on variable nonlabor costs should be increased to a certain level before increased investment in livestock is undertaken.[13] Table 13 shows that for the given level of variable nonlabor costs, farms in this area may be over stocked.

The Results of the Fourth Regression Fit

The data used in the third regression fit were converted into logarithms. The results of the fourth regression fit are given in Table 14. The elasticities of the input categories (regression coefficients) are related to their marginal value products.[13] The returns to scale given by the sum of the elasticities Σb_i is estimated to be 1.005, 1.018, and .847 in Mayo I, Mayo II, and Mayo III, respectively (Table 14).

The marginal value productivities are not discussed as the implications drawn from them are similar to implications drawn from the MVPs of the previous regression fits. When testing for constant returns to scale based on a Cobb-Douglas production function, the null hypothesis becomes HN: $b_1 + b_2 \ldots + bk = 1$ where there are k factors of production. The t statistic computed from Σb_i is

TABLE 14. Elasticities (Regression Coefficients) and Significance Levels for Random Samples of Farms in Three Different Regions in County Mayo, 1967/68, 4th Function

Input Category	Mayo I		Mayo II		Mayo III	
	b_i	Significance Level	b_i	Significance Level	b_i	Significance Level
Variable Nonlabor Costs	0.412	<0.0005	.367	.002	0.299	<.0005
Labor Units	0.115	0.142	.063	.563	0.047	.518
Total Livestock Investment	0.714	0.001	.985	.0005	0.455	.035
Farm Size	-0.236	0.248	-0.397	.067	0.046	.766
	$\Sigma b_i = 1.005$		$\Sigma b_i = 1.018$		$\Sigma b_i = 0.847$	
Adjusted Coefficient of Multiple Determination	$\bar{R}^2 = .892$		$\bar{R}^2 = .851$		$\bar{R}^2 = .881$	
Standard Error of Estimate	S = .110		S = .133		S = .092	
Sample Size	n = 32		n = 55		n = 27	
Constant Returns to Scale Test	t = .047		t = .142		t = 1.698	

$$t = \frac{\Sigma b_i - 1}{\hat{V}(d)} \quad 14$$

where $\hat{V}(d)$ is the estimated variance of the sum of the b_i's computed from the coefficients of the variance/covariance matrix normalized and the variances of the elasticities.

The constant returns to scale test of Table 14 shows that the t values are too small to have the sum of the elasticities (Σb_i) significantly different from one. The estimated sum of the elasticities for the Mayo III region is .847. This figure is almost significantly different from one at the 10 percent level. Similar results were found by Rasmussen.[15] Where the Σb_i's is <1 decreasing returns to scale are implied and where Σb_i's is >1 increasing returns to scale are implied. Returns to scale are constant if Σb_i's is unity. The Mayo III farms show a tendency towards decreasing returns to scale meaning that if all inputs are increased by 1 percent, output will increase by less than one percent or by .847 percent.

Returns to scale will be underestimated if excluded inputs vary less than proportionately with changes in the included factors over the sample observations. Heady and Dillon say "the exclusion of management may be expected to lead to underestimation of returns to scale. Likewise, neglecting quality differences in other input factors will lead to biased estimates of scale returns."[16] Some inputs are not controlled by the farmer. The availability of

capital and land is controlled by the institutional framework. "There is little point in telling a farmer that more profit can be attained by increasing or decreasing his scale of operation if uncontrollable factors are included in the recommendations."[17] Given the underlying assumptions of the analysis and given the limitations of the data, it can be said from an economic policy point of view if the government's aim is to increase agricultural production in County Mayo there is no reason to favor large rather than small farms. Hence, there is no reason for introducing discriminatory practices so far as farm size is concerned. There may be social reasons for governments to favor large or small farms but this must be done apart from economic policy considerations which are only concerned with the productivity of agriculture.[18] Agriculture and social welfare policies should complement each other rather than be substitutes for each other.

The constant returns to scale result in Table 14 helps to confirm the linearity assumption of the previous regression fits in this study.

Major Conclusions

1. Farm output declines as farmers grow older in the three areas examined.

2. Farm output rises as family size increases. This result is true for all regions studied and $MVP_{X_{12}}$ is

statistically significant from zero at less than the 10 percent level in the Mayo I area.

3. Farmers receiving unemployment benefit have a lower farm output than farmers not receiving unemployment benefit. This result is in agreement with the hypothesis that farmers believe unemployment benefit will be withdrawn if they increase overall productivity on their farms.

