THE UNIVERSITY OF MANITOBA

AN ECONOMETRIC ANALYSIS OF CANADIAN FLAXSEED EXPORTS AND PRICES

by

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ABSTRACT

In developing this thesis, it was pointed out that a major characteristic of the agricultural industry in Canada is the wide fluctuation in prices of farm commodities and the variability of farm cash income from year to year. The thesis considers flaxseed, an important oilseed crop in Western Canada, which contributes to the level and variability of farm cash income. The price of flaxseed and the quantity of flaxseed sold in the foreign export market are important factors contributing toward uncertainty in the flaxseed industry.

The general objectives of the study were to determine the major factors which influence the exports and prices of Canadian flaxseed by developing and estimating suitable econometric models. The level of annual, quarterly, and monthly flaxseed prices basis the Lakehead were considered in the analysis. These models could be used for forecasting purposes, thereby reducing uncertainty within the flaxseed industry.

The empirical analysis used time-series data and the regression technique in estimating the export and price relations for flaxseed. The study analyzed the market during a period of time in which patterns of production and trade were relatively stable. The market-generated data for the period 1955 - 1971 were used in the analysis and were considered to be representative of a market in which no significant technical or economic changes had occurred. The single-equation regression method was useful since predictions can be obtained for the dependent variable by specifying the value of the independent variables.

The estimated export relation indicated that the level of Canadian flaxseed exports is influenced by both Canadian flaxseed supplies and the price level. The level of annual exports of flaxseed is inversely related to the annual price. In addition, the level of exports is positively related to available flaxseed supplies. However, due to the limits of interchangeability, an increase in Canadian flaxseed supplies is accompanied by a smaller proportionate increase in exports as flaxseed supplies become larger.

The annual price relation indicated that, historically, Canadian flaxseed prices have been influenced by the total supply of flaxseed available in three principal exporting countries, namely, Canada, Argentina, and the United States. The trend variable in the relation indicated that flaxseed prices have been declining over time. This may be due to the increased interchangeability among oils and the introduction of synthetic materials which may have caused a reduction in the specific demand for flaxseed with a resulting downward trend in prices.

The quarterly and monthly price relations indicated that information regarding flaxseed supplies, which are available or which are expected to become available in the future, have an impact upon the flaxseed price at certain times of the year. The econometric models specified known or projected supply and price levels as independent variables in order to determine whether quarterly and monthly flaxseed prices vary in a systematic manner. Although the econometric models cannot quantitatively express the varied and complex factors which influence the short-term prices of flaxseed in the futures market, it does indicate that price variations have an economic basis.

Hence, it is hoped that the examination of the export and price relations discussed in the thesis has advanced the understanding of the price determination and export determination of flaxseed and similar commodities. The relative success of the empirical estimation indicated that the market operates in a systematic manner.

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CHAPTER I

INTRODUCTION

(A) THE PROBLEM

One of the most important characteristics of the agricultural industry in Canada as well as around the world is the wide fluctuation in the prices of farm commodities and the apparent variability of farm incomes from year to year. Certain sectors of the agricultural industry continue to experience wide fluctuations in farm cash income which is caused by variations in farm commodity prices and marketing opportunities. The coarse grains and oilseed industry in Canada is heavily dependent upon export markets as an outlet for the commodities produced within the country. Hence, it follows that farm cash receipts from flaxseed, which is an important oilseed crop in Canada, will experience large annual fluctuations since international market factors will influence the price and quantity of flaxseed sold by domestic exporters.

In the past, wide fluctuations in price, combined with wide variations in production, has contributed to the level and instability of farm incomes. However, during the past several decades, production on Canadian farms has increased while the year-to-year fluctuations in output have decreased. Undoubtedly, improved farming practices, the wider use of irrigation, increased mechanization, and the use of improved feed and variation of seed and types of livestock have led to a greater level and stability of farm output. A Canada Department of Agriculture study into farm cash income concluded that the improvements in farming practices, marketing methods, and the introduction of price support and stabilization measures has led to a reduction in the variability of farm cash income (44, p. 2). The various marketing boards, which have been established, have introduced price support and stabilization measures in order to prevent producer product prices declining to very low levels and to reduce the variability of farm cash income. However, price fluctuations of agricultural commodities continues to be an important factor in determining the level and variability of farm incomes.

In the market for oilseeds and other agricultural products that lend themselves to objective grading, a system of trading in futures contracts[1] has grown up along with the marketing system for the physical product. The primary aim of the commodity exchange is to provide and regulate a market place so that its members, and through them other trade interests, including the public, have facilities for trading in futures contracts for specific commodities. The exchange provides a focal centre or a market place where buyers and sellers may meet directly to conduct their transactions and at the same time contact the many other parties concerned in the movement and marketing of specific commodities.

The buying and selling activities of traders in the exchange determine the price in future or upcoming time periods. The futures price is the best estimate at that particular instance in time as to what the price will be at some specified future point in time. The time periods are specified calendar months. The relationship of cash and futures prices is based on the theory of the carrying charge. The basis

[1]Contracts calling for the delivery of specified kinds and amounts of the physical commodity at a specified time and place.

is the price of a cash commodity at the delivery point in relation to the nearby dominant future. Since there are costs in holding the cash commodity, there should be, on balance, an increase in price during the season equal to the cost of storage. Therefore, the relationship between cash and futures prices will change over time. The estimated futures price level of the commodity changes almost continually over time which is reflected in cash prices. Hence, the nature of the change in cash prices at any given time is due to basis change and price level change.

The Winnipeg Commodity Exchange is the sole organization which determines the market price of the agricultural crops of flaxseed, rapeseed, and rye in Canada. Consequently, the cash price of the commodity at any point in time during the crop year is directly determined by the trade in futures contracts. The street price of the commodity is equal to the cash price less the marketing costs. The producer receives the street price established for the commodity at the point in time when he makes the decision to sell the commodity. Since the futures price is allowed to fluctuate within a certain range each trading day as determined by the Board of Governors, the cash price and, hence, the street price will be directly affected. Since the futures price determines the street price of the commodity, a change in the estimate of the price at some future point in time will be reflected in the price the producer receives for the commodity. The market responds to relevant information made available during the crop year which guides it in providing an estimate of the price in the future. Since both qualitative and quantitative information of the present and possible future situation may change very rapidly, the price may vary a great deal within a relatively short period of time. The price the producer receives for the commodity will be directly influenced by the introduction of new information. A better understanding of the futures market with recurring price variations may contribute to a strategic method for marketing of commodities by producers in order to attain a higher average price.

The street price of flaxseed, rapeseed, and rye are determined by futures trading and, hence, a change in the estimated future price will be reflected almost immediately at the producer level. In the case of wheat, oats, and barley,[1] which are marketed by the Canadian Wheat Board, each producer in Canada receives a specific price for the commodity in each crop year. The actual price is determined by subtracting marketing costs from cash receipts for the crop year and dividing by the quantity of the product marketed during that crop year. Hence, the day-to-day price variations in Wheat Board-marketed commodities are not reflected at the producer level. However, in the case of flaxseed, rapeseed, and rye, the producer receives the street price of the commodity at the time of sale. Therefore, the producer's decision to sell flaxseed at a particular time during the crop year will determine the price received for the crop which may have a substantial impact upon the cash receipts realized from flaxseed and the contribution it makes toward the level of farm income.

Flaxseed was selected in this study because of the prominence flaxseed has attained in Western Canadian agriculture and because of the large price variations which appear to be a major characteristic of the industry. In addition, the lack of past research into the economic aspects of the flaxseed industry has stimulated interest in the topic.

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[1]On August 1, 1974, a new open marketing system similar to the system currently used in the marketing of flaxseed, rapeseed, and rye come into effect for feed grains sold on the domestic market. However, the Canadian Wheat Board still acts as the sole selling agency for export feed grains and for milling grains.

Table 1.1, which was derived from the Canada Yearbook series (Dominion Bureau of Statistics, 46) from 1926 through 1970, illustrates the increase in the contribution of flaxseed toward farm cash income in Canada. Flaxseed has remained a prominent crop even though other agricultural crops have been introduced into Canadian agriculture.

Table 1.1

Farm Cash Income from the Sale of Flaxseed Expressed in Five Year Averages for 1926-1970

Year	Farm Cash Income
	. . . . thousand dollars . . . .
1926-30	5,686
1931-35	1,001
1936-40	1,654
1941-45	18,434
1946-50	29,813
1951-55	25,871
1956-60	49,755
1961-65	48,126
1966-70	50,263

Flaxseed was chosen in the study rather than rapeseed or rye because of its historical significance in Canada and because of the relative importance of it as a crop in Canadian agriculture. Prior to 1968, annual flaxseed cash receipts were larger than those received from either rapeseed or rye. In recent years rapeseed, which is a relatively new crop in Canada, has become the major oilseed crop in Canadian agriculture. During the ten-year period from 1963 to 1972, total cash receipts from rye accounted for an annual average of 8.96 million dollars, or only 0.53 percent of total cash receipts from crops in Canada during this period. Meanwhile, flaxseed accounted for an annual average of 50.53 million dollars, or 3.11 percent of total cash receipts from crops in Canada during the same period. Flaxseed has continued to be a major oilseed crop in Canada, being second only to rapeseed in terms of total cash receipts from an oilseed crop.

Since certain producers may allocate a substantial portion of their acreage to a specific crop, the fluctuating price of a particular commodity such as flaxseed may have a greater impact upon individual producer incomes than upon the industry as a whole. Consequently, the thesis is concerned with the variables which influence the level and variability of flaxseed cash receipts, namely flaxseed prices at the producer level and the quantity of flaxseed sold during the crop year.

The level and variation of agricultural income has several injurious economic effects on farmers, and those effects extend to other sectors of the economy. The level and stability of incomes are directly related to the amount of utility or satisfaction attained. A greater income contributes to a higher level of utility or satisfaction. Unstable incomes have a psychological effect upon the level of satisfaction attained. Geoffrey Shepherd states that "income is subject to diminishing returns" (12, p. 18). Consequently, an additional increment to an individual's income would yield less satisfaction than the addition of the previous increment of the same amount. Hence, an unstable income would provide less satisfaction than a stable income at the same average level.

However, the economic and financial effects of instability are more devastating. Price uncertainty[1] has a considerable effect on pro-

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[1] Price uncertainty is a short term for describing a situation in which decisions must be based upon incomplete knowledge of future street prices for a commodity.

duction. When the prices of different farm commodities are difficult to predict, farmers cannot tell accurately what the market wants most, nor what returns to expect from the various crops by the time they reach the market. Therefore, farmers cannot formulate their production plans to accurately allocate their resources in such a manner so as to equate marginal costs and prices or equalize the marginal profit possibilities in alternative lines of production. In the case of flaxseed, the futures market provides the farmer with an estimate of what the prices will be at harvest time. The extent of the misallocation of resources will depend upon (1) the error of price expectation; (2) elasticities of the respective supply functions. If the errors are present and the supply functions are very elastic, significant misallocation will result because even small changes in expected prices will elicit important shifts in relative output. Therefore, in the short run, the major effect of price uncertainty is the influence of inaccurate expectations on the allocation of a given supply of resources.

In the long run, the ramifications of uncertainty affect the size, number, and structure of firms within the industry. It has an effect upon the availability of capital funds as well as upon the need to maintain liquidity. Although the futures market makes it possible to hedge flaxseed at a certain price, quota restrictions make it difficult to hedge the entire crop. Capital rationing makes it necessary that the firm protect itself by maintaining unused assets in a liquid form. It is generally recognized that the elimination or reduction of uncertainty promotes improved planning by individuals, lower costs, and greater security for credit.

The problem of fluctuating prices for agricultural products and its affect upon farm incomes has received a great deal of attention during the past sixty years. The larger price movements in farm products following World War I focused attention on the need for an investigation into the economic process of price determination. In 1922, Englebert Taylor stated that "the fundamental problem for agriculture concerns the relative decline in prices" (39, p. 194). Subsequently, research was initiated and expanded in the area of agricultural prices. However, as mechanization and other technological developments (e.g. chemicals, fertilizers, etc.) expanded in the agricultural industry, the relationship between the level of flexible agricultural product prices and less flexible cash farm production costs became a major factor influencing the level and variability of farm income. The problem has persisted and remained a focal point of governmental concern through time.

The fact that net farm incomes have been low in the past, both absolutely, in terms of returns to labor or investment, and relatively, when compared to managers and owners in other industries, is well documented. Geoffrey S. Shepherd recognized two aspects of the farm income problem (12, p. 21):

> Agriculture's price and income problems arise not only from the short-run instability of agricultural prices and incomes, but also from the long-run level of agricultural prices and incomes. Stabilization would reduce the short-run variations in agricultural income, but that would not necessarily result in an optimum long-run level of agricultural income, that is, the level would not necessarily be equal to the level of income from comparable ability in other businesses or occupations.

In 1955, the Royal Commission on Agriculture and Rural Life recognized the important economic aspects of agriculture as it relates to farmers. It arrived at the following conclusions (51, p. 3):

> Markets, marketing, and prices are the focal points of the farmer's economic attention. Farmers, like all businessmen, need reasonably stable prices and incomes to achieve a satis-

factory standard of living and to operate their enterprises efficiently.

In 1969, the Federal Task Force On Agriculture recognized that the basic farm problem of low and unstable incomes has persisted through time (50, p. 31). The report recognized "higher net farm income per capita" as a second-level goal and "stable net farm incomes" as a third-level economic goal of importance to agriculture. It stated that supply management has an important contribution to make toward the stabilization of farm incomes. In addition, the Task Force predicted that the trend toward better forecasting of markets and prices would continue to become an important part of the 1990 model of the Canadian agriculture system.

The level and stability of farm cash income can be influenced by an effective and efficient information system which informs producers of the latest market developments, and the effect of certain factors upon prices and marketing opportunities. Hence, it is important to fully understand the factors influencing the price of a commodity such as flaxseed as well as the market available for the commodity. Government policy may be designed with the objective of influencing the producer decisions in the most favorable direction. In this manner, producers may allocate their resources more efficiently, thereby achieving a more stable income at a higher level. Hence, market research plays a prominent role in the operation of an efficient modern agricultural system.

(B) SCOPE AND OBJECTIVES

Flaxseed has been a traditional oilseed crop in Canada during the past sixty years. Although it may have a minor position in Canadian agriculture, it continues to be an important cash crop to Western Canadian agriculture. Table 1.2 indicates the relative importance of flaxseed to Canadian producers in terms of farm cash receipts. It was derived from the Canada Yearbook series (Dominion Bureau of Statistics, 46) with statistics of more recent years provided by the Farm Cash Receipts publication (Statistics Canada, 52). Table 1.3 indicates the relative importance of flaxseed to Western Canadian agriculture. It was derived from the Farm Cash Receipts publication (Statistics Canada, 52) from 1952 through 1973. It is evident that flaxseed is more important to Western Canadian agriculture, particularly to crop producers, thereby having a greater impact upon regional agriculture.

It should also be noted that historically flaxseed has been an important source of farm cash receipts when total cash receipts from crops tended to be low. For instance, in 1970 total cash receipts from crops on the Prairies were at the lowest level since 1961. However, cash receipts from flaxseed in 1970 were approximately 59 million dollars, which was exceeded by only one other year in history. In that year, flaxseed accounted for 7.78 percent of total cash receipts from crops in the Prairie provinces. This was at a time when market opportunities for wheat and other coarse grains were highly unfavorable. Hence, it is evident that flaxseed has been an important cash crop to Prairie crop producers by providing an alternative to other crops which have been difficult to market.