4. The marginal value products of dairy cow (X_8) and pig (X_9) livestock investment are greater than the marginal value products of sheep (X_6) and cattle (X_7) livestock investment. This suggests that investment in dairy cows and pigs was more profitable than investment in cattle and sheep in all areas given the conditions of the 1967/68 period. The dairy cow livestock investment figure was statistically significant from zero at less than the 1 percent level in the Mayo I and Mayo II areas. The pig livestock investment figure was statistically significant from zero (at less than the 10 percent level) in the Mayo II area only.

5. The regression coefficient for labor units (X_5) was significantly less than that required to equate its marginal value product with its estimated marginal factor cost in all areas (i.e., returns to labor are low in all areas examined).

6. The estimated marginal value productivity of land is significantly less than its estimated marginal factor cost in all areas.

7. Estimates of marginal value products for variable nonlabor costs (X_3) and total livestock investment (X_{11}) are not significantly different from their respective marginal factor costs in the lowland dry area (Mayo I). The marginal value product of variable nonlabor costs is significantly different from its marginal factor cost at the 5 percent level in the lowland wet area (Mayo II). In the mountainous region (Mayo III) the marginal value products of variable nonlabor costs and livestock investment are significantly different from their respective marginal factor costs.

8. The analysis shows that the sum of the elasticities of production are not significantly different from one when the data are converted into logarithms. Returns to scale are constant, meaning that if all inputs are increased by 1 percent output will increase by 1 percent in the regions examined.

Chapter VI discusses the validity and implications of these conclusions.

NOTES--CHAPTER V

[1]Heady and Dillon, Agricultural Production, p. 119.

[2]Kmenta, Econometrics, p. 202.

[3]P. Rao and R. L. Miller, Applied Econometrics (Belmont, Calif.: Wadsworth Publishing Company, Inc., 1971), p. 14. (Hereinafter referred to as Applied Econometrics.)

[4]The hypothesis is that farmers believe that unemployment assistance will be withdrawn if they increase overall productivity on their farms.

[5]Mordecai Ezekiel and Karl A. Fox, Methods of Correlation and Regression Analysis (New York: John Wiley and Sons, Inc., 1959), p. 283. (Hereinafter referred to as Correlation and Regression Analysis.)

[6]Kmenta, Econometrics, p. 388.

[7]Ezekiel and Fox, Correlation and Regression Analysis, pp. 283 and 307F.

[8]Heady and Dillon, Agricultural Production, pp. 145-49, 192.

[9]Ezekiel and Fox, Correlation and Regression Analysis, pp. 285-86.

[10]Gerard Tintner and D. H. Brownlee, "Production Functions Derived from Farm Records," Journal of Farm Economics, XXVI (August, 1944), 566-71.

[11]Higgins, "Marginal Productivity Study," p. 69.

[12]Scully, Agriculture, p. 67.

[13]County Mayo Committee of Agriculture, Annual Report 1968 (County Mayo: Committee of Agriculture, 1969), p. 51.

[14]Rao and Miller, Applied Econometrics, pp. 138-41.

[15]Rasmussen and Sandilands, Production Function Analyses, p. 55.

[16]Heady and Dillon, Agricultural Production, p. 230.

[17]Ibid., p. 232.

[18]Gerard Tintner, "Significance Tests in Production Function Research," in Resource Productivity, Returns to Scale and Farm Size, ed. by E. O. Heady, G. L. Johnson, and L. S. Hardin (Ames, Iowa: Iowa State College Press, 1956), p. 126F.

CHAPTER VI

IMPLICATIONS AND RECOMMENDATIONS

Estimates of the marginal value productivities of various inputs used in the production process on farms in County Mayo during the 1967/68 period were calculated in the previous chapter. The variables, age, family size, and unemployment benefit, examined in this study are expected to affect gross farm output because of the indirect effect these variables have on the quality of the management and labor inputs. The estimates of the effects of age and unemployment benefit are meaningful and bear out current and prior expectations.[1] However, the estimates are not statistically significant at the 10 percent level. The regression coefficient of dependent children (X_{12}) is significantly different from zero at less than the 10 percent level in Mayo I and not significantly different from zero in Mayo II and Mayo III. Currently in the west of Ireland 56 percent of farmers are over 50 years of age and of these, 50 percent have no prospective heirs.[2] Recommendations for improving the agricultural productivity of a region must take account of the related demographic

and land tenure factors. Further studies are required to measure the extent of the misallocation involved where farms are being owned and operated by farmers who are over 50 years of age and who have no prospective heirs.

The estimates from the first regression fit where the total livestock investment category is disaggregated suggest that farmers should increase investment in dairy cows and pigs in all areas where feasible. Pig meat and milk prices are supported. Cattle and sheep prices fluctuate widely. For a variety of reasons including age, lack of skills, internal and external capital restrictions, fragmented farms and adverse soil and topographical conditions many farmers will not be in a position to increase investment in dairy cows and pigs. This is especially true in mountainous regions.

The main recommendations of this study are based on a comparison of marginal value products and marginal factor costs of variable nonlabor costs (X_3), labor units (X_5), livestock investment (X_{11}), and farm size (X_{13}). Given the conditions existing in the 1967/68 period considerable reorganization in the use of resources is necessary on most farms.

The regression coefficient for labor units was significantly less than that required to equate its marginal value product with its minimum expected return in all areas. In 1967, 49.6 percent of farms operated by full-time farmers in County Mayo had less than 150 standard

man-day labor requirements.[3] The amount of labor actually used may have been overestimated in the present study. Still it can be said that the lack of labor intensive enterprises in the west of Ireland results in the underemployment of labor available and in low labor earnings on most farms. Labor productivity on farms can be increased by (a) using less labor, (b) by intensifying production, (c) by adjusting to technological changes or by combinations of all three. Increasing labor productivity by means other than intensifying production results in labor displacement. Off-farm employment opportunities are required for those displaced. Currently, adequate off-farm employment opportunities for the majority of farmers willing to farm part time do not exist. Young people beginning farming should be given estimates, however crude, of their expected future income streams. Projections are needed through time of the required employment levels in agriculture which give farmers equitable living standards. These projections can be made by examining age specific groups of farmers while holding the variables livestock investment, variable nonlabor costs, and farm size in equilibrium. Many farmers are locked in agriculture as a result of past mistakes in decision making.

The opportunity cost of labor outside agriculture may be very low where few opportunities for off-farm employment exist. In the short term where there are little chances of obtaining off-farm employment farmers

should intensify production by increasing investment in livestock and variable nonlabor costs. Productivity and incomes would rise providing current price levels persist. Lucey and Kaldor found that in areas where part-time employment opportunities exist, farmers worked harder and longer than they had done when farming was their sole occupation.[4] Their study revealed that part-time farmers showed no reduction in farm output.

The data for the lowland dry area show that the estimates of the marginal value products for variable nonlabor costs and livestock investment are not significantly different from their respective marginal factor costs. However, the estimated marginal value product for variable nonlabor costs is much greater than its marginal factor cost. Farmers should increase expenditures on variable nonlabor cost up to the point where its MVP is equal to its MFC. Farm management experts in the area would consider that if variable nonlabor costs are increased by way of improving pastures then investment in livestock should be increased also. Similar recommendations can be made for the lowland wet area.

In the mountainous region the coefficient for variable nonlabor cost appears to be overestimated while that for livestock investment seems to be underestimated probably due to multicollinearity and measurement error effects. Even so, increased expenditure on variable

nonlabor costs can be recommended. Given the conditions of this area, most farm management experts would agree that expenditure on variable nonlabor costs should be increased to a certain level before increasing investment in livestock.

The estimated marginal value productivity of land is significantly less than its estimated marginal factor cost in all areas. The estimated returns to land are very low and despite reservations concerning multicollinearity and measurement error, improved estimates would still be expected to be low because of the unintensive nature of farming in these areas. No matter how intensified the present combinations of enterprises on farms in the west of Ireland become, adequate incomes will not be forthcoming with the existing farm sizes. It must also be recognized that the majority of older farmers operate small farms and probably have extremely low incomes. Irrespective of how much land they have, it is improbable that they will increase productivity since the majority of them, especially those without prospective heirs, are not in a position to undertake worthwhile farm development programs. For this reason, new schemes will have to be developed to increase the size of farms operated by younger farmers and to channel farms into the hands of beginning farmers at an earlier age.

In the short term, present farming conditions can be improved by promoting a more efficient allocation of

available resources. If those who are still viable or potentially so wish to remain or become commercial farmers, they will have to allocate resources efficiently, adopt modern farm practices, and participate in both short- and long-term farm development programs. Development programs may be undertaken at the individual farm level. Farmers who take advantage of the Small Farm (Incentive) Bonus scheme have a very significant part to play in the development of agriculture in the west of Ireland.