The market for Canadian flaxseed may be divided into a domestic market and a foreign export market consisting of several countries. The foreign market is the dominant market with domestic requirements within

Table 1.2

Cash Receipts from Flaxseed in Canada

Year	Flaxseed receipts	Flaxseed receipts as percent of total receipts	Flaxseed receipts as percent of crop receipts
	. . thousand dollars . .	. . . . . percent	. . . . .
1952	26,456	.93	2.45
1953	18,886	.68	1.78
1954	19,691	.84	3.12
1955	41,034	1.75	2.27
1956	61,938	2.33	3.31
1957	58,238	2.26	4.34
1958	36,179	1.27	3.63
1959	49,671	1.77	4.85
1960	42,581	1.49	4.03
1961	49,770	1.69	4.48
1962	47,617	1.53	3.87
1963	36,367	1.14	2.75
1964	59,754	1.73	3.81
1965	47,120	1.24	2.89
1966	62,267	1.46	3.51
1967	46,235	1.06	2.50
1968	26,593	.61	1.53
1969	56,792	1.35	3.89
1970	59,427	1.41	4.24
1971	57,075	1.26	3.34
1972	53,687	1.01	2.61
1973	59,745	1.41	4.07

Table 1.3

Cash Receipts from Flaxseed in Prairie Provinces

Year	Flaxseed receipts	Flaxseed receipts as percent of total receipts	Flaxseed receipts as percent of crop receipts
	. . thousand dollars . .	. . . . . percent	. . . . .
1952	25,830	1.76	2.45
1953	18,573	1.28	1.81
1954	19,377	1.85	3.19
1955	40,240	4.17	7.64
1956	61,200	4.92	7.84
1957	57,805	4.92	8.72
1958	35,756	2.79	5.37
1959	49,273	3.86	7.09
1960	41,440	3.35	5.90
1961	48,711	3.60	6.51
1962	46,590	3.15	5.35
1963	35,384	2.39	3.83
1964	58,756	3.38	5.10
1965	45,428	2.40	3.85
1966	61,097	2.73	4.76
1967	45,190	2.11	3.44
1968	25,976	1.25	2.13
1969	56,678	3.21	5.97
1970	59,198	3.32	7.78
1971	57,014	2.72	5.13
1972	53,856	2.07	3.77
1973	59,198	3.32	7.19

Canada being relatively small and stable from year to year. Table 1.4 indicates the variation in the value of flaxseed exports to foreign markets. It was derived from the Trade of Canada - - Exports publication (Dominion Bureau of Statistics, 49) and the Canada Yearbook series (Statistics Canada, 46) for 1952 through 1971. Since the sharp increase in exports in 1955, the value of exports has never been below 30 million dollars while attaining a high of over 60 million dollars in 1966. The value of exports has been determined by two variables, namely price and quantity. Since flaxseed is marketed through futures trading, the export price at any point in time is not reflected in the farm price at the same instance in time after giving consideration to a given marketing cost per bushel. During this period, the average farm price also varied a great deal; however, it was below the export price by varying amounts. Therefore, both the price and quantity of flaxseed sold in the foreign export market are important factors contributing towards uncertainty in the flaxseed industry.

The general objectives of the study are to determine the major factors which influence the exports and prices of Canadian flaxseed by developing and estimating suitable econometric models. These models can be used for forecasting purposes, thereby reducing uncertainty within the flaxseed industry. The specific objectives are as follows:

1. To formulate and estimate a model which can be used to determine the level of annual Canadian flaxseed exports for the crop year.
2. To discuss the factors which influence flaxseed prices in the international market and to estimate a model which can be applied to the prediction of annual Canadian flaxseed prices.
3. The empirical analysis will provide quarterly and monthly models

Table 1.4

Exports of Flaxseed from Canada

Year	Quantity	Value	Average export price
	. thousand bushels .	. thousand dollars .	. dollars/bushel .
1952	4,050	16,038	3.96
1953	3,795	11,546	3.05
1954	4,442	13,717	3.09
1955	9,673	31,279	3.24
1956	12,252	43,624	3.56
1957	21,538	64,719	3.01
1958	14,278	45,046	3.16
1959	12,562	41,225	3.29
1960	14,507	47,283	3.26
1961	13,885	46,269	3.34
1962	11,514	41,920	3.64
1963	11,538	38,560	3.35
1964	14,845	48,662	3.28
1965	16,100	51,658	3.21
1966	20,198	60,816	3.01
1967	13,920	44,517	3.20
1968	10,959	38,014	3.47
1969	15,905	52,410	3.30
1970	19,454	55,757	2.87
1971	24,648	63,849	2.59

which hypothesize that the price within a specified period of the year can be determined by considering known or projected price and supply levels.

Information on the quantity of exports and the level of prices for the crop year reduces uncertainty within the industry and, consequently, it could be applied to the following situations:

1. Various groups concerned with the movement and storage of grain require information regarding the possible level of flaxseed exports for the crop year.
2. Farm management extension specialists require information regarding possible future prices in order to advise farmers on the most efficient allocation of resources. When recommendations are made to many farmers, advisors must be aware of the aggregate effects which may occur when all farmers act on their advice, thereby having an influence upon the forecasted price level.
3. Since the use of farm inputs will be influenced by product prices, farm input suppliers must relate possible future price levels to the quantities of inputs required by farmers, thereby serving the needs of farmers more efficiently.
4. The information may contribute to the suggestions given to farmers by the government concerning the appropriate level of flaxseed acreage during spring seeding.
5. Farmers may be advised about the probable annual price of flaxseed and, therefore, obtain guidance concerning the appropriate time to market flaxseed in order to achieve a higher level of net farm income.
6. In addition to the objective or empirical uses described, the information could contribute to agricultural policy formulation related to

the level and stability of farm income from flaxseed.

Therefore, it is evident that information on the quantity of exports and the level of prices for flaxseed would be useful to various sectors of the agricultural industry. Hence price and market research is essential for increased efficiency in the production and marketing of flaxseed in Canada.

(C) THE ANALYTICAL PROCEDURE

The empirical analysis will assume the form of the single-equation regression technique in estimating the export and price equations for flaxseed. Estimates will be made for:

1. The annual (crop year) exports of Canadian flaxseed.
2. The annual (crop year) cash price of Canadian flaxseed basis the Lakehead.
3. The quarterly and monthly cash price of Canadian flaxseed basis the Lakehead.

The estimated level of exports or prices will be compared with the actual value for that period. The empirical analysis will provide estimates of exports and prices for periods not included in the analysis by utilizing available information about the value of explanatory variables in the equation. Therefore, it will be possible to forecast the future level of exports and prices given specific information about the value of certain explanatory variables.

The analysis uses time-series data and the regression technique, therefore, certain limitations are imposed on the predictive value of the estimated relationships. It should be noted that the study analyzes the market during a period of time in which patterns of production and trade were relatively stable. The market-generated data for the period 1955-1971 were considered to be representative of a market in which no significant technical or economic changes had occurred. The single-equation regression method is useful since predictions can be obtained by merely varying the values of specific explanatory variables. Hence, it is possible to determine the value of the dependent variable given the actual or computed value of the independent variables.

(D) DESCRIPTIVE OUTLINE OF THE REMAINDER OF THE THESIS

In Chapter II, a descriptive analysis of the Canadian flaxseed industry in the world oilseed market is provided. The complexity of the world oilseed market is indicated. In addition, it describes the various aspects of the flaxseed industry and the position of the Canadian flaxseed market in the world market. Chapter III consists of a review of past research in agricultural price analysis and describes the contribution that it has made to the development of the field. In Chapter IV, a description of the models and their functional aspects are presented. Chapter V presents the statistical results obtained from the models formulated in the previous chapter. The final chapter, Chapter VI, provides a summary of the study and discusses the conclusions drawn from it.

CHAPTER II

A DESCRIPTIVE ANALYSIS OF THE CANADIAN FLAXSEED INDUSTRY IN THE WORLD OILSEED MARKET

(A) FLAXSEED AS AN OILSEED CROP

(1) INTRODUCTION

Flaxseed is an oilseed crop which is important as a source of vegetable oil and protein. The noun "fat" refers to material which is insoluble in water and has an oily or greasy feel and consistency, that can be separated from plant and animal tissue. The word oil is used to mean the same type of material as fat but it is completely liquid instead of partly solid. "It is sometimes referred to as fatty oil or fixed oil to distinguish it from such entirely different substances as mineral oil and essential oil" (2, p. 2). The fats make up one of the three classes of organic matter that are the main building materials of living organisms. Every living thing contains protein, carbohydrate, and fat in varying proportions. Although the exact function of fat in living plants is not known with certainty, its importance is evident from its presence in every cell and its concentration in the reproductive organs such as pollen grains and seeds. The vegetable fats are important to mankind as food since they are a concentrated food material, having more than twice the net heat value of the same weight of carbohydrates or proteins. However, nonfood uses have been important in the past for oil derived from flaxseed.

(2) THE CULTIVATION OF FLAXSEED

The Geraniales order which derives its name from the geranium family, is comprised of two families of which individual members have attained great practical importance as producers of oilseeds. The family Linaceae includes flax, from which linseed oil is obtained, and the family Euphorbiacea includes the tung tree and the castor plant. Only one species of plant belonging to the flax family has any commercial importance as a producer of oilseeds. This is Linum usitatissimum which produces the seed from which linseed oil and linseed meal are derived. The genus Linum has a number of other species but these are either wild plants of no utility or plants cultivated for their beauty in the flower garden. Although the seeds of five such species have been found to contain oils that resemble linseed oil in having a high degree of unsaturation, only the species L. usitatissimum is cultivated for its useful products.

The flax that is grown to produce fibre for the production of linen and the flax grown for its oilseed belong to the same species but are different varieties. The varieties cultivated for fibre have long stems with relatively few branches, while the varieties cultivated for oilseed have shorter straw and more branches producing a greater quantity of seed. Since the flax produced for fibre ordinarily is harvested when the seed is not mature, the seed harvested from this type of flax is principally that required for sowing and does not come into the oilseed markets in very large quantity.

The cultivation of seed flax, in the western hemisphere at least, is a highly mechanized operation, carried out with the same machinery used for the production of wheat and other small grains. The straw is not used for the production of linen fibre; however, some of it is used as the source of a high-grade paper-making fibre for the production of cigarette paper, while some is used in the manufacture of the strawboard in corrugated containers.

Flax is an annual crop which is grown in many parts of the world, chiefly in temperate regions. Flax is principally grown as an oilseed in such areas as Canada and the United States, Argentina and Uraguay, U.S.S.R., and the various countries of Europe. There has been a great deal of fluctuation in the quantities of flaxseed grown in various parts of the world. In the period prior to World War I, the United States domestic production was approximately equal to total domestic requirements while between World War I and World War II, more than half the flaxseed consumed in the United States was imported, chiefly from Argentina. However, since World War II, North America has been supplying almost all of its own requirements from domestic production while production has decreased in Argentina and exports have declined substantially due to the expansion of the domestic crushing industry. The fluctuation in flaxseed production was due to several reasons. The acreage planted to flax is sensitive to the price of linseed, relative to that of wheat and other crops which compete with it for the available acreage. In addition, flax is a crop which is sensitive to adverse weather conditions, susceptible to diseases and attack by insects, and is a poor competitor with weeds. Some of the hazards have been eliminated or reduced by the development of disease-resistant varieties, the use of cultural practices that help eliminate weeds, the use of chemicals, and other measures. During the past two decades, the average yield obtained has increased substantially, reflecting a permanent increase in yield due to improved varieties, cultural practices, etc. This has tended to stabilize the production of flaxseed in regions which generally are well suited for its production.

(3) LINSEED OIL --- A PRODUCT OF FLAXSEED

The flaxseed is contained on the plant in globular capsules, each containing as many as ten seeds. In most varieties, the capsules do not split open when ripe and, therefore, flax is a good crop for harvesting with a combine since it does not shatter easily and may be left standing longer than grain. The seeds are flat, elliptical ovoids, pointed at the lower ends. Beneath the smooth seed coat is a thin layer of endosperm, inside which the main volume of the seed is occupied by the two cotyledons containing oil.

The oil content of the whole seed depends upon several factors, including the variety of linseed grown, maturity of the seed, and the locality, soil, temperature, rainfall, and other conditions of climate and weather in which the seed is grown. The usual range is from 35 to 46 percent on a moisture-free basis (2, p. 534). The average oil content of the Canadian crop has been between 41 and 43 percent on a moisture-free basis (16, p. 26). Linseed oil is composed principally of unsaturated fatty acids. The glycerides of linseed oil consist mainly of the mixed glycerides of linolenic, oleic, linoleic, and saturated acids, with linolenic acid the principal and characteristic acid of the oil.

Linseed oil has several distinct characteristics which make it useful as a drying oil. Linseed oil is a low-melting oil, a little less viscous than most vegetable oils, with a high iodine value, reflecting the high degree of unsaturation of its fatty acid radicals. Due to the unsaturation, the oil reacts readily with oxygen when exposed to air in thin films, or when blown with air at elevated temperatures. It also polymerizes[1] when heated. The products obtained as a result of these reactions have desirable properties which make linseed oil highly useful in the manufacture of paints and related products. The practical availability of the oil makes it useful as a standard drying oil. The usefulness of the oil as a food is limited by its reactivity with oxygen which prevents the oil from keeping a good flavor long when exposed to air, especially if it has been refined and deodorized.

The principal use of linseed oil is for non-food uses. In North America, the principal uses of linseed oil are in the manufacture of paints and varnishes, linoleum and oilcloth and printing inks. Various other uses include the manufacture of core oils, linings and packings, synthetic resins, caulking, and soap. The relative stability in the usage of linseed oil in comparison with the rising population of Canada and the United States is due partly to the gradual increase in the use of other oils such as tung, oiticica, dehydrated castor, fish and especially soybean oil. Another factor is the increased usage of various synthetic materials as substitutes for drying oils and as ingredients of modified drying oil products such as the oil-modified alkyds.

In some parts of eastern Europe and neighboring countries, especially in the U.S.S.R., raw cold-pressed linseed oil is used as an edible oil to a considerable extent. However, it is not well suited for the manufacture of the refined, deodorized types of oils and shortenings commonly used in the United States. Studies conducted with the objective of developing methods for using linseed oil for the manufacture of food

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[1]Polymerization is the formation of bonds, not with carbon atoms but between chains, thereby inhibiting their relative movement.

products have not been very successful in the past (37, pp. 295-300). Therefore, it is generally recognized that competition between linseed oil and other edible oils available at normal times is limited.

(B) CHARACTERISTICS OF THE WORLD OILSEED MARKET

(1) INTERCHANGEABILITY OF PRODUCTS

One of the most important characteristics of a member of the oilseeds group of products is the number of different kinds with economic significance and the large extent of interchangeability in their intermediate and end uses. International trade makes available a wider array of oilseed products to many markets than are produced in any one country, thereby increasing the scope for and actual extent of interchangeability. The degree of interchangeability of products derived from an oilseed such as flaxseed will be dependent upon both technical and economic factors. From a technical point of view, a large number of individual oils is substitutable since the characteristics of the different kinds can be altered by processing. An important use of oil derived from oilseed crops is in miscellaneous industrial processes and products. It is difficult to generalize as to technical interchangeability because of differing requirements in each case. Nevertheless, there has been a trend toward greater interchangeability, including the replacement of some natural oils by synthetic products. This trend is typified by the use of certain traditional edible oils such as coconut oil for industrial purposes in some countries. In the future, the introduction of technological innovations in the oilseed industry may contribute to increased interchangeability in the use of oilseed products.

A traditional secondary use of most oilseeds but one of increasing importance recently is its value as a source of protein in oilcake and meal for livestock feeding. "The most important types of cakes or meal of vegetable origin are soybean, groundnut, cottonseed, palm kernal, copra, rapeseed, sunflowerseed and linseed but most oil-yielding seeds give a residue after oil-extraction which is of economic value" (19, p. 4). In addition, fish meal, meat meal, and tallow are important as ingredients for animal feedingstuff mixes. The digestable protein content of various oilcakes varies a great deal by kind. This is the main determinant of the pattern of oilcake/meal prices (19, p. 7). The interchangeability of the different kinds is limited by technical factors, particularly the composition of their essential amino acids and their fibre content. Oilcake or meal may be used as an ingredient of compound feeds which are fed to cattle, pigs, and poultry. Any kind of cake or meal can be fed, within limits, to mature milk and meat animals and thus all compete on this market. However, different ingredients are not completely interchangeable in rations for other animals which leads to the existence of partially separate markets.

The oil which is derived from agricultural crops such as flaxseed has certain physical and chemical characteristics which are unique to that particular vegetable oil and, therefore, influence its use. Vegetable oils are glycerides of fatty acids consisting essentially of triglycerides produced by the combination of one molecule of glycerol and three molecules of fatty acids. The physical properties of these oils is influenced by the proportions and nature of the different fatty acids they contain. The essential differences between fatty acids are dependent upon the number of carbon atoms forming the chain and on the nature and position of the bond between the carbon atoms. When all carbon atoms in the chain are bonded to two hydrogen atoms, the bond is said to be simple and the acid saturated. When two or more carbon atoms in the chain are bonded to only one or no hydrogen atoms, double or triple bonds exist and the acid is said to be unsaturated. One group of unsaturated fatty acids has more than two double bonds and/or triple bonds. The commonest acid in this group consists of linolenic acid, the main constituent of linseed oil. The most important characteristic is their capacity to polymerize and to form a resistant film upon drying. As indicated previously, the characteristics of linseed oil help to make it a valuable oil for various industrial purposes while limiting its use as an edible oil.

Hydrogenation is a process which alters the property of fats and oils. It is a process whereby it is possible to add certain amounts of hydrogen to a fatty substance by means of a catalyst when one or more of its component acids has one or more double bonds. Hydrogenation has made it possible to widen the natural interchangeability of oils by increasing the preservative qualities and resistence to degradation of semi-drying oils. "It also permits all unsaturated fatty substances to compete with naturally semi-solid oils and fats in the manufacture of margarine and edible fats or of saturated fatty acids for industrial purposes" (19, p. 61). Although desaturation or dehydrogenation is possible, it is not practical because of the high cost and technical difficulties involved. However, it could become practical in the future if these obstacles can be overcome, thereby increasing the possibility of interchange between saturated and unsaturated fatty acids. Hence, it would appear that as technological innovations develop, the trend toward greater interchangeability of all oils will continue into the future.

Various other technical aspects may influence the degree of interchangeability of an oil. These technical characteristics include the solidification point, the nature and specific properties of the fatty acids, viscosity at different temperatures, the possible presence of inedible substances which cannot be removed, and taste, smell, colour, etc. For instance, it would be possible to use linseed oil for edible purposes to a limited extent in such uses as salad oils. However, several considerations such as customary preference for locally available oils, consumer preference for certain organoleptic qualities (particularly smell) and, dietary considerations such as the presence of essential fatty acids, limit interchangeability among the different edible fluid oils. In addition, for certain industrial users there is little interchangeability since their demands are specific to their finished products and their requirements are technical. For instance, manufacturers of coating materials use all oils that are naturally drying or that may be made so, but linseed oil, tung oil, soybean oil and dehydrated castor oil do not give the finished product the same properties. Although various synthetic products have replaced linseed oil in many of its traditional uses, it remains an important industrial oil for which no substitutes are available for specific uses. Therefore, interchangeability is only significant in relation to the criterion of choice which may include a comparison of the technical properties of different oils, and the purposes for which they are to be used.

Interchangeability among various oils is affected by economic aspects in addition to any political or social conditions which may affect the manufacturer's choice. The manufacturer's technico-economic decision regarding substitutability is influenced by availabilities and the prices of the raw materials suitable for the purpose. However, his choice will influence the supply and demand relationship, and prices and price differentials, by modifying the market for each oil.

Due to interchangeability, any oil, which is in excess supply on its traditional or customary market for some reason, can compete on other markets traditionally supplied by other oils. A chain reaction may occur if the oil displaced is in excess supply on their own traditional markets. They may take advantage of interchangeability by turning to the market of the invading competitor or to other markets. As the distribution of oils for different uses changes, each oil enters into competition with others and it is faced with the risk of losing a market unless it sells at a lower price. Given this situation, the price effects of interchangeability should exert downward pressure on the price of all mutually substitutable oils, the pressure being greater the more numerous and larger are the user markets where substitution must deal with possible cheaper usable substances. If substitution is possible, there will be interdependence of the prices among all interchangeable oils and a reduction of the price differential between them. However, since not all oils are interchangeable, there will be various price differentials between different groups of oils.

The interdependence of prices becomes rather complex since the manufacturer must consider not only the technical suitability and the cost of each oil, but also the ratio of its cost to the possible selling price of any processed product. The economic constraint due to the cost/price relationship may be stronger or weaker in different situations. It is assumed to be weaker, the more importance the end user attaches to certain specific natural characteristics which cannot be reproduced artificially and for which he may be prepared to pay higher prices. Markets of this nature may be referred to as markets with specific demand. There is no interchangeability and the price of each product is determined independently of that of the others.

On the other hand, the economic constraint from the cost/price ratio should be strongest when end users are indifferent to the raw material used and consumers refuse to pay a high price for the processed product. Therefore, the prices of all interchangeable oils are interdependent. Markets of this nature may be referred to as markets with interchangeable demand. It is difficult to determine the effect of interchangeability upon prices since most oils (including linseed oil) are used on both types of markets at the same time. At any one moment price formulation for various oils is both mutually dependent and interdependent, according to their end uses. Therefore, it may be assumed that for each oil capable of several uses, the price level will depend upon the volume of specific and interchangeable demand, respectively. From this assumption, it follows that the price of any oil should be higher, the greater the aggregate volume of specific demand for it in relation to the volume of its supply, assuming all other factors are constant. Therefore, oils with no specific demand at all would be among the cheapest. In addition, the prices of oils with similar characteristics and the same uses (specific or interchangeable) will be strongly interdependent. The prices of oils with different characteristics, but suitable for the same use after processing, will be interdependent and the relative price level should reflect the differences in processing costs. The most important processing operation is hydrogeneration. Hence, the possibility of interchangeability will affect the prices of numerous oils as well as the relationship of the prices between different oils.

Thus, various degrees of interchangeability exist between different oils or groups of oils as determined by a subjective factor and an objective factor. The subjective factor is based on consumer habits, tastes and beliefs. The objective factor determines which oils are interchangeable on the basis of various technical and economic considerations. It is the processing industries which determine which of the objectively and subjectively interchangeable oils to use from among those available on the domestic and international markets. Drying oils traditionally have tended to have uses with less interchangeability and, consequently, the price interdependency between various drying oils such as linseed oil and other oils is less marked. However, as technological innovation in the processing of various oils developes, the interdependency of linseed oil with other oils may increase.

(2) COMPETITION

The second characteristic of the international oils market is the diversity of commercial competition and its various aspects. The countries of the world compete with each other for the markets for oil bearing crops. Therefore, domestically produced supplies of a particular crop must compete with imported supplies given that no import restrictions are imposed. Recently, the competition from supplies of by-products has become a prominent aspect of the competitive environment of oilseed crops. Annual crops receive competition from other annual crops as well as tree crops. The trend toward increased use of synthetic material has intensified the competition between natural oils and synthetics. These factors are important in determining the demand and supply of flaxseed in the international market, thereby having an impact on prices and export requirements.

Competition between supplies from all over the world exists on the international oilseed market. However, the pattern of production of various oilseeds is dictated by climatic and agrological conditions in certain parts of the world. Flaxseed is produced and exported by both developed and developing countries. However, during the past twenty years, competition from the developed countries increased substantially and successfully in the whole oils sector.

The domestically produced supplies of most countries must compete with imported supplies. Nearly all countries in the world produce some kind of oilseed. In a major deficit area such as Western Europe for instance, up to 45 percent of the total needs of fats and oil are met by supplies produced domestically (19, p. 9). These supplies are in competition with supplies offered on the world market by exporting countries. In order to provide a degree of protection for producers thereby encouraging domestic production, countries implement price support schemes, quotas, tariffs, taxes, etc. These measures will have an effect on the demand for imported oilseeds and their products and, hence, price and export levels of oilseeds produced in exporting countries. A structural change in international trade may have a substantial effect upon a particular commodity from a major exporting country.

Flaxseed is the source of linseed oil which is a principal oil in the drying oils group. It competes with tung oil which is also a vegetable oil in the drying oils group. However, tung is produced on tung trees which come into full production only after about seven years from the date of planting. Another sector of drying oils consists of marine oils which chiefly originate from pilchard and sardine. In addition, semi-drying oils and dehydrated castor oils compete with linseed oil in other non-food uses; however, since these oils do not confer the same properties on the finished product, the degree of competition between linseed oil and other oils is very small where specific demands exist.

Many oilseeds are the source of a by-product which is of economic value. Most oilseeds are of primary importance due to the oil which can be extracted; however, the residual remaining after the oil is removed may be of considerable importance in view of its high protein content. The meal derived from most oilseeds is considered a by-product; however, in certain cases such as soybeans usually about half the value is due to the cake meal component. The various cake meals derived from oilseeds also compete with fish meal on the basis of both technical and economic considerations. Linseed cake meal has been regarded as a secondary product of flaxseed with some economic value. It consists of approximately 40-45 percent protein (16, p. 26). Nevertheless, in a world of abundant protein supplies, it has been regarded of minor importance in the flaxseed market in terms of export promotion or price determination. However, as the world becomes more affluent and increases its demand for meat, it is conceivable that the agricultural sector will shift its attention toward valuable protein supplies at which time flaxseed may make a valuable contribution.

The various oil-bearing crops may originate either from tree or annual crops. The developed countries export almost the entire volume of annual crops where olive oil, a tree crop exported from both developed and developing countries, is an exception. On the other hand, developing countries export most of the tree crops which are unable to respond to changes in demand due to the long investment period before a return is realized and the fixed nature of the resource itself. For instance, the tung tree bears tung fruit in substantial quantity after six or seven years from the time of planting. In addition, even in situations where developing countries produce an annual crop (e.g., groundnuts), institutional and political influences may inhibit the expansion of production as demand changes.

Natural fats and oils have received increasing competition from synthetics. Synthetic products have been developed which have replaced many of the traditional uses of industrial oils. Synthetic detergents based on petroleum derivatives have replaced soap made from natural fats to a large extent. Linoleum has been replaced by asphalt, synthetic rubber, vinyl and vinyl asbestos tiles. Latex paints and alkyd resins are taking over the markets for interior finishes and traditional linseed oil paints are meeting serious competition in the formulation of exterior and machinery paints. Printing inks have been developed which dry faster to meet requirements of modern high speed presses. "The scope and severity of competition from synthetics is expected to increase" (19, p. 12). However, a major field that has defied the synthetic chemist is the production of the basic food materials consisting of carbohydrates, fats, and proteins. The volume production of the basic food requirement is a task which remains the basic function of agriculture. Hence, oilseeds which provide high quality protein meals such as meat, milk, eggs, and cheese, still are an important factor in the agricultural industry.

(3) THE PATTERN OF PRODUCTION AND TRADE

Tables 2.1 and 2.2 indicate that the pattern of flaxseed production and trade in the world has not changed a great deal during the past fourteen years. Table 2.1 was derived from the FAO Production Yearbook series (Food and Agricultural Organization, 54) for 1959 through 1972. Table 2.2 was derived from the FAO Trade Yearbook series (Food and Agricultural Organization, 55) for 1959 through 1972. The tables serve to illustrate the concentration of flaxseed production in the world with only certain countries, which are major producers of flaxseed, exporting a significant amount to other countries. Canada and the United States account for a large portion of flaxseed exports while Argentina is prominent in the linseed oil market. The principal markets which depend heavily upon imported flaxseed and its products are Western Europe and Japan.

The volume of trade in flaxseed and linseed oil has not changed a great deal in recent years. The shares of unprocessed and processed products have changed only moderately. However, the Argentine portion of linseed oil exports has declined somewhat in recent years.

(4) ORGANIZATION OF INTERNATIONAL TRADE

The present organization of trade in oilseeds and its products is characterized by its complexity. In the majority of countries there are various domestic market interventions by governments or Marketing Boards before the product reaches the point of export. A number of distinct trade flows often is maintained by preferential tariffs, protective or revenue duties, quotas or price provisions. Large trading and manufactur-

Table 2.1

Production of Flaxseed: Total and Major Countries

Year	Canada	U.S.A.	U.S.S.R.	Poland	India	Argentina	Uraguay	Total
			. . . . . thousand metric tons					
1959	450	772	395	38	438	825	50	3,100
1960	585	563	345*	56	395	562	67	3,200
1961	368	563	N.A.	61	456	818	96	3,057
1962	407	819	480	65	463	839	96	3,574
1963	536	788	420	61	430	771	84	3,472
1964	516	620	400	55	379	815	62	3,309
1965	741	899	449	77	503	570	71	3,674
1966	559	594	607	74	335	577	38	3,142
1967	238	509	519	73	260	385	40	2,365
1968	500	688	485	65	438	510	27	3,033
1969	700	892	344	57	329	640	56	3,395
1970	1,243	751	470	65	469	680	81	4,126
1971	569	462	540	75	474	316	42	2,889
1972	483	353	500	66	510	330	43	2,662

* Official Estimate

N.A. Not Available

Table 2.2

Trade of Flaxseed and Linseed Oil in Flaxseed Equivalence: Total and Major Countries

	Exports						Imports		
Year	Canada	U.S.A.	Argentina	Uraguay	Belgium, Luxembourg	Total	Europe	Japan	Total
				. . . . . thousand metric tons					
1959	322	223	523	45	14	1382	1208	90	1445
1960	377	176	716	74	19	1306	1181	77	1358
1961	377	140	676	79	36	1424	1153	105	1404
1962	298	106	753	45	24	1360	1126	84	1303
1963	304	107	623	92	29	1293	1076	100	1315
1964	394	199	580	28	36	1370	1127	96	1410
1965	437	151	676	48	41	1466	1090	103	1471
1966	530	186	342	45	41	1366	1125	117	1378
1967	365	164	597	37	44	1334	1024	112	1252
1968	306	259	223	20	43	1068	1037	103	1242
1969	415	218	416	59	41	1315	1085	128	1332
1970	531	111	436	91	39	1385	1094	142	1416
1971	657	69	518	54	37	1482	1250	112	1547
1972	640	265	294	17	42	1739	1416	115	1733

ing firms purchase a large portion of tropical oilseed products, thereby influencing the market strongly. These numerous and varied influences on the operation of market forces limit the interplay of supply and demand to a certain extent. They "have a definite bearing on the level of prices and the volume and pattern of trade in oilseeds, oils, and fats" (19, p. 24). Nevertheless, these interventions do not prevent the existence of an international market usually described as vigorously competitive by those engaged in it. These many forms of intervention may be regarded as a semi-permanent part of the framework of the market wherein buyers and sellers deal freely.

A feature common to most exporting countries is government intervention at some stage of the production and domestic marketing process. These interventions in certain instances may be limited to non-price measures, such as research and extension, subsidies to reduce the cost of fertilizer, or distribution of improved cultural practices to farmers. However, in many instances the price measures adopted are to ensure that producers receive a fair return through price stabilization schemes. For instance, in many African countries a regulatory body fixes minimum prices that producers must receive and imposes a levy on exports. The proceeds go into a fund which is used to undertake stabilization operations. Guaranteed prices and price support schemes are also present in a number of Latin American and Asian countries, such as Argentina, Brazil, and Ceylon. Price support measures also are operative in a number of developed exporting countries. The United States supports the prices of the major oilseed crops through the operation of the Commodity Credit Corporation, which stands ready to make loans to farmers at rates corresponding to the support price and accepts the commodity itself as collateral. Canada has a limited price support scheme for oilseeds including such crops as soybeans and sunflowerseed but excluding the more important export crops such as flaxseed and rapeseed.

Many governments use various kinds of export controls and arrangements for export sales. In many developing countries, governments have a direct control on the export of oilseeds and their products. In some countries, export trade is the absolute monopoly of governmental bodies which deal directly with importers, thereby strengthening their bargaining position and thus having a certain influence on the level of international prices. However, this influence may be limited because of the extensive degree of interchangeability of many oils and the existence of a large number of suppliers of any one kind. Export taxes are frequently heavy in developing countries which may influence the pattern of trade and have an indirect affect on the level of prices on international markets through their affect on supplies. In certain cases, export tariffs are used to encourage the export of processed products in preference to that of raw materials with the objective of encouraging industrialization and providing a domestic supply of oil. The United States has maintained a tariff on flaxseed with a larger tariff on imported linseed oil. These objectives may also be attained by a system of multiple exchange rates favoring processed materials, or by export quotas or the restriction of exports in the form of seed as is the case with Argentine linseed exports. A sufficient supply in relation to estimated requirements for domestic consumption may be provided by the use of quotas and controls, as in India. Therefore, government intervention is an important factor in determining the pattern of trade which occurs in the international market.

The various government measures in developed, importing countries have an influence on the pattern of trade and the level of international prices in oilseeds. The main aims of these interventions are to provide protection to domestic primary producers, to shelter domestic processing industries from outside competition, and to grant preferential treatment to certain countries. The protection of domestic primary producers is achieved through tariffs, quotas and price support schemes. Almost all importing countries provide a certain degree of protection for domestic processing industries through the levy of taxes and import duties. In Japan, imports of oilseeds and oils have been closely controlled by tariffs and quotas. The European Economic Community maintains an import duty on flaxseed and linseed oil. A significant aspect of the tariff structure was that the Commonwealth countries benefited from United Kingdom purchases which were exempt from import duty. Consequently, the entry of Great Britain into the European Economic Community on January 1, 1973, may have an influence on the pattern of trade in flaxseed and linseed oil. Therefore, it is obvious that the pattern of trade in an oilseed such as flaxseed is influenced by the policies of many countries around the world.

(C) THE CANADIAN FLAXSEED INDUSTRY

(1) INTRODUCTION

The Canadian flaxseed industry has been successful in providing the domestic market with a sufficient quantity of flaxseed while at the same time fulfilling the demands of export markets. Canada has been successful in meeting a substantial portion of the import requirements of various countries by exporting flaxseed in an unprocessed form. The following is a brief discussion of flaxseed production in Canada and the various aspects of the industry.

The central objective of this thesis is to empirically estimate the parameters of a model reflecting the price-determining forces in the Canadian flaxseed market. A further model also determines the factors which influence the level of exports, thereby determining the amount of carryover into the next crop year. Therefore, it is necessary to develop appropriate statistical models which account for the various interrelationships which characterize an international market.

As indicated previously, the international flaxseed market is influenced by the various vegetable oil and/or protein meal markets. Although the flaxseed market represents the major price-determining force, each of the other markets have partial influence.

(2) FLAXSEED PRODUCTION

Flaxseed is a traditional oilseed crop in Canada. Prior to the phenomenal growth of rapeseed production, it was the major oilseed crop in Canada. Before World War I, production of flaxseed was limited; however, the war caused a substantial increase in the demand for oils and, hence, flaxseed production began to increase. During the inter-war period, acreage declined but the Second World War stimulated a renewed interest in the crop as a source of oil. After the war, industrial uses for linseed oil increased and, consequently, the price of flaxseed increased. Since the mid 1950's, acreage has varied from year to year but production has been adequate to satisfy domestic consumption and export markets at the prevailing price level.