Scully suggests, from knowledge gained in pilot area research work, that group development projects should be encouraged.[5] He states that farmers with viable and potentially viable farms should be encouraged to cooperate in organizing and implementing formalized producer/marketing groups and that each producer/marketing groups should be concerned with one commodity only. Generous financing and cheap external credit facilities are required in the initial stages if the producer/marketing groups are to be successful. The evolution of cooperative groups based on "grass roots" membership and participation, is vital to agricultural development in the west of Ireland.

Structural Reform Proposals

Individual farm and group development programs will bring rapid short-term gains to farmers capable of participating in them. However, as long as structural

problems exist agricultural development in the west of Ireland will be hindered and the low farm income problem will persist. Farmers with viable and potentially viable farms can help in the development of the west provided they have the means to do so. As soon as possible, measures must be devised and implemented to help farmers, especially those in the younger age groups, to enlarge and consolidate their farms.

The basic premise of most structural reform plans in Western Europe is that too many small "inefficient" farms exist given present market conditions and technology levels. Structural reform proposals state that assistance be given only to farmers who have the capacity to earn adequate incomes from the land and that farmers willing to retire or learn a new trade be encouraged financially to do so.[6] The conditions for assistance are that potentially viable and viable farmers draw up, individually or collectively, plans for farm development in conjunction with agricultural advisors. The present methods aimed at structural reorganization of Irish farms are very time-consuming and costly and not adequate in solving adjustment problems. Many analysts believe that solutions to structural problems in agriculture cannot be found while users of land do not have to pay for it at its full market value.[7]

Under a system of owner occupancy where a land tax equivalent to the rental value of the land would have to be paid, an economically "efficient" allocation of land would develop provided a well-operating money market for the purchase of land existed. An "efficient" system of land allocation would also exist under a landlord-tenant system whereby competitive rents are paid to the landlord. In the west of Ireland the landlord could be the state or a neighboring farmer. In the landlord-tenant case the tenancy period should be sufficiently long to allow the tenant to get satisfactory returns on his investment and should guarantee renewal of tenancy contracts provided certain minimum conditions are observed by the tenant. Further fragmentation of farms, whether occurring under lease or new ownership arrangements, must be avoided. All new sale and rental arrangements should be supervised by the Irish Land Commission.

Under the land tax proposition "inefficient" farmers would be forced out of farming. This method of attaining "efficient" land allocation would be highly acceptable provided employment opportunities or adequate welfare payments are available for those displaced. A combination of both propositions may be necessary in trying to enlarge and consolidate farms in the west of Ireland. For the success of schemes aimed at structural reform, measures must be implemented to induce elderly

people to lease or sell their farms. Elderly farmers can be induced to lease their land for long-term periods provided adequate retirement pensions are forthcoming. A land tax could also be selectively applied introducing a measure of coercion where elderly farmers with no successors are loath to accept pension schemes plus the payments from leasing their land. The application of a selective land tax would force more farms on to the market than at present. This would probably at least check the increases in land prices enabling farmers with access to capital to buy land. However, it is envisaged that the main purpose of a selective land tax would be to force more land on to the market for leasing purposes. This would enable young progressive farmers to enlarge their farms at relatively low outlays. The beginning farmer would be in a more healthy capital position than he would otherwise be if he had to buy land. Opportunities and incentives should also be provided so that young and middle-aged farmers, who are willing to lease or sell their land to their more "efficient neighbors," can do so.

The farm business grows and declines in productivity with the farm family cycle.[8] More dynamic farm business arrangements are required so that the life cycle of two generations can overlap. In the west of Ireland many farmers die intestate and many farmer's sons do not become owner/occupiers until they are 40 years old or

more. For financial reasons many cannot marry until they become owners. At succession age many farmers cannot find a spouse. Farms operated by these farmers ultimately become nonviable.

The success of the above-mentioned schemes depend on: (a) how successful a selective land tax can be applied, (b) the attractiveness of the incentives to lease or sell land, (c) the availability of alternative off-farm employment opportunities for young and middle-aged farmers who are willing to lease or sell their land, and (d) on the passage of the necessary legislative acts required to bring about structural reform.

Structural reform together with scientific inputs is needed to attain large gains in agricultural productivity. Economic incentives to apply the scientific inputs (including educational and technological) are necessary to reap optimum rewards. Even in Ireland, the economic distortions caused by direct price supports and subsidies have been costly in terms of disposing surpluses and in terms of the regressive effects that these policies have had on the distribution of personal income within agriculture. Most countries including Ireland and the E.E.C. countries have problems when trying to provide effective economic incentives without increasing misallocations and inequalities.