Table 2.3 summarizes the level of flaxseed acreage, yield, and production during the past 21 years. It was derived from the Grain Trade of Canada series (Dominion Bureau of Statistics, 48) and the Oilseeds Review (Statistics Canada, 53) from 1953 to 1974. The crop is principally grown in the three prairie provinces with Manitoba and Saskatchewan together producing well over 50 percent of the crop.

Flaxseed production in Western Canada has been encouraged by the availability of markets and a competitive rate of return from production. The producer receives the full payment for the amount delivered at the time of delivery if he wishes to accept payment. However, the volume of grain which can be marketed at any one time by a producer is determined by the grain delivery quota. The grain delivery quota is established by the Canadian Wheat Board to regulate the flow of grain. The quota allocates among producers equal delivery opportunities per assigned quota acre when the amount of country elevator space is limited. Generally, domestic and export sales of flaxseed allow a fairly continuous flow from the farm to the elevator system; however, in the past farmers have not delivered a great deal of flax during the summer months from April till September.

Most of the flaxseed is harvested during September while the remaining portion is usually harvested in October. The producer is allowed to make delivery to the grain elevator or domestic crusher at any time during the crop year[1] in accordance with his allocated delivery quota. The movement of flaxseed into export positions occurs entirely within the country elevator system with the principal export terminals

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[1]The Canadian crop year extends from August 1 until July 31 of the following year.

Table 2.3

Flaxseed -- Canada

Estimated Acreage, Yield, and Production

Crop Year	Acreage Seeded	Average Yield	Production
	. thousand .	. bushels/acre.	. thousand bushels .
1953-54	956	10.2	9,748
1954-55	1,178	9.3	10,998
1955-56	1,836	10.3	18,990
1956-57	3,040	11.5	34,991
1957-58	3,486	5.5	19,205
1958-59	2,551	8.8	22,342
1959-60	2,052	8.4	17,191
1960-61	2,508	9.0	22,571
1961-62	2,086	6.9	14,478
1962-63	1,446	11.1	16,042
1963-64	1,682	12.6	21,176
1964-65	1,977	10.3	20,305
1965-66	2,315	12.6	29,176
1966-67	1,918	11.5	22,020
1967-68	1,023	9.2	9,378
1968-69	1,524	12.9	19,666
1969-70	2,341	11.8	28,048
1970-71	3,368	14.5	47,966
1971-72	1,762	12.7	22,387
1972-73	1,321	13.3	17,617
1973-74	1,450	13.4	19,400

Intentions to plant as of March 15, 1974 indicated farmers intend to plant 1.61 million acres of flaxseed in 1974.

at Thunder Bay and Vancouver. Virtually all the flaxseed exported is in a raw, unprocessed form. The export market is the major market while domestic consumption remains fairly constant. Table 2.4 indicates the principal export markets for Canadian flaxseed during the past 20 years. It was derived from the Grain Trade of Canada series (Dominion Bureau of Statistics, 48) with statistics of more recent years provided by the Oilseeds Review (Statistics Canada, 53).

(3) AN INDUSTRY FLOW CHART

The industry flow chart is a convenient method of indicating the major economic relationships which influence an economic system. The flow chart is derived from the postulates of economic theory and a knowledge of the industry. The flow chart is a simple way to represent all the factors which are interrelated in the industry and has an advantage over an econometric model since it is usually not possible to quantitatively specify every variable in the relationship. The inability to specify behavioral relationships, data availability, aggregation problems, and various statistical problems all are factors restricting detail in the econometric model. For these reasons a model is usually a simplified representation of an industry flow chart, but nevertheless the flow chart provides a systematic method of examining the basic theoretical roots of the problem. The major statistical relationships are derived from the flow chart.

A flow chart represents a complete model in the sense that most of the forces influencing supply, demand, and price are represented. As Foote points out, a flow chart is useful in several ways: (1) to help the investigator think through basic factors and relationships involved; (2) to aid in the preparation of a logical writeup of the economic struc-

Table 2.4

Exports of Canadian Flaxseed: Total and Major Markets

Crop Year	Japan	Britain	Netherlands	Germany, Federal Republic	Belgium, Luxembourg	Total
		. . . . . '000 bushels				
1953-54	1,168	582	98	-[a]	1,835	5,172
1954-55	1,520	1,069	871	74	1,058	6,345
1955-56	1,449	4,328	2,350	289	1,248	11,583
1956-57	2,780	6,737	3,964	1,543	1,883	21,582
1957-58	2,579	4,317	2,348	557	1,359	13,650
1958-59	2,517	6,949	1,094	834	594	14,276
1959-60	2,682	5,293	1,518	708	619	12,494
1960-61	4,039	7,302	200	404	97	13,603
1961-62	3,120	4,643	1,418	277	694	11,988
1962-63	3,785	5,061	956	839	408	12,566
1963-64	3,830	4,545	1,476	865	334	13,638
1964-65	4,051	4,776	2,039	903	462	14,346
1965-66	4,308	5,119	3,732	2,033	923	18,936
1966-67	4,745	3,546	4,106	1,546	171	16,568
1967-68	3,801	2,605	2,229	851	138	12,611
1968-69	4,852	2,127	2,102	1,349	444	13,421
1969-70	5,684	2,931	4,102	931	1,130	18,611
1970-71	4,338	1,876	6,772	3,153	686	21,194
1971-72	4,541	1,918	11,186	3,736	920	25,741
1972-73	4,283	874	5,766	4,115	617	19,640

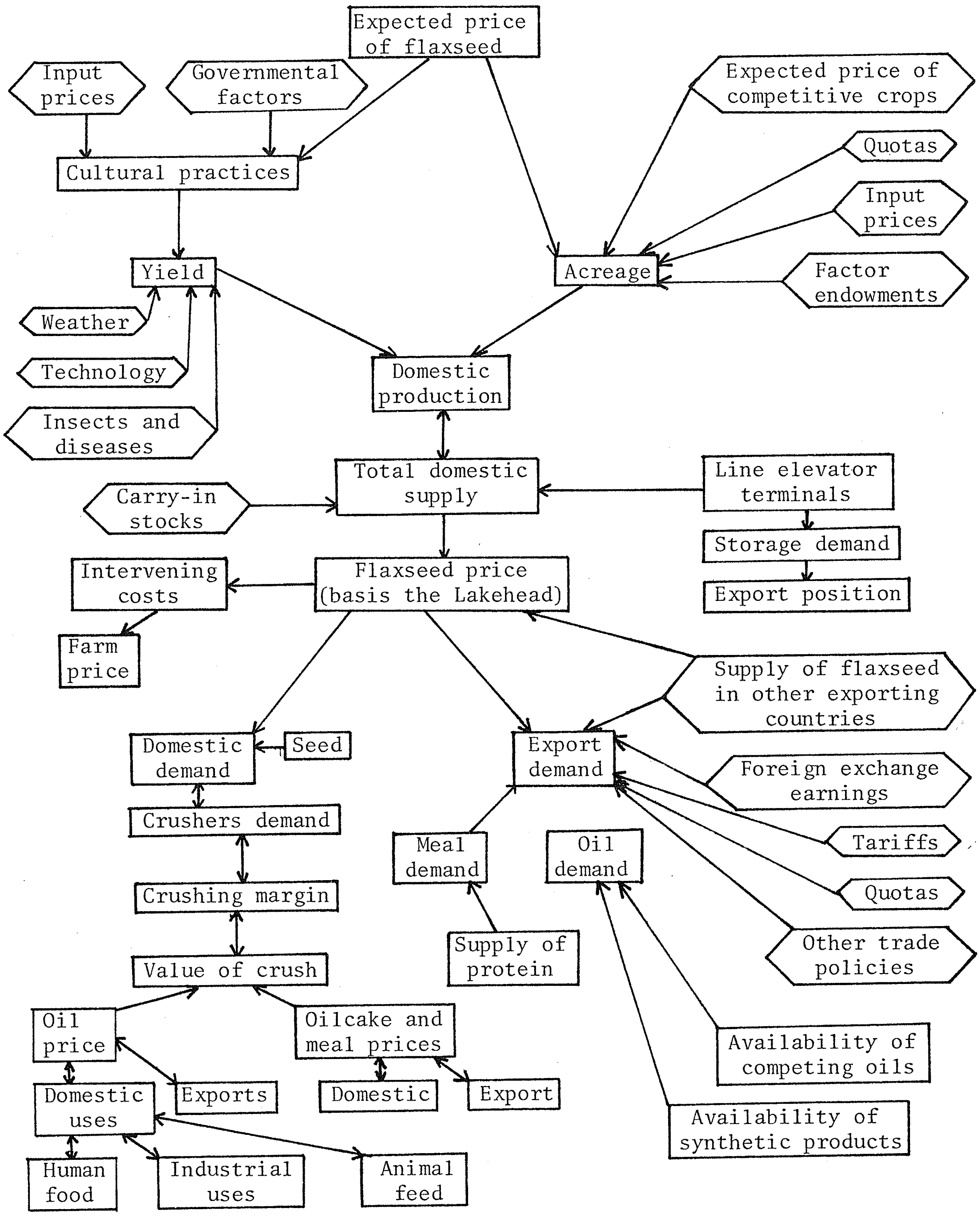
[a]This indicates an amount smaller than 1,000 bushels.

ture of the industry; and (3) to assist the reader in following fairly complex relationships and discussions (3, p. 1).

The following flow chart of the Canadian flaxseed industry outlines the movement of flaxseed from the producer to the consumer and indicates the major relationships involved. In the diagram, the arrows indicate the hypothesized direction of influence, where two-directional arrows represent simultaneous relationships and single directional arrows represent a single causal relationship.

The flow chart is a diagramatic representation of the forces and relationships operating in the flaxseed market. It indicates that in addition to physical and technological factors various economic factors have a strong influence upon the flaxseed market. For instance, domestic production of flaxseed is determined by yield and acreage. Yield is influenced by physical and technological factors while acreage is influenced by economic factors. Total domestic supply consists of production and carry-in stocks. The flow chart also indicates that a distinction can be made between several markets represented in the diagram. Spatial differentiation exists between export and domestic markets. Markets for oil and meal can be distinguished on the basis of product form. It is apparent that many of the economic factors which are hypothesized to influence the Canadian flaxseed industry in the international market cannot be quantitatively specified. Hence, an econometric model is a simplification of the real world which attempts to explain relationships which can be quantitatively expressed. The econometric models in this study attempt to explain only the flaxseed price and export determining relationships.

Chapter II has discussed flaxseed as a member of a group of products known as oilseeds where both technical and economic considerations



Arrows indicate hypothesized direction of influence.
Single directional arrows represent single causal relationships.
Two-directional arrows represent simultaneous relationships.

Figure 2.1 A flow chart of the Canadian Flaxseed Industry in the International Market.

are important factors in the production, utilization, and marketing of flaxseed. Since the Canadian flaxseed industry is heavily dependent upon export markets, many international market factors will have an influence upon the market as is indicated in the industry flow chart. Chapter III now presents a review of past research in the field of price analysis as it has developed over a period of time.

CHAPTER III

A REVIEW OF PAST RESEARCH

Although a great deal of research in the field of price analysis has focused on agricultural commodities, no statistical price analysis of flaxseed has been published. This chapter provides a brief description of price research in agricultural commodities which has been associated with the development of price analysis. Several recent studies, which have been published on topics directly related to the objectives of this thesis, are briefly described.

The various factors affecting prices of commodities must have been observed and analyzed in an elementary way by practical businessmen ever since the first appearance of organized commerce. This line of development has caused the formation of economic research departments of many modern large-scale businesses. However, a second and more important line of development began a few centuries ago when outside observers (the early economists) became interested in the study of prices. The work of economists has been in part inductive or statistical and in part deductive or theoretical. However, the attention of the economist during the past fifty years has shifted toward statistical or quantitative studies of prices. In the broad sense of the term, price research includes all the work relating to the study of value but in the narrower sense it refers only to prices of commodities. The history of price research in the narrow sense indicates that it has developed rapidly during the past century as the development of other sciences has complimented it.

Some of the earliest English economists were empirical and quantitative in their methods. King, Davenport, and Petty were statistical economists living in the sixteenth century and referred to their work as "political arithmetic" (Davenant, 1). In 1696 Gregory King drew up the first demand curve on record which was a demand curve for wheat (Davenant, 1). Although his statistical methods may have been simple and informal, his economic observation was keen and the results he obtained were highly significant. From the seventeenth century until the early twentieth century, progress in statistical research was very slow, with qualitative analysis of value and prices developing more rapidly than quantitative analysis. The statistical work that was done during this period was mainly in the collection of historical data and in the study of major price movements over a considerable period of time.

Leon Walrus in 1873 extended the static law of demand for a single commodity from dependence on its own price to dependence on prices of all commodities and services. Here the problem became one of mutual determination. The position of the demand curve for a given commodity will depend on the values assigned to the prices of the various other commodities and services. The Walrasian System expressing the law of demand may be inverted and expressed as the law of price. That is, the price of any given commodity may be expressed as a function of the quantities of all commodities and services produced or consumed (Walsh, 41).

With the advent of the twentieth century, a new period of analytical price research began. After 1920, progress was particularly rapid with the two principal characteristics of the period being (1) the attention given to the refinement of statistical methods; and (2) the predominant interest in forecasting prices. However, as work in the field of price research has advanced, there has been a growing tendency to broaden both the methods and the objectives of the research so as to depend less on mechanical methods and more on statistical analysis, and to direct study more in the direction of an understanding of the whole price-making process.

In 1914, H. L. Moore (7) published his study of the elasticities of demand for corn, oats, potatoes, hay, and pig-iron. Moore's work is universally regarded as "the real foundation stone of American analytical price-research" (Cassels, 17, p. 9). In 1917 he published "Forecasting the Yield and Price of Cotton" (8), which contained the first statistical study of acreage response to price. He made a valuable contribution toward the development of price research by concerning himself more with methodology and theory than with practical results.

About the same time that Moore's early work was being done, other economists, who were more interested in the practical problems of agricultural prices, made an independent investigation on similar subjects. In 1915, H. C. Taylor's bulletin (29) on "The Marketing of Wisconsin Potatoes" contained some significant analysis on prices. In 1917, H. A. Wallace (15) began to study hog prices by referring to the relationship between past hog prices and corn prices. Later he devised a forecasting formula in which he made use of the corn-hog ratio. However, during the war period and immediately following it, prices were studied from a different perspective by various price-fixing authorities and other public agencies. In 1919, G. P. Scoville's publication (27) of the study of the demand for potatoes marked the beginning of a long series of bulletins and reports.

After 1920 research in prices of farm products was greatly expanded. Colleges in several different states, particularly Minnesota and Cornell, began doing important work in the field. In 1922 Holbrook Working (32) published his study of factors affecting the prices of Minnesota potatoes. F. V. Waugh (31) made a similar study at New Jersey which was published in 1923. These studies were followed in 1924 by research into the demand for melons in New York City by W. P. Hedden (21) and a study of the demand for beef by Henry Schultz (38, pp. 254-278) of the University of Chicago. At the same time research was begun in supply response.

As increased interest in this new field developed, a program of price research was started in the new Bureau of Agricultural Economics in the Department of Agriculture under the direction of Dr. O. C. Stine. The staff of workers which was assembled furnished much assistance to the states during the early period.

With the outlines of the statistical price research developed by 1925, the following years saw the refinement of technique, the collection of better basic data, and the application of the new methods of analysis to a larger number of commodities. The use of standard correlation techniques in the study of prices was stressed during the decade following 1925. In 1926, Holbrook Working stated that "correlation studies of prices may give two kinds of information: first, qualitative, what factors have been important in influencing prices in the past; and second, quantitative, precisely what has been the influence of these factors" (43, pp. 224-227).

A large number of studies relating to factors affecting prices were undertaken in the middle and late 1920's. The focal point for these studies was the Bureau of Agricultural Economics, which published many prominent bulletins, with the most notable being the bulletins of Killough (25) on oats, Haas and Ezekiel (20) on hogs, and R. B. Smith (28) on cotton. These studies were characterized by extremely comprehensive and detailed examination of the basic data and the probable factors affecting prices, together with the calculation of a considerable number of alternative multiple correlations of those factors. The high point of multiple correlation analysis, which was originally begun by H. L. Moore, probably was Ezekiel's "A Statistical Examination of Factors Related to Lamb Prices" (35), in which changes in lamb prices were explained by changes in seven independent variables.

Many studies were done at State colleges and experiment stations. A significant study was "Interrelationships of Supply and Price", by G. F. Warren and F. A. Pearson (30). The focus of this study was the fitting of supply-price curves to data for some 20 agricultural commodities. In the field of theory and methodology, E. J. Working's "What Do 'Statistical Demand' Curves Show?" (42) indicated the conditions under which a demand curve, supply curve, or a regression line containing some elements of both would be obtained from time-series of prices and quantities.

During the early 1930's the keen interest in price analysis continued, with a great deal of emphasis being placed upon supply response research. John D. Black was influencial in the field of price analysis during this period. He had reservations about the results that could be obtained from correlation analysis and the large role ascribed to price forecasting. In 1938, Cassels and Malenbaum (33) demonstrated the weakness of correlation techniques for the determination of supply functions. In 1938, Ezekiel (36) in his "Cobweb Theorem" illustrated that a lag in the supply response, actual prices, and production may eventually converge toward the equilibrium point of the underlying demand and supply curves, move farther and farther away, or oscillate systematically about it, depending on the relative elasticities of the two curves. In the same year, Henry Schultz (10) published the "Theory and Measurement of Demand" which according to Tintner (40) was "the end and climax" of the line of analysis initiated by Henry L. Moore. He explicitly introduced time as a variable in the demand function. Finally, the appearance of F. L. Thompsen's "Agricultural Prices" (14) in 1936 and Shepherd's "Agricultural Price Analysis" (11) in 1941 verified the fact that the field had gained wide recognition as a separate discipline.

Although no sharp break exists between the prewar and postwar periods, the years from the middle 1920's to the late 1930's was a period of unusually intense interest in price research. Activity subsided just prior to World War II as the contemporary statistical techniques became rather fully exploited and their limitations became increasingly apparent. The war provided an additional retarding factor since most analysts were either in military service or engaged in some phase of the wartime food and agriculture program.

The postwar period was characterized by a marked renewal of interest and activity. It was stimulated by new insight into the application of statistical methods, the availability of more and better economic time-series of all sorts, and a general resurgence of quantitative analysis in economics. These developments have produced a number of powerful analytical tools, including the structural equation systems of the Cowles Commission, the interindustry matrix of Leontieff, and the closely related techniques of linear programming. Agricultural price analysis has participated in the general expansion and improvement of quantitative research.

Price research was extended to the empirical analysis of other agricultural commodities following the war; however, the published studies associated with oilseeds have focused on soybeans and its products. A study in 1951 by Jordon (24) recognized relationships between the price of soybeans and the price of soybean meal and oil. Separate analyses of soybean meal and oil prices were made. A simple function explaining the crushing and handling margin was used to predict the farm level price of soybeans from the combined value of the meal and oil components of a bushel of processed beans.

A study carried out by Houck (22) in 1963, involved the computation of empirical estimates of the parameters in a simultaneous-equation model of the United States soybean market. The model constructed by Houck was an eight-equation linear model, and the parameters were estimated by least squares and two-stage least squares. He expressed the farm level of demand for soybeans by linking the oil and meal demand with storage and export demand. The computed prices of meal and oil were combined to obtain estimates of the marketed year average return per bushel for processed soybeans. The calculated average return per bushel and the general level of the margin produced estimates of the farm level price of soybeans.

In the export equation, Houck assumed that the entire demand for United States soybeans for export was determined by the price of soybeans at the farm level and by factors such as world production and prices of competing fats, oils and oilseeds, foreign consumer incomes and trends in feeding practices.

However, in actuality, Houck's model only used the farm price of

United States soybeans and the supply of fats and oils in other countries in explaining export demand. Houck's model considered the farm price as a jointly determined variable and the supply of fats and oils in other countries as a predetermined variable.

The results of the estimated export demand for United States soybeans were not entirely what Houck had expected. The negative relationship between farm price and the quantity of soybeans exported was as expected; however, the results indicated that a competitive demand relationship did not exist between the quantity of soybeans exported and world supplies of oils and fats. He concluded that the positive relationship between the quantity of soybeans exported and world supply of oils and fats was the result of trends and other factors not accounted for in the model.

In a study conducted by Houck and Mann (23) the Japanese demand for United States soybeans was estimated by a single equation technique. In this analysis, the quantity of soybeans exported was assumed to be a function of national income in Japan and the average farm price of United States soybeans. An alternative form of the same equation replaced the national income variable with a measure of the livestock units in Japan. The results indicated that national income and the number of livestock units were positively related to the export of United States soybeans to Japan. The study was successful in providing general expressions of the price making forces within the market.

In a study carried out for the Rapeseed Association of Canada (Coral, Inc., 18) in 1968, the Japanese demand for Canadian rapeseed was investigated. This study assumed that the price of soybeans is a major determinant affecting the Japanese demand for Canadian rapeseed. The study also claimed that the degree of product differentiation between United States soybeans and Canadian rapeseed places Canadian rapeseed in a disadvantageous position. However, this study did not empirically assess the oilseed market in Japan.

Studies of numerous agricultural commodities within specific markets have been conducted by economists with the application of newly refined techniques of price analysis in order to fully understand the economic mechanism of price determination, and the various economic factors influencing supply and demand. The review of past research has made it apparent that the techniques of price research could be extended to other agricultural commodities which have not been empirically analyzed in the past.

CHAPTER IV

ECONOMETRIC MODELS FOR THE ANALYSIS OF CANADIAN FLAXSEED EXPORTS AND PRICES

(A) INTRODUCTION

The econometric models which are developed in this chapter are based on the descriptive analysis of the market and a knowledge of economic theory as it relates to Figure 2.1. The models presented in this study are based on a purely competitive type of market. Therefore, the models attempt to quantitatively express the influence of the basic supply and demand relationships on export and price levels. The models presented for export and prices of flaxseed consider various factors which can be quantitatively expressed.

The hypotheses, which constitute the basis for the models, concern the Canadian flaxseed export and price levels within a crop year. The central purpose of the thesis is the estimation of the parameters of these models which will permit prediction into future time periods. The models presented were developed with consideration given to statistical aspects of econometric analysis. In view of the difficulties involved in attempts at obtaining empirical estimates of the theoretical relations, the problems and limitations of econometric analysis should be considered.

(B) ECONOMIC AND STATISTICAL CONSIDERATIONS IN MODEL FORMULATION

(1) ECONOMIC CONSIDERATIONS

The economic model is formulated on the basis of all a priori information which is available. The structure indicates the process by which a set of economic variables is believed to be generated. "The term economic model is applied to the set of structures consistent with the assumptions developed by the investigator from economic theory and knowledge of existing factors that relate to a particular commodity area" (Foote, 3, p. 7). However, due to several limitations, it is not possible to express the relations postulated by economic theory in empirically estimated relations.

Some economic considerations should be outlined when a particular statistical procedure for fitting equations is used. The analyst may have very little interest in the true demand and supply curves but only wants a model that will assist him in studying the future level and variability of prices. Working states that "even though shifts of supply and demand curves are correlated, a curve which is fitted to the points of intersection will be useful for purposes of price forecasting, provided no new factors are introduced which did not affect the price during the period of study" (24, p. 221). Figure 4.1 illustrates a hypothetical situation where the curve D' D", which is fitted to the points of intersection of the supply and demand curves, indicates the relationship between price and quantity. In studying a commodity such as flaxseed, complex and varied factors can have an impact upon the study of certain relationships within the market. Therefore, a simplified model of the real world must be abstracted in order to isolate those factors which are of prime importance in determining the value of the variable under consideration. In using an econometric model for forecasting, the model can be represented by a dependent variable for which a prediction is desired and the other variables which are considered to be predetermined.

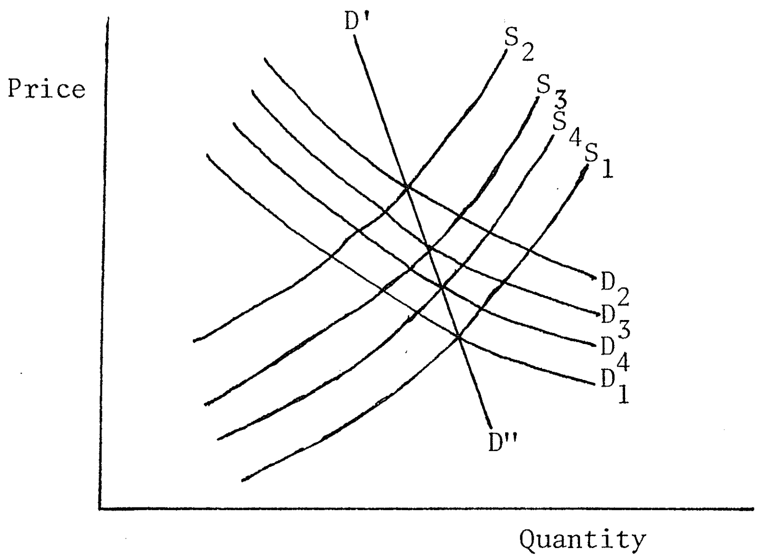


Figure 4.1 Shifts of Supply and Demand Curves.

The statistical model is developed by using the economic model as a guide. "In the present state of economic and statistical theory, a research worker typically finds it necessary to make additional assumptions for which economic and commodity considerations offer little if any guide" (Foote, 3, p. 7). The necessary data must be located or developed and the exact nature of the variables and relations must be decided. However, various difficulties in the formulation of the statistical model may be encountered.

The econometric models which are developed attempt to explain the variables which have been identified in the problem. "The econometric model is seen to be a highly flexible device. Rather than a substitute for judgement, it is a framework within which judgement must be exercised, providing a guide to the factors about which judgement is needed, and converting such judgement into a consistent economic outlook" (Suits, 13, p. 14). A complete model must contain one equation for each endogeneous variable. In general, complete models are required if we wish to derive from them equations to be used for analytical purposes or prediction.

(2) LIMITATIONS OF EMPIRICAL ANALYSIS

The availability of data is a major limitation in the empirical analysis of certain market factors. The empirical analysis must rely on time-series data generated by the market. Statistical information regarding all the variables specified in the theoretical relationship may not be available. In addition, the amount of statistical information for a time interval of less than one year may be severely limited. These difficulties must be resolved in the utilization of the available data by considering a common time period in which a large portion of the data is expressed. However, the data used must be over a sufficient period of time in order to allow valid estimates. Therefore, although the theoretical analysis may imply the model which should be specified, data limitations may result in the estimated relationship being not entirely representative of the market.

A severe limitation of short-term price forecasting is the lack of available data and the lack of complete compilation of data when the forecast is made. Therefore, it is frequently necessary to estimate the value of a variable used in a relation since it may not have come completely into existence by the time the forecast is made. An estimate based upon surveys may be a close approximation of the actual or final value of the variable.

Time can be introduced into the analysis to compensate for the fact that certain data are not available. "Time frequently is introduced as a variable into an analysis as a measure of sources of continuous systematic variation for which no data are available" (Foote, 3, p. 39). The use of the time variable must be related to the problem at hand by the use of economic theory.

Another major limitation in regression analyses using time-series data is the fact that it is based on the past. They are reflections of historical relationships and, therefore, they cannot predict in light of new variables and structures, not previously encountered but expected to come into existence in the future. "No satisfactory method is in sight for incorporating major changes in technology, institutions, and government policy into regression approaches" (Heady, 5, p. 3). The problem is one of projecting into the future and having weak links with data and coefficients in the past. Technological change, developments in market institutions, and structure, government programs, increased educational and informational services, and related phenomena limit the usefulness of coefficients based on time series data.

(3) VARIOUS PROBLEMS OF EMPIRICAL ANALYSIS

A problem which is encountered in the empirical analysis is the specification of the form of the relations. Although theory may indicate the variables in a relation which is representative of the market under consideration, it does not give an indication of the specific form which the relation should assume. Linear and logarithmic equations are the principal functional forms used in economic analysis. As Foote points out, from a statistical point of view, logarithmic equations are used when (1) relationships are believed to be more stable in percentage than in absolute terms; (2) unexplained residuals are believed to be more uniform over the range of the independent variable when expressed in percentage rather than in absolute terms; and (3) relationships between the variables are believed to be multiplicative rather than additive (3, p. 37). Careful consideration of the variables involved in the particular equation may give strong reasons for expecting relationships to be either additive or multiplicative. However, the model may have to be changed as the results of the original model are examined.

The application of ordinary least squares to a specified model is utilized to obtain estimates of the regression coefficients. Before proceeding with a detailed examination of the results, the signs of the regression coefficients are inspected to determine if they are consistent with expectations based on economic theory.

The application of ordinary least squares for estimating the regression coefficients or making probability statements about the dependent variable is related to several crucial assumptions. The simplest set of crucial assumptions is that: (1) the error term is a variable with zero expectation; (2) the error terms are uncorrelated and have the same variance; (3) the matrix of predetermined variables denotes a set of fixed numbers which are measurable; (4) the number of observations exceeds the number of parameters to be estimated and that no exact linear relation exist between any of the X variables (Johnston, 6, pp. 122-123). The violation of any of these assumptions may have a substantial impact upon the results attained by ordinary least squares.

One of the crucial assumptions of the linear model is that the error terms are uncorrelated. The zero covariance for the disturbance terms means that in time-series analysis, the disturbance terms are serially independent. There are three main consequences if the assumption is violated and autocorrelation of disturbance terms is present. First, the estimates of the coefficients of regression will be unbiased, but the sampling variances of these estimates may be unduly large compared with those attained by a different method of estimation. Second, if the usual least-squares formula is applied for the sampling variances of the regression coefficients, a serious underestimate of these variances will be attained. The precise forms of the t and F tests derived for the linear model are no longer valid. Third, inefficient predictions with needlessly large sampling variances will be obtained. Therefore, the presence of autocorrelation may require the re-specification of the statistical model.

Another problem in many analyses is multicollinearity which is present when the independent variables are not normally and independently distributed with one another. "They (economic statisticians) have given particular attention to the extreme case ("multicollinearity") in which two or more independent variables are so highly correlated that their separate effects upon the dependent variable cannot be distinguished" (Fox, 4, p. 257). The increasing levels of intercorrelation is reflected in increasing standard errors of net regression coefficients; therefore, a lower reliability for the individual regression coefficients is attained. In addition, the regression coefficients which have been calculated may be biased, thereby reducing the precision of the estimate. However, in the real world, a certain amount of multicollinearity is always present between variables; therefore, the degree of multicollinearity is the important consideration in determining if the model should be changed. Certain variables may have to be deleted from the model. The fact that only a few of the relevant variables can be introduced in time-series analysis due to multicollinearity is an important limitation of the regression approach.

Although these problems and limitations exist in regression analysis, reasonably valid estimates are still possible if they are based on relations which are adequately specified so as to reduce the effects of partial fulfillment of the assumptions. The degree to which the underlying assumptions are violated and the impact which it may have on the results is an important consideration in regression analysis. Nevertheless, it is necessary to fully recognize the limitations of the method and the underlying assumptions in the models which have been developed.

(C) THE MODELS

The first model in this section is formulated to determine the degree to which certain variables affect the amount of flaxseed which is exported from Canada during the Canadian crop year. The next model attempts to determine the influence of certain variables on the annual (crop year) price of Canadian flaxseed. Finally, the quarterly and monthly price models attempt to explain the variation in prices by considering the influence of certain variables.

(1) THE EXPORT MODEL

The export of Canadian flaxseed is hypothesized to be influenced by the price and supply of flaxseed in Canada. On the basis of economic theory, the export demand for flaxseed is hypothesized to be influenced by the price. A lower price should stimulate the use of flaxseed products in many countries by increasing the scope of interchangeability. In addition, stocks of flaxseed in other countries may be built up during periods of lower prices. Since a lower price is hypothesized to increase buying interest in flaxseed, a negative relationship is hypothesized between the amount of exports and the annual price.

Another variable which appears to influence the export demand for flaxseed is the Canadian supply. The total supply of Canadian flaxseed consists of carryover stocks at the start of the crop year on August 1 plus the production of flaxseed during the crop year. When a large supply of flaxseed exists in Canada, export sellers may become more active and promote the virtues of flaxseed to foreign customers. In addition, better credit terms may be provided to foreign buyers by selling interest. Therefore, the amount of exports is hypothesized to be positively associated with the supply of flaxseed in Canada.

Another variable which relates flaxseed supplies available for export to the volume of exports is specified in the export equation. Since it is assumed that exports do not increase in a given proportion with supplies, a variable is introduced to reflect the non-proportionate relationship between supplies of flaxseed and exports. The variable utilized is the square of the total supply of flaxseed in Canada. A negative relationship is hypothesized between this variable and exports since exports are assumed to increase at a decreasing rate as supplies increase.

In addition, two dummy variables are introduced into the export equation to reflect the changing relationship between exports and flaxseed supplies as total supplies become very large. Linseed oil, which traditionally has been the major product derived from flaxseed, has a limited degree of interchangeability. Consequently, foreign buyers will first purchase an amount of flaxseed which satisfies specific demands for the product. However, since large supplies of flaxseed are available in exporting countries, economic and political considerations may influence the increased use of linseed oil and meal in many countries. However, due to the limits of interchangeability, the quantity of flaxseed which can be used in foreign countries will be limited. Therefore, exports may not increase appreciably after a certain point when available supplies become very large. In the past, the quantity of annual flaxseed exports and domestic utilization did not exceed a level of 30 million bushels, hence, this value was used in the specification of the dummy variable in the relation. It is hypothesized that when supplies are greater than 30 million bushels, the relationship between exports and supplies will change and that the dummy variables will reflect this change in the relationship.