The prospects for agricultural development in the west of Ireland depend on the pace at which general economic growth of the region will proceed. Structural reform to a great extent depends on the level of employment created by the development of many small-scale industries, forestry and fishing, and by the development of tourism and recreational facilities. When off-farm employment opportunities are plentiful structural reform programs are less costly to implement and are completed in relatively short time periods. Studies have shown that small-scale owner-controlled (manufacturing) enterprises are more conducive to economic growth and social justice than large management-controlled operations.[9]

Small-scale enterprises contribute more to the developmental process than large-scale management controlled operations when compared by such economic indicators as capital/output ratios, savings/income ratios, and import/export ratios.[10] The above findings have important policy implications for the west of Ireland where no large-scale industries exist.

Limitations of the Study

Results which are clear extrapolations from regression fits should be treated with caution. However, the global recommendations may still be very much to the point as suggestions of directions of change required. Regression analysis results should complement knowledge

obtained from experience in the field. Recommendations outlining reorganization of typical farms in the three areas in County Mayo, based on regression analysis should coincide in a broad sense with those presented by most farm management experts working in the county. Useful recommendations depend on the range of inputs and outputs considered in the fitted function, the functions reliability in terms of statistical and economic logic, and the quality of data on which it is based. The assumptions underlying the recommendations in this study are based on the belief that farmers are profit maximizers. Many farmers behave as satisfiers when searching for the pattern of resource use which they desire most.

Input and output categories of production functions based on cross-sectional survey data are usually highly aggregated. Farmers would like to know what particular livestock category is most profitable for their given situation. They would also like to know whether money should be spent on feed or fertilizer. Variable nonlabor costs (X_3) is a highly aggregated input category.

Satisfactory recommendations may be feasible only for individual farms of an average character. Estimates of marginal value products become less reliable as "distances" from the mean input values increase.

Due to problems of asset fixity, and investment and disinvestment on individual farms recommendations made

in this study will be hindered to a certain extent in the short run.[11] Many individual farmers will not be able to find off-farm employment. The high age structure and low levels of education together with the high cost of mobility prevent many farmers from getting full- or part-time off-farm employment. These farmers are trapped in agriculture.[12] Farm size is a relatively fixed variable in the short run of a few years and in many cases for generations. It is meaningless to tell a farmer that he should be using more land and/or capital when not available or when those inputs cannot be afforded. Restraints on capital and land are best handled by linear programming methods.

The present analysis is static in nature and only attempts to measure the effects of various inputs given the prices and institutional patterns existing in the 1967/68 period.

Problems of multicollinearity exist because of the high intercorrelations between the livestock investment categories, variable nonlabor costs, and farm size.

The marginal value products and marginal factor costs were compared individually in the current study. Rather than test coefficients individually a more refined comparison can be made between marginal value products and marginal factor costs by considering a joint hypothesis test.[13] The joint hypothesis test considers a simultaneous

comparison between several marginal value products and marginal factor costs.

Concluding Comments

Many rural people do not benefit from commodity price supports. According to Ruttan[14] agricultural policies in affluent societies have been too commodity-oriented. He states that it is no longer possible to have an impact on rural poverty by implementing programs designed to increase agricultural production or to increase nonfarm employment in rural areas. A prosperous agriculture no longer implies a prosperous rural community. Rural and urban poverty problems are more or less the same in their psychological, sociological, and economic dimensions. Health, education, and welfare programs have greater impact on rural poverty than price support programs.

While the west of Ireland may not be regarded as an affluent society, Ruttan's statements may be very relevant. The proposals to increase agricultural production and off-farm employment in the west of Ireland will be effective in achieving overall regional growth. However, poverty problems will remain demanding a new policy orientation.

Investment in education and research can help to reduce the degree of future land, labor, and capital misallocation within the agricultural sector. The degree of

uncertainty in farmers' minds must be reduced to lessen mistakes in decision making. Prediction of agricultural prices in Ireland will be very difficult, especially in the first decade of E.E.C. membership. Agricultural prices have already risen in anticipation of higher prices in the E.E.C. There will be a tendency to over invest and miscalculate future income streams in agriculture. Young farmers will become trapped in agriculture and the low farm income problem will be perpetuated unless adequate educational and industrial training programs are initiated.