The export demand equation can be written as:

(4.1) $Q_{FE} = f\ (P_F, S_C, S_{CC}, D_1, D_2)$

where: Q_{FE} = quantity of Canadian flaxseed exports during the crop year (millions of bushels),

P_F = annual price of flaxseed basis the Lakehead (dollars per bushel),

S_C = total supply of Canadian flaxseed in millions of bushels (carryover and production),

S_{CC} = total supply of Canadian flaxseed in millions of bushels squared,

D_1 = first dummy variable, use 0 if S_C is less than 30 or use S_C if S_C is greater than 30, and

D_2 = second dummy variable, use 0 if S_C is less than 30 or use 1 if S_C is greater than 30.

(2) THE ANNUAL PRICE MODEL

The annual (crop year) price of Canadian flaxseed basis the Lakehead is considered as the dependent variable. Although the price is probably influenced by many other variables in the world oil and meal markets, a simplified model of the real world is hypothesized to express the major factors having an influence upon price. The total supply within a country is the total quantity of flaxseed produced in the crop year plus the amount of carryover available for export or domestic use at the start of the crop year. Since it is hypothesized that the current price does not influence the quantity of flaxseed supplied, supply is considered an exogenous variable. However, the amount of flaxseed in Canada during the crop year is hypothesized to have a major influence on the annual price of flaxseed. On the basis of economic theory, the price of flaxseed is hypothesized to be negatively associated with the supply of flaxseed. Therefore, an increase in the supply of flaxseed would cause a decline in the price.

Since Canada exports a large amount of flaxseed, it is hypothesized that Canadian flaxseed must compete with that supplied by other exporting countries. The total supply of other countries consists of the carryover stocks at the start of the marketing year in addition to domestic production during the marketing year. Therefore, since the United States exports a significant amount of flaxseed, it is hypothesized that the quantity of flaxseed in the United States will have an influence on

Canadian flaxseed prices. The total supply of American flaxseed consists of carryover stocks on July 1 plus total domestic flaxseed production during the marketing year. An increase in the quantity of American flaxseed supplies is hypothesized to have a negative influence on the price in Canada.

Argentina is an important country in the flaxseed market since it exports a large amount of flaxseed derived products to various importing countries. These products compete with Canadian flaxseed on the world market. Consequently, on the basis of economic theory, an inverse relationship is hypothesized between Canadian flaxseed prices and Argentine supplies. The total supply of Argentine flaxseed consists of carryover stocks on December 1 plus total domestic flaxseed production during that marketing year. As indicated previously, Canada, the United States, and Argentina are the major flaxseed and flaxseed-product exporting countries in the world.

In addition, a trend variable is included as a factor which represents the total effect of those variables for which no data are available but which are a source of continuous systematic variation.

The annual price model for Canadian flaxseed can be expressed in the following relationship:

(4.2) $$P_F = f\,(S_C, S_{US}, S_{ARG}, T_F)$$

where: P_F = annual price of Canadian flaxseed basis the Lakehead (dollars/bushel),

S_C = total supply of Canadian flaxseed (millions of bushels),

S_{US} = total supply of United States flaxseed (millions of bushels),

S_{ARG} = total supply of Argentine flaxseed (millions of bushels), and

T_F = a trend variable.

(3) THE QUARTERLY PRICE MODELS

The quarterly price relationships are introduced in an attempt to determine the influence of certain factors on the price of flaxseed during specific times of the year. The various factors which are operative in the flaxseed market may have a significant influence upon the price of flaxseed during a specific period of the year.

The demand for flaxseed is a function of the demand for flaxseed for export, processing, and commercial storage. Although the export market is the chief source of demand for Canadian flaxseed, processing and commercial storage demands have an influence on the variation in flaxseed demand during different periods of the marketing year. Carryover stocks are assumed to be influenced largely by predetermined variables such as the total supply of flaxseed and anticipation of the following year's supply. Therefore, the level of predetermined supply of flaxseed influences the level of storage demand. The level of stocks held by commercial firms was presumed to increase if anticipations indicated a smaller crop and decrease if a larger crop was foreseen. A similar anticipation variable was used in measuring the storage demand for wheat.[1] (Meinken, 26, p. 40). Therefore, the level of demand for flaxseed may increase during certain periods in the marketing year which is hypothe-

[1]The variable used was the Crop Reporting Board's annual estimation of the domestic winter wheat crop for the following year as made on December 1.

sized to have an influence upon the price level at that time.

First Quarter (January, February, March)

The price of flaxseed for the first three months of the calendar year is hypothesized to be influenced by the average price during the final quarter of the previous year. It is assumed that the demand for flaxseed is such that the prevailing price during the first quarter of the year will be less than that during the previous three months.

The supply of flaxseed in Canada as well as the supply in the United States may exert an influence on the price during this period. On the basis of economic theory, the supply variables should exert downward pressure on the price.

A variable which may be useful in explaining the price during this period is the annual price. The annual price model hypothesized that the annual flaxseed price is determined by supplies available in three major countries and a trend variable. Since flaxseed production was completed in Canada and the United States in the previous quarter while the major portion of the Argentine crop is harvested in February, the total supply of flaxseed in these three countries is know. Specific information about intended acreage for the coming crop year is not available at this time. Therefore, the price in the first quarter is hypothesized to be influenced by the average price prevailing for the crop year. The annual price for the crop year should be directly related to the price in the first quarter.

The average price in the preceeding month is hypothesized to influence the price during this period. It may indicate the trend that prices are likely to follow for the next three months.

Thus, the first quarter price equation can be written as:

(4.3) $P_{JFM} = f\ (P_{OND},\ S_C,\ P_F,\ P_{DEC},\ S_{US})$

where: P_{JFM} = average price of flaxseed during January, February, and March (dollars/bushel),

P_{OND} = average price of flaxseed in previous three months, October to December,

S_C = total supply of Canadian flaxseed,

P_F = annual price of Canadian flaxseed basis the Lakehead (crop year price),

P_{DEC} = price of flaxseed in the preceding month, December, and

S_{US} = total supply of flaxseed in the United States.

Second Quarter (April, May, June)

The price in the second quarter is hypothesized to be influenced by the price in the first quarter. There is no *a priori* condition for determining the direction of influence; however, seasonal price effects will be reflected in the model in this manner.

A variable which may be significant in explaining the price during this period is the annual price. Flaxseed is being seeded in Canada and the United States during this quarter; however, estimates of the actual acreage seeded are not available at this time. Therefore, the price during this quarter should be influenced by the supplies available in the three major exporting countries. The annual price is hypothesized to reflect the influence of predetermined supplies. A positive relationship is hypothesized between the annual price and the dependent variable.

Another variable which is considered is the average price in the preceding month. It may be used as an indication of the possible trend of prices in the following quarter and, hence, it may have a positive or negative relationship with prices in the second quarter.

The final variable is an estimate of flaxseed production in Canada based on average yields and the intended acreage. The acreage yield is calculated from the flaxseed yields obtained in the previous ten years. Prior to spring seeding, Statistics Canada, which is a branch of the government, selects a sample of farmers who are asked to indicate the acreage of each crop they intend to seed. Thereby, a statistical estimate of the intended acreage of a particular crop such as flaxseed is obtained for Canada. Historically, intended acreage has been a fairly reliable indicator of actual acreage seeded and, thus, does in some sense give a reasonable estimate of actual production. Therefore, on the basis of economic theory, the amount of intended production based on the average yield in the previous ten years and farmers' intended acreage is hypothesized to be negatively related to price.

The second quarter price relationship can be expressed as:

$$(4.4) \qquad P_{AMJ} = f\,(P_{JFM}, P_F, P_{MAR}, I_A)$$

where: P_{AMJ} = price of flaxseed in the second quarter,

P_{JFM} = price of flaxseed in the first quarter,

P_F = annual price of flaxseed in Canada,

P_{MAR} = average price of flaxseed in the preceding month, March, and

I_A = estimated production based on intended acreage of flaxseed.

Third Quarter (July, August, September)

As in the previous model, the estimated production of flaxseed in Canada based on the intended acreage and average yields is hypothesized to have an influence upon flaxseed prices during this period. A negative relationship is hypothesized between production based on intended acreage and the price.

The price during the third quarter is hypothesized to be related to the price in the previous quarter. Although the crop is being harvested in Canada and the United States during the latter part of this quarter, only a small amount may have been marketed during this period. Therefore, the price is hypothesized to be higher during this quarter than in the previous quarter, assuming all other factors constant.

During the latter part of this quarter, the seeded acreage is estimated and an indication of the prospective yield is provided. Therefore, it is possible to estimate the supply of flaxseed (production and carryover) in Canada during the new crop year. On the basis of economic theory, it is hypothesized that an increase in supplies in the new crop year will have a negative influence on price.

The third quarter price equation can be written as:

$$(4.5) \quad P_{JAS} = f\ (I_A,\ P_{AMJ},\ P_{JN},\ S_E)$$

where: P_{JAS} = price of flaxseed during the third quarter,

I_A = estimate of flaxseed production in Canada based on intended acreage,

P_{AMJ} = price of flaxseed during the second quarter,

P_{JN} = average price of flaxseed in the preceding month, June, and

S_E = estimated total supply of flaxseed in the new crop year.

Fourth Quarter (October, November, December)

The average price in the fourth quarter is hypothesized to be related to the price in the third quarter. The seasonality of prices is reflected by the inclusion of this variable into the relationship. Farmer marketing of flaxseed during this period may have a depressing effect upon prices. The quantity of flaxseed marketed during this period will depend upon the level of quotas and the amount of elevator space available. Generally, farmers prefer to fill the existing quota before winter snowfall makes delivery difficult. In addition, the level of storage demand is expected to be small since ample quantities of farmer marketings are expected in the months which follow.

Another variable which is hypothesized to have an impact upon prices is the Canadian supply of flaxseed. On the basis of economic theory, it is hypothesized that the quantity of flaxseed available has a negative effect on prices.

A variable which may be helpful in explaining the price in this quarter is the annual flaxseed price in Canada for the crop year. Since the production of flaxseed in Canada and the United States has been completed, the total available supply of flaxseed in North America is hypothesized to have an influence upon the price. Therefore, the annual price is hypothesized to be positively associated with price in this quarter.

Another variable utilized in the equation is the average price in the preceding month which in this case is September. It is used as an indication of the future trend in prices.

Finally, the total supply of flaxseed in the United States is hypothesized to have an influence on the price as farmers market the flaxseed which they harvested during the fall. This variable is hypothesized to have a negative influence on prices during this period.

The fourth quarter price equation can be formulated in the following relationship:

(4.6) $P_{OND} = f(P_{JAS}, S_C, P_F, P_{SR}, S_{US})$

where: P_{OND} = price of flaxseed in the fourth quarter,

P_{JAS} = price of flaxseed in the third quarter,

S_C = total supply of flaxseed in Canada,

P_F = annual price of flaxseed in Canada,

P_{SR} = average price of flaxseed in preceding month, September, and

S_{US} = total supply of flaxseed in the United States.

(4) THE MONTHLY PRICE MODELS

The monthly price models are developed in order to determine whether the seasonality of prices may be explained by relating the price to all a priori information in previous time periods. The relations represent an attempt to explain the seasonality of prices given certain available information during specific periods of the year. In many cases, there is no a priori condition for determining whether a positive or negative relationship exists between the dependent variable and the explanatory variable.

Each model specifies the price of flaxseed for the month as a function of specific independent variables. Although the name of the dependent variable changes from month to month, in each case the dependent variable is the average price of flaxseed basis the Lakehead for that particular month. The independent variables consist of previous or anticipated price and supply levels. The marketing year or crop year average price is taken into consideration in the formulation of the models. Hence, the inclusion of other independent variables in the relation accounts for the seasonal influence of various market factors during the year. Since certain factors are hypothesized to be influential in determining the price at specific periods of the year, certain relations will consist of the same set of independent or explanatory variables. Therefore, the name of the dependent variable will change from month to month while the names of some of the independent variables in the relation will change according to the specific month being estimated.

November to February

A general price model is specified for the four months from November to February inclusive. The average price of flaxseed for each month is specified as the dependent variable being considered. In each case, the independent variable for the relation includes the price in the preceding month, the total supply of flaxseed in Canada for the crop year, the estimated price of flaxseed, and the total supply of flaxseed in the United States for the crop year.

The average price of flaxseed in the preceding month is specified as an independent variable in the model. It may indicate the trend of prices during the year. The price of flaxseed during certain months of the marketing year may be consistently greater or smaller than the price in the preceding month, assuming all other factors constant. The level of demand for flaxseed may be greater during specific periods of the year and, therefore, the price of flaxseed is hypothesized to be higher during these months. However, since the change in the level of demand from month to month cannot be determined, it is not possible to hypothesize a positive or negative relationship between the price in the current month and the price in the preceding month.

The supply of flaxseed in Canada is hypothesized to have a negative influence on the price of flaxseed during these four months. The level of predetermined supply of flaxseed will influence the storage demand. The level of stocks demanded by commercial firms is presumed to increase if there is a smaller level of Canadian flaxseed supplied. Since Canada is a major flaxseed exporting country, a reduction in Canadian supplies is hypothesized to have an influence upon the world market, thereby contributing towards generally higher flaxseed prices. Consequently, both an increase in demand and/or a reduction in supply are hypothesized to have a positive effect on flaxseed prices.

The estimated price of flaxseed for the month based on the expected annual price is hypothesized to be directly related to the actual price of flaxseed in that month. The estimated price of flaxseed is calculated by determining the average price of flaxseed for the remaining months of the crop year given the average price for the crop year and the price prevailing during the previous months of the crop year. Therefore, the model indirectly takes into consideration the expected annual price of flaxseed. Hence, if the price during the early part of the crop year is somewhat below the expected annual price, the estimated price for the months to follow would be larger. A positive relationship is hypothesized between the estimated price for the month and the dependent variable..

The supply of flaxseed in the United States is hypothesized to have a negative influence on the price. Since the United States is a major flaxseed exporting country, a reduction of American flaxseed supplies should have an influence upon the world market. The export demand for the flaxseed supplies of other countries such as Canada is expected to increase and, consequently, an increase in flaxseed prices is hypothesized. Therefore, a reduction of predetermined American flaxseed supplies is hypothesized to be reflected in a higher price for Canadian flaxseed during these four months, assuming all other factors constant.

Thus, the price relation for the months of November, December, January, and February can be written as:

(4.7) $$P_M = f\,(P_{M-1}, S_C, P_E, S_{US})$$

where: P_M = average price of flaxseed basis the Lakehead for month M where M is November, December, January, or February,

P_{M-1} = average price of flaxseed in the preceding month,

S_C = total supply of flaxseed in Canada for the crop year,

P_E = estimated price of flaxseed in month M based on the expected annual price, and

S_{US} = total supply of flaxseed in the United States for the marketing year.

March

The price model specified for the month of March is a slight variation of the model specified for the preceding four months. The three independent variables specified in the model include the total supply of flaxseed in Canada, the price in the preceding month, and the estimated price of flaxseed based on the expected annual price.

The price in the month of March in hypothesized to be influenced by total Canadian flaxseed supplies for the crop year. The total supply of flaxseed in the United States for the crop year is not included in the relation. It is believed that the introduction of new supplies of flaxseed, which have been harvested in the southern hemisphere, will reduce the influence of American flaxseed supplies upon the market. Nevertheless, Canadian flaxseed supplies are hypothesized to influence the market since commercial and processing firms' demand for flaxseed will influence the market. The greater the amount of Canadian flaxseed supplies available, the smaller will be the storage demand for Canadian flaxseed for March. Consequently, a negative relationship is hypothesized between Canadian flaxseed supplies and the price in March.

In addition, the price in the preceding month and the estimated price of flaxseed based on the expected annual price are included in the relation as independent variables. The price in the preceding month is hypothesized to indicate the trend of prices during the year. The estimated price of flaxseed is based on the expected annual price; therefore, the model indirectly accounts for the introduction of new supplies of flaxseed upon the world market during this period of the year. It is assumed that the annual price model can be utilized to obtain a fairly reliable empirical estimate of the annual price of flaxseed for the marketing year.

Thus, the price relation for March can be written as:

$$(4.8) \quad P_M = f\,(P_{M-1}, S_C, P_E)$$

where: P_M = average price of flaxseed for month M where M is March,

P_{M-1} = average price of flaxseed in the preceding month,

S_C = total supply of flaxseed in Canada for the crop year, and

P_E = estimated price of flaxseed in month M based on the expected annual price.

April to June

A general price model is specified for the three months of April, May, and June. The dependent variables specified in the relation is the average price of flaxseed basis the Lakehead for the month under consideration. The independent variables in the relation include the estimated supply of flaxseed in Canada for the next crop year based on intended acreage, the price in the preceding month, and the estimated price of flaxseed for the month.

The model is similar to the price model specified for the month of March; however, the estimated supply of Canadian flaxseed for the coming crop year is specified as a variable in the relation instead of the predetermined level of flaxseed supplies for the same crop year. The estimated supply of flaxseed for the coming crop year is determined from estimated flaxseed production and carryover supplies. The production of flaxseed for the coming crop year is estimated by considering the intended acreage for the coming crop year and the average yield of flaxseed in the past five years. The carryover supply is determined by estimating the amount of flaxseed utilized in the domestic market and the amount of flaxseed exported to other countries. Since most of the flaxseed produced in Canada is exported, the amount of carryover into the next crop year will be largely determined by the level of flaxseed exports for the crop year. Therefore, an estimate of the annual exports of flaxseed can be used to determine the level of carryover supplies. The level of stocks held by commercial firms is presumed to increase if anticipations indicate a smaller crop and decrease if a larger crop is foreseen. Hence, a negative relationship is hypothesized between the price of flaxseed and the estimated supply in Canada for the coming crop year.

The price in the preceding month and the estimated price of flaxseed based on the annual price are included as independent variables in the model on the bases of the same rationale as in previous models.

Thus, the price relation for April, May, and June can be written as:

(4.9) $P_M = f\ (P_{M-1}, I_S, P_E)$

where: P_M = average price of flaxseed for month M where M is April, May, or June,

P_{M-1} = average price of flaxseed in the preceding month,

I_S = estimated supply of Canadian flaxseed in the new crop year beginning on August 1 based on intended acreage, and

P_E = estimated price of flaxseed in month M based on the expected annual price.

July to October

A general price model is specified for the four months from July to October inclusive. The average price of flaxseed basis the Lakehead for the month under consideration is specified as the dependent variable. The independent variables specified in the relation include the price of flaxseed in the preceding quarter, the price in the preceding month, and the average price of flaxseed for the marketing or crop year.

The average price of flaxseed in the preceding quarter is specified as an independent variable. The price of flaxseed during specific months of the marketing year may be consistently greater or smaller than the price in the preceding three months, assuming all other factors constant. However, it is not possible to hypothesize a positive or negative relationship between the price in the current month and the price in the previous three months.

The price of flaxseed in the preceding month also is specified as a variable to account for the trend of prices during the year. Therefore, it is hypothesized that the price level in the preceding month will be related to the price level in the current month.

The annual price of flaxseed is included as an independent variable in the relation. The seeding of flaxseed in Canada and the United States has been completed; therefore, the production of flaxseed can be estimated on the basis of average yields. The annual price is hypothesized to reflect the influence of available flaxseed supplies; therefore, the price of flaxseed during this period of the year is hypothesized to be directly related to the annual price, assuming all other factors constant.

Thus, the price relation for the months of July, August, September, and October can be written as:

$$(4.10) \quad P_M = f\,(P_{Q-1}, P_{M-1}, P_F)$$

where: P_M = average price of flaxseed basis the Lakehead for month M where M is July, August, September, or October,

P_{Q-1} = average price of flaxseed in the preceding quarter,

P_{M-1} = average price of flaxseed in the preceding month, and

P_F = annual (crop year) price of flaxseed in Canada.

(D) ESTIMATION OF THE MODEL

The statistical problem in the analysis involves the estimation of the unknown parameters in the stochastic equations of the export and price models. With the dependent variables represented by Y and the independent variables represented by X, a linear statistical model can be written stochastically[1] as follows:

$$(4.11) \quad Y_1 = a_1 + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n + U_1$$

A logarithmic equation can be expressed as follows:

$$(4.12) \quad \log Y_1 = a_1 + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_n \log X_n + U_1$$

The individual relations specified in this manner are the structural equations of this analysis and the coefficients of the X variables are the structural parameters. The parameters, the equations and the disturbances are known as the structure. It is possible for many structures to be associated with a particular model. Therefore, the problem of estimation is to develop the most acceptable structure based on the available sample data.

In this analysis, each stochastic equation was estimated by the single-equation least-squares procedure and the dependent variables are those shown on the left side of the equality signs in equations 4.1 through 4.10. The dependent variable is a function of the independent variables specified in the models. Each equation represents a complete model since the independent variables are considered to be predetermined

[1]A random variable is sometimes referred to as a stochastic variable. A random disturbance is assumed to exist and the U's merely reflect the random influence of all other unspecified variables on individual equations.

or exogenous for the particular analysis. "A complete model is one that contains one equation for each endogenous variable" (Foote, 3, p. 9). Hence, ordinary least squares can be applied to the equations in order to estimate the structural coefficients.

CHAPTER V

RESULTS OF THE STATISTICAL ESTIMATION

The results derived from the statistical models were generally satisfactory. The statistical fits which were obtained by ordinary least squares were acceptable and most of the signs on the structural coefficient were consistent with expectations based on the theoretical framework. However, the limitations of this approach became increasingly apparent when applied to the short-term price models.

In the presentation of the results, the statistics beneath each regression coefficient in parentheses represent the standard error of estimate. The Durbin-Watson statistic is a small sample test used to indicate the presence of serial correlation or autocorrelation among the calculated residuals. It is represented beneath each equation by the letter 'd'. An appropriate value for the Durbin-Watson statistic does not reject the hypothesis that disturbances are randomly distributed, while inconclusive values fall within the upper and lower bounds calculated by Durbin and Watson (34, pp. 409-428). The Durbin-Watson statistic will tend to be small for positively autocorrelated series, large for negatively autocorrelated series and somewhere in between for random series. Illustrative calculations by Durbin and Watson have shown that the value ranges around two for random series.

The multiple correlation coefficient, R^2, indicates the fraction or proportion of the total variation in the dependent variable that is explained by the regression. In general, as the R^2 value approaches 1.0, the explanation of the dependent variable by the set of independent variables is considered to be more complete. The standard error of the estimate is represented under each equation by the letter S. The t test is applied to the regression coefficients to test the significance of the independent or explanatory variables in the relation.

Equations 5.1 to 5.18 present the estimated coefficients and the statistical results obtained. The estimates are not completely reliable since it was not possible to account for all the trends and variables which have an impact on the market.

FLAXSEED EXPORTS

Relation 5.1 represents an ordinary least-squares estimate of annual Canadian flaxseed exports.[1]

$$(5.1) \quad Q_{FE} = 3.529 - \underset{(2.307)}{3.077^{***}} P_F + \underset{(0.442)}{1.545^{*}} S_C - \underset{(0.095)}{.0299^{*}} S_{CC} + \underset{(0.448)}{1.180^{**}} D_1 - \underset{(13.888)}{34.087^{**}} D_2 + U_1$$

$$d = 2.265 \qquad S = .758 \qquad R^2 = .964$$

The value of the multiple correlation coefficient indicates that the set of explanatory variables explains 96.4 percent of the variation in the dependent variable Q_{FE}. The Durbin-Watson test statistic indicates

[1]The estimated regression coefficients with an asterisk are statistically significant at the 1 percent level, those with a two-asterisk superscript are significant at the 5 percent level, and those with a three-asterisk superscript are significant at the 20 percent level.

The absence of an asterisk on the Durbin-Watson test statistic d, indicates no serial correlation at the 1 percent level of significance. The presence of an asterisk indicates that the test was inconclusive.

at a certain price is restricted. Therefore, exports do not increase as rapidly as supplies increase.

In figure 5.1, the estimated values of the dependent variable, annual exports of Canadian flaxseed, as computed from equation 5.1 by the ordinary least-squares technique, are compared with actual values for the period sampled. The estimated values of flaxseed exports were generally close to the actual values. The largest deviation between actual and estimated exports occurred during the 1965-66 crop year when estimated exports were 1.56 million bushels greater than actual exports. The standard error of the estimate was 0.758 million bushels.

The equation estimated was used to calculate exports during the 1971-72 and 1972-73 crop years. The estimate utilizes information for the independent variables which is available at a time when the value of the dependent variable, annual flaxseed exports, is not known. The new values of the independent variables for these crop years were used in calculating the dependent variable, exports of Canadian flaxseed. Actual exports during the 1971-72 crop year amounted to 25.741 million bushels. The calculations using the estimated model predicted approximately 27.056 million bushels of exports. Actual 1972-73 crop year exports were 19.640 million bushels compared with a predicted value based on the model of 12.420 million bushels. The predicted level of annual exports is based on the most recent estimate of Canadian supply for the crop year. It should be recognized that these estimates are subject to slight revisions after several years. Consequently, since the model is quite sensitive to Canadian supply, slight revision of Canadian flaxseed supply may cause some change in the predicted level of flaxseed exports for the 1972-73 crop year.

that there is no evidence of serial correlation. The signs on the regression coefficients conform with those which were hypothesized previously on the basis of economic theory. An increase in the volume of exports was expected to be associated with a decrease in flaxseed prices because of the competitive relationship between various oilseeds and related products. Although the flaxseed price variable was not significant at the 10 percent level of significance, it was significant at the 20 percent level. Economic theory provided a strong basis for its inclusion in the equation.

The volume of exports is believed to be influenced by price and sales promotion activities. Therefore, as flaxseed supplies become large, flaxseed is promoted by exporters. However, flaxseed exports do not increase in a constant proportion with increases in available supplies in Canada. As flaxseed supplies increase, the volume of exports will also be greater but by a smaller amount than the increase in supply. This situation is accounted for by the inclusion of supply squared as a variable in the export equation. As expected, the sign of the regression coefficient is negative. Therefore, as supplies increase, the volume of exports will also increase in relation to supplies available.

The last two variables in the equation are used as dummy variables. The t-values associated with the regression coefficients indicates that the dummy variables D_1 and D_2 are statistically significant at the five percent level of significance. The null hypothesis of the regression coefficients being equal to zero is rejected. When supplies are greater than 30 million bushels, the relationship between exports and supplies changes. The relationship between exports and supplies is related to the activity of export sellers in the market. However, due to the limitations of interchangeability of flaxseed products, the amount which is exported

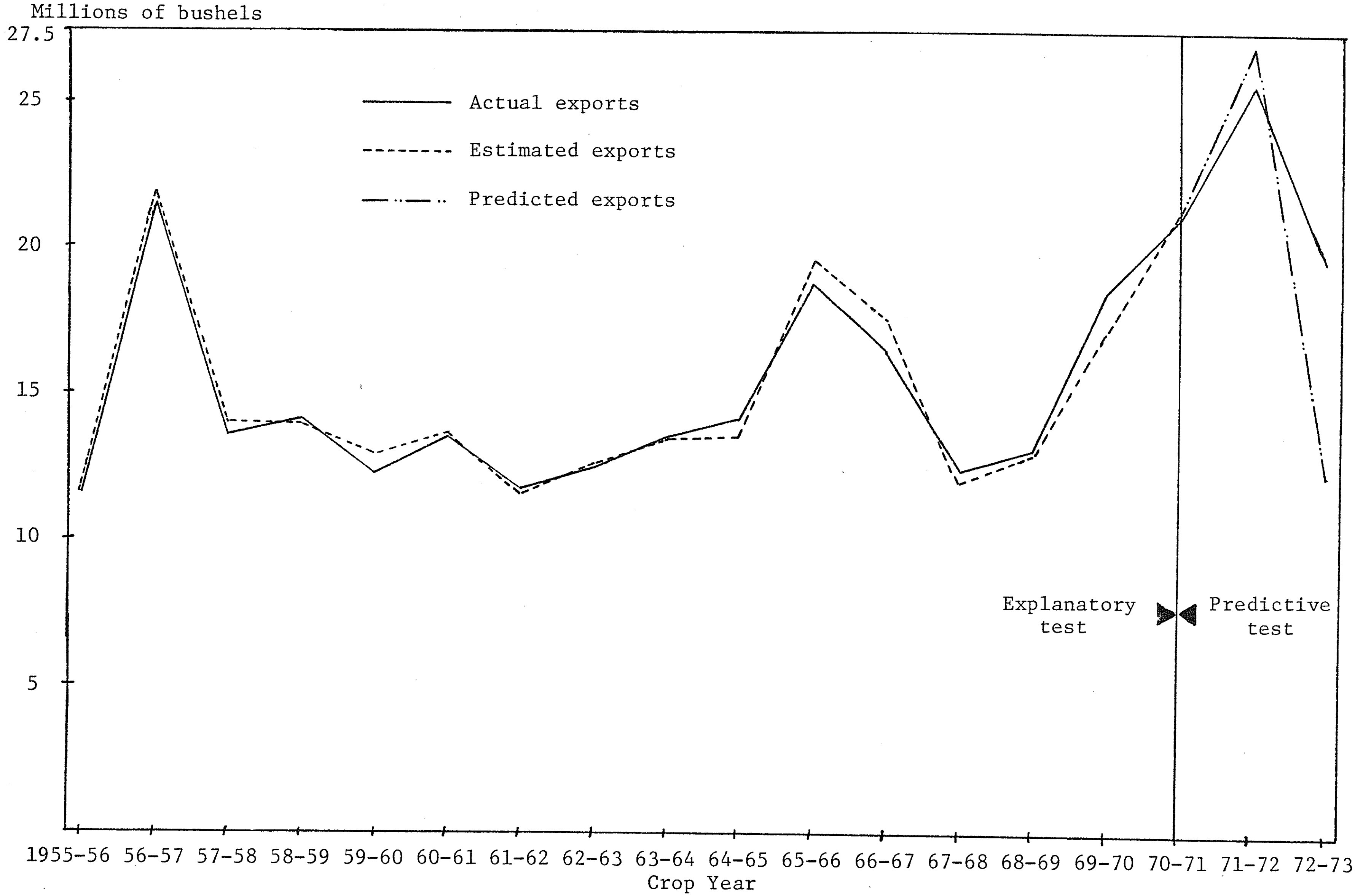


Figure 5.1 Comparison of actual and estimated exports of Canadian flaxseed computed from O.L.S. estimates of equation 5.1, 1955-56 to 1970-71 with predictive test for 1971-72 and 1972-73.

THE ANNUAL PRICE

The estimated relation 5.2 represents an ordinary least-squares estimate of the annual price of Canadian flaxseed during the Canadian crop year. A logarithmic equation is specified as indicated below:

$$(5.2) \quad \log P_F = 1.180 - \underset{(0.059)}{0.202^{*}} \log S_C - \underset{(0.029)}{0.051^{***}} \log S_{ARG}$$

$$- \underset{(0.079)}{0.181^{**}} \log S_{US} - \underset{(0.015)}{0.029^{**}} \log T_F + U_2$$

$$d = 2.05 \qquad S = 0.104 \qquad R^2 = 0.913$$

The multiple correlation coefficient associated with equation 5.2 indicates that 91.3 percent of the variation in the dependent variable is explained by the independent variables in the equation. In addition, the Durbin-Watson test statistic indicates that serial correlation is not present. The signs of the regression coefficients are consistent with those hypothesized from the theoretical approach.

The results of the analysis indicate that a one percent increase in Canadian flaxseed supplies will result in a 0.202 percent decrease in Canadian flaxseed prices. It indicates that the Canadian supplies have a definite negative impact upon prices; however, the relationship between domestic flaxseed supplies and price is elastic for average supply and price levels. The t test indicates that the regression coefficient is significant at the one percent level.

Since Canadian flaxseed exports must compete on the international market, supplies from other countries were hypothesized to have an impact upon flaxseed prices. As postulated on the basis of economic theory, a negative relationship exists between the Canadian price and supplies in major exporting countries. Although Argentine exports consist principally of linseed oil, the quantity of flaxseed in Argentina will have an impact upon Canadian prices. A one percent increase in Argentine supplies is associated with a 0.051 percent decline in Canadian prices. The negative sign of the regression coefficient associated with U.S. supplies of flaxseed indicates that Canadian supplies are competitive with U.S. supplies. A one percent increase in U.S. supplies will result in a 0.181 percent decrease in the Canadian price. Consequently, the Canadian price of flaxseed is strongly influenced by the amount of flaxseed supplied by the United States. The results substantiate the claim that American flaxseed is highly competitive with Canadian flaxseed since both are of similar quality.

The negative sign on the trend variable supports the evidence of a decline in flaxseed prices over the period 1955-1970. This variable reflects the omissions of other explanatory variables. Such variables could include the prices of other close competitors in the industrial oil market. In addition to the use of more synthetic material, the trend toward increased interchangeability among different oils may have had an impact upon flaxseed prices during this period.

Figure 5.2 represents the ordinary least-squares estimated value of flaxseed prices compared with the actual values from 1955 to 1970. Fluctuations in the market-generated observations appear to be fairly closely predicted by the estimated relation. The standard error of the estimate was 0.103 dollars.