Education will be a very important factor in determining the success of individual and group farm development programs. In the west of Ireland the degree of investment in human capital[15] will largely determine the success of programs required to implement a sustained development movement.

Individual farm development programs and group farm development programs require "grass roots" participation which helps to instill a sense of community into the people concerned. When a community or group of people realize that they themselves can help to alter their own social and economic well being then a major step in the developmental process has occurred.

NOTES--CHAPTER VI

[1]Scully, Agriculture, Chapter 4.

[2]Ibid., p. 38.

[3]Ibid., p. 67.

[4]D. I. F. Lucey and D. R. Kaldor, Rural Industrialization (Dublin: Geoffrey Chapman, Ltd., 1969).

[5]Scully, Agriculture, p. 166.

[6]"European Community Information Service," European Community, No. 135 (New York: European Community Information Service, June, 1970), p. 7.

[7]Crotty, Irish Agricultural Production, Chapter IX and Scully, Agriculture, Chapter XV.

[8]Heady, Back and Peterson, Interdependence Between Farm Business and Farm Household, p. 384F.

[9]Keith Marsden, "Towards a Synthesis of Economic Growth and Social Justice," International Labor Review (November, 1969), 389F.

[10]Ibid., p. 410.

[11]Glenn L. Johnson, "The State of Agricultural Supply Analysis," Journal of Farm Economics, XLII, No. 2 (May, 1960), 435, 442.

[12]Glenn L. Johnson, "The Labor Utilization Problem in European and American Agriculture," Agricultural Economics Journal (English), XIV, No. 1 (June, 1960), 74-87.

[13]Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics (New York: John Wiley & Sons, Inc., 1970), pp. 248-57.

[14]Vernon Ruttan, "Agricultural Policy in an Affluent Society," Journal of Farm Economics, XLVIII, No. 5 (December, 1966), 1100F.

[15]T. W. Schultz, Investment in Human Capital (New York: The Free Press, 1971).

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APPENDIX

TABLE I. Simple Correlations Between Input Categories, Mayo I

	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_3	1	-.05	.43	.53	.13	.71	.80	-.43	.69	.15	.40
X_4		1	.16	-.07	-.11	-.12	.02	-.09	-.13	.43	-.15
X_5			1	.56	.21	.23	.22	.11	.51	.02	.49
X_6				1	.38	.48	.02	-.09	.80	-.07	.79
X_7					1	-.05	-.15	-.13	-.69	-.21	.72
X_8						1	.47	-.25	.60	.14	.37
X_9							1	-.46	.28	.26	-.05
X_{10}								1	-.29	-.17	-.10
X_{11}									1	-.05	.86
X_{12}										1	-.13
X_{13}											1

Note: X_3 = Variable nonlabor costs; X_4 = Unemployment benefit; X_5 = Labor units; X_6 = Sheep livestock investment; X_7 = Cattle livestock investment; X_8 = Dairy cow livestock investment; X_9 = Pig livestock investment; X_{10} = Age of decision maker; X_{11} = Total livestock investment; X_{12} = Number of dependent children; X_{13} = Farm size.

TABLE II. Simple Correlations Between Input Categories, Mayo II

	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_3	1	-.17	.21	.07	.58	.80	.75	-.52	.80	.27	.62
X_4		1	.04	-.08	-.08	-.27	-.06	-.19	-.19	.09	-.17
X_5			1	.09	.32	.20	.14	-.02	.37	-.13	.34
X_6				1	.35	.00	.04	.02	.31	-.03	.48
X_7					1	.37	.26	-.44	.87	.03	.80
X_8						1	.51	-.53	.72	.10	.57
X_9							1	-.26	.48	.23	.26
X_{10}								1	-.57	-.18	-.46
X_{11}									1	.07	.88
X_{12}										1	.14
X_{13}											1

TABLE III. Simple Correlations Between Input Categories, Mayo III

	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_3	1	-.22	.15	.29	.68	.34	.56	-.18	.76	.01	.55
X_4		1	.04	-.13	-.13	-.18	-.18	-.38	-.19	.13	-.09
X_5			1	.07	.01	.27	-.09	.18	.11	-.31	.17
X_6				1	.45	-.14	-.14	-.35	.72	-.09	.87
X_7					1	-.12	-.06	-.17	.90	-.07	.76
X_8						1	.30	.13	.10	-.11	-.09
X_9							1	-.08	.05	.30	-.12
X_{10}								1	-.27	-.28	-.29
X_{11}									1	-.08	.90
X_{12}										1	-.07
X_{13}											1