The estimated relation was utilized in calculating the annual price during the 1971-72 and 1972-73 crop years. The actual price during the 1971-72 crop year was $2.57 per bushel. The calculation using the estimated model predicted a value of $2.65 per bushel. The actual price

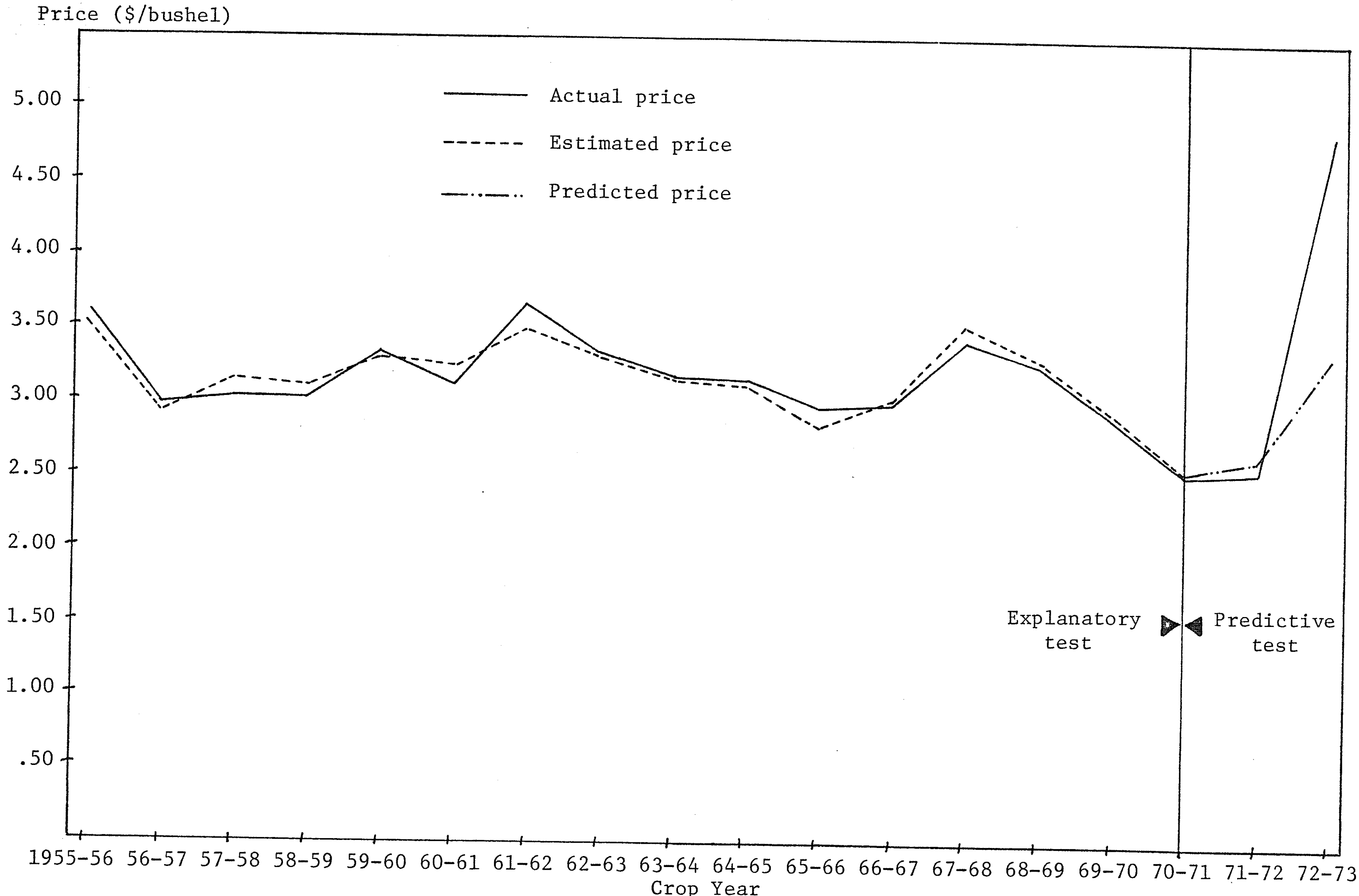


Figure 5.2 Comparison of actual and estimated annual price of flaxseed computed from O.L.S. estimates of equation 5.2, 1955-56 to 1970-71 with predictive test for 1971-72 and 1972-73.

in 1972-73 was \$4.82 per bushel compared with a predicted value based on the model of \$3.35 per bushel. The unusually high price in 1972-73 reflected the substantial increase in flaxseed prices during the latter half of the year. In addition, it should be noted that the values of the independent variables used in the calculation of the predicted price are subject to revisions which may have a slight effect upon the estimate.

THE QUARTERLY PRICE

The estimated relations 5.3 to 5.7 represent estimates of Canadian flaxseed prices during three month periods of the year. The quarterly price is related to variables of price and supply during the 1955-1971 period in an attempt to explain the seasonal variation in flaxseed prices. It is assumed that weather conditions which may be important in seasonal prices will be expressed by considering recent prices. Consideration is given to the price in the preceding quarter, the price in the preceding month, the estimated annual price, and supplies of flaxseed available or estimated.

First Quarter (January, February, March)

Equation 5.3 is an O.L.S. estimate of flaxseed prices in the first quarter of the calendar year.

$$(5.3) \quad P_{JFM} = -1.104 - \underset{(0.063)}{0.353^{*}} P_{OND} + \underset{(0.002)}{0.004^{**}} S_C + \underset{(0.119)}{0.958^{*}} P_F + \underset{(0.078)}{0.645^{*}} P_{DEC} + \underset{(0.001)}{0.005^{*}} S_{US} + U_3$$

$$d = 1.739^{*} \qquad S = 0.059 \qquad R^2 = 0.971$$

As indicated by the value of R^2, the set of explanatory variables explains 97.1 percent of the variation in the price of flaxseed during this quarter. The Durbin-Watson test for serial correlation was inconclusive in this case, which may be an indication of a weakness in the model. The signs on the regression coefficients relating to Canadian flaxeeed supply and U.S. supply are positive. This may be contrary to those expected from the theoretical approach; however, since seasonal considerations may be influential in determining the price, the positive sign may be justifiable. The standard error of the estimate was 0.059 dollars.

Second Quarter (April, May, June)

Equation 5.4 is an ordinary least squares estimate of flaxseed prices in the second quarter.

$$(5.4) \quad P_{AMJ} = 0.593 - \underset{(0.002)}{0.005^{**}} I_A - \underset{(0.233)}{0.181} P_{JFM} + \underset{(0.222)}{0.114} P_F + \underset{(0.166)}{0.929^{*}} P_{MAR} + U_4$$

$$d = 1.836 \qquad S = 0.120 \qquad R^2 = 0.904$$

The value of R^2 indicates that the explanatory variables explain a large portion of the variation in the dependent variable. The 'd' statistic indicates that the null hypothesis of autocorrelation is rejected at the one percent level. The standard error of the estimate is 0.120. As postulated on the basis of economic theory, a negative relationship exists between the estimated Canadian production based on intended acreage and the price during this period. Therefore, a larger intended acreage will have a depressing affect upon prices during this quarter.

Third Quarter (July, August, September)

Equation 5.5 is an ordinary least-squares estimate of flaxseed prices in the third quarter.

$$(5.5) \quad P_{JAS} = \underset{}{0.366} + \underset{(0.003)}{0.001} I_A + \underset{(0.097)}{0.016} P_{AMJ}$$

$$-\underset{(0.001)}{0.004^{*}} S_E + \underset{(0.105)}{0.885^{*}} P_{JN} + U_5$$

$$d = 2.12 \qquad S = 0.143 \qquad R^2 = 0.850$$

The equation fits the data fairly closely and exhibits residuals which contain little evidence of autocorrelation. The estimated supply of Canadian flaxseed (S_E) for the new crop year beginning August 1 has an impact upon the price during this period. An increase in the estimated supply based on carryover supply and production will have a negative impact upon prices. The price during the third quarter will be closely related to the price during the month of June by being somewhat less.

Fourth Quarter (October, November, December)

Equation 5.6 is an O.L.S. estimate of flaxseed prices in the final quarter of the calendar year.

$$(5.6) \quad P_{OND} = 0.127 - \underset{(0.097)}{0.129} P_{JAS} - \underset{(0.004)}{0.003} S_C$$

$$+\underset{(0.138)}{0.338^{**}} P_F + \underset{(0.105)}{0.741^{*}} P_{SR} + \underset{(0.003)}{0.002} S_{US}$$

$$+ U_6$$

$$d = 1.94 \qquad S = 0.117 \qquad R^2 = 0.886$$

The multiple correlation coefficient associated with equation 5.6 indicates that 88.6 percent of the variation in the price in the fourth quarter is explained by the set of explanatory variables specified in the equation. The 'd' statistic indicated that autocorrelation of residuals was not present. The negative regression coefficient of the Canadian supply variable was consistent with expectations based on economic theory. However, the regression coefficients relating to Canadian supply and the United States supply were not significant even at the 20 percent level. The general trend of flaxseed prices for each quarter was accounted for by the estimated quarterly models. The estimated values of the quarterly prices are compared with the actual values for the sample period in figures 5.3 through 5.6.

THE MONTHLY PRICE

The twelve estimated relations 5.7 to 5.19 represent ordinary least-squares estimates of the Canadian flaxseed price during each month of the year. The explanatory variables which are utilized attempt to relate the price in a specific month to previous prices, the estimated annual price, and the estimated supplies of flaxseed in the crop year. The consideration of these factors in the estimated relation uses all *a priori* information of prices and supplies to estimate the seasonal variation in price and, hence, the price for the month. However, it should be noted that the empirical estimates of short-term prices are based on past relationships and that in certain instances, the degree of multicollinearity among certain independent variables is relatively high. Nevertheless, as the statistical results indicate, the estimated equations provide a fairly close fit to the data. Certain variables may not be statistically significant; however, since the inclusion of them into the equation improves the fit of the equation by explaining a greater proportion of the variation in the seasonal price, they are left in the relation.

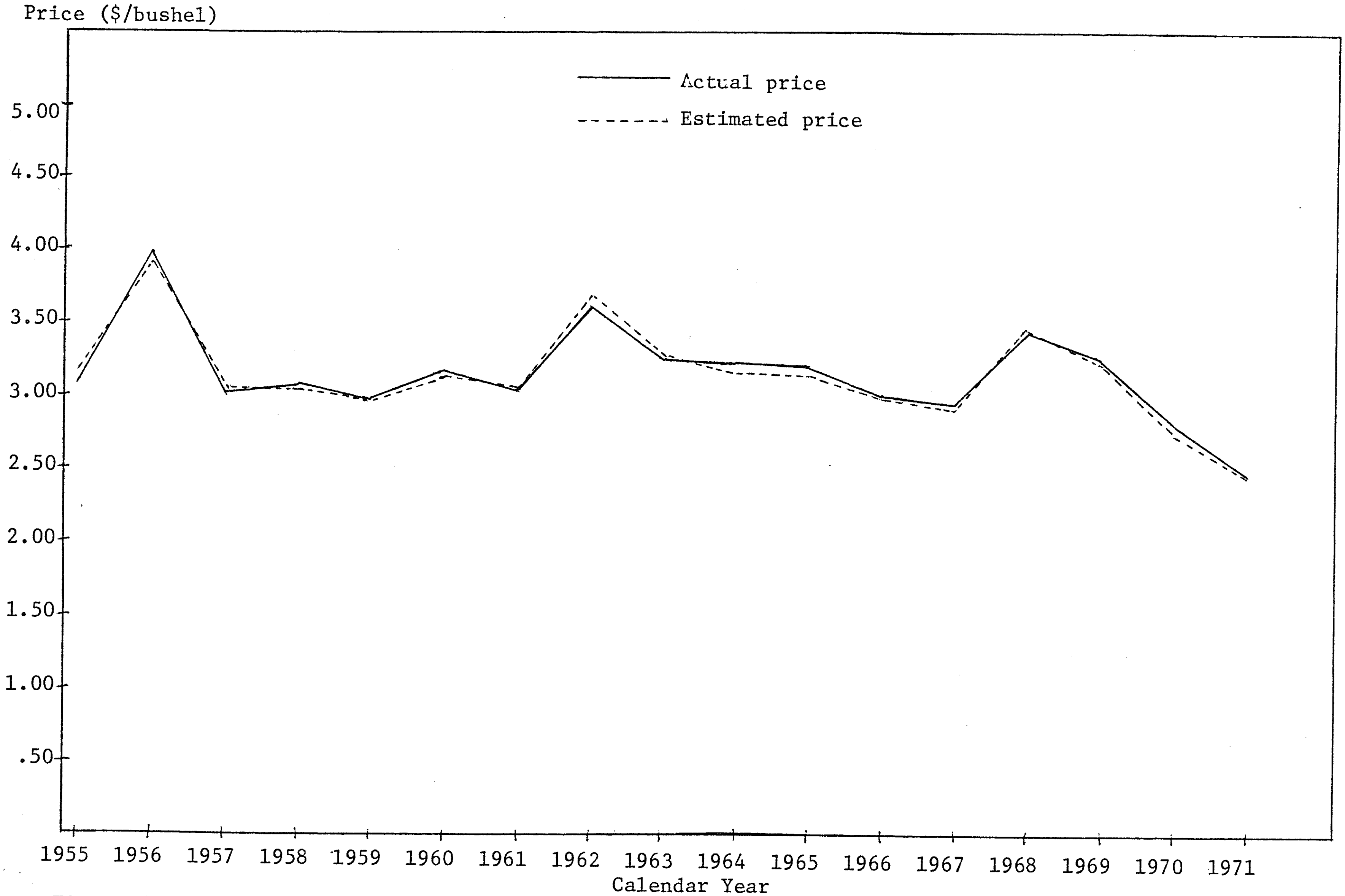


Figure 5.3 Comparison of actual and estimated price of flaxseed for the first quarter of the calendar year computed from O.L.S. estimates of equation 5.3, 1955 to 1971.

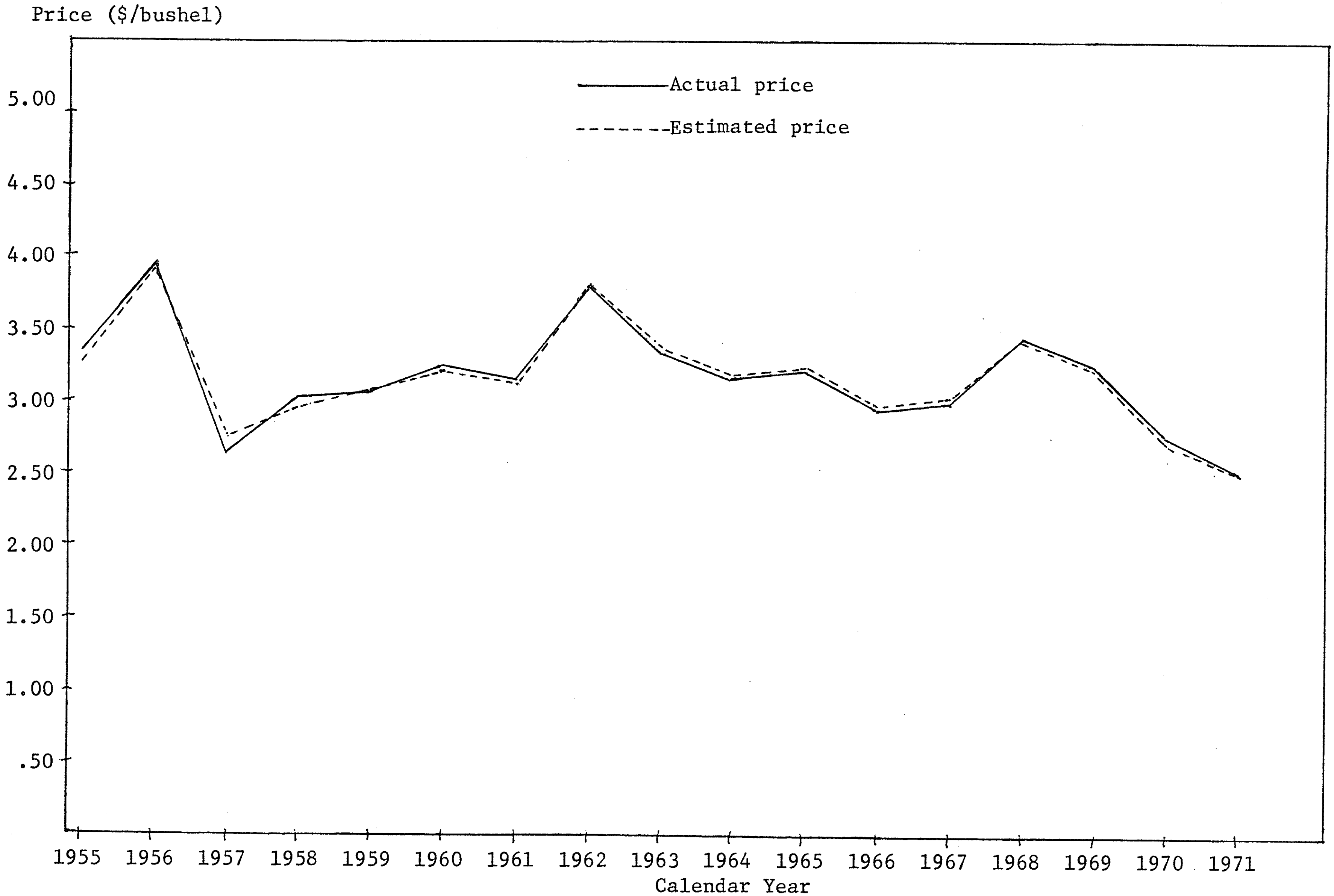


Figure 5.4 Comparison of actual and estimated price of flaxseed for the second quarter of the calendar year computed from O.L.S. estimates of equation 5.4, 1955 to 1971.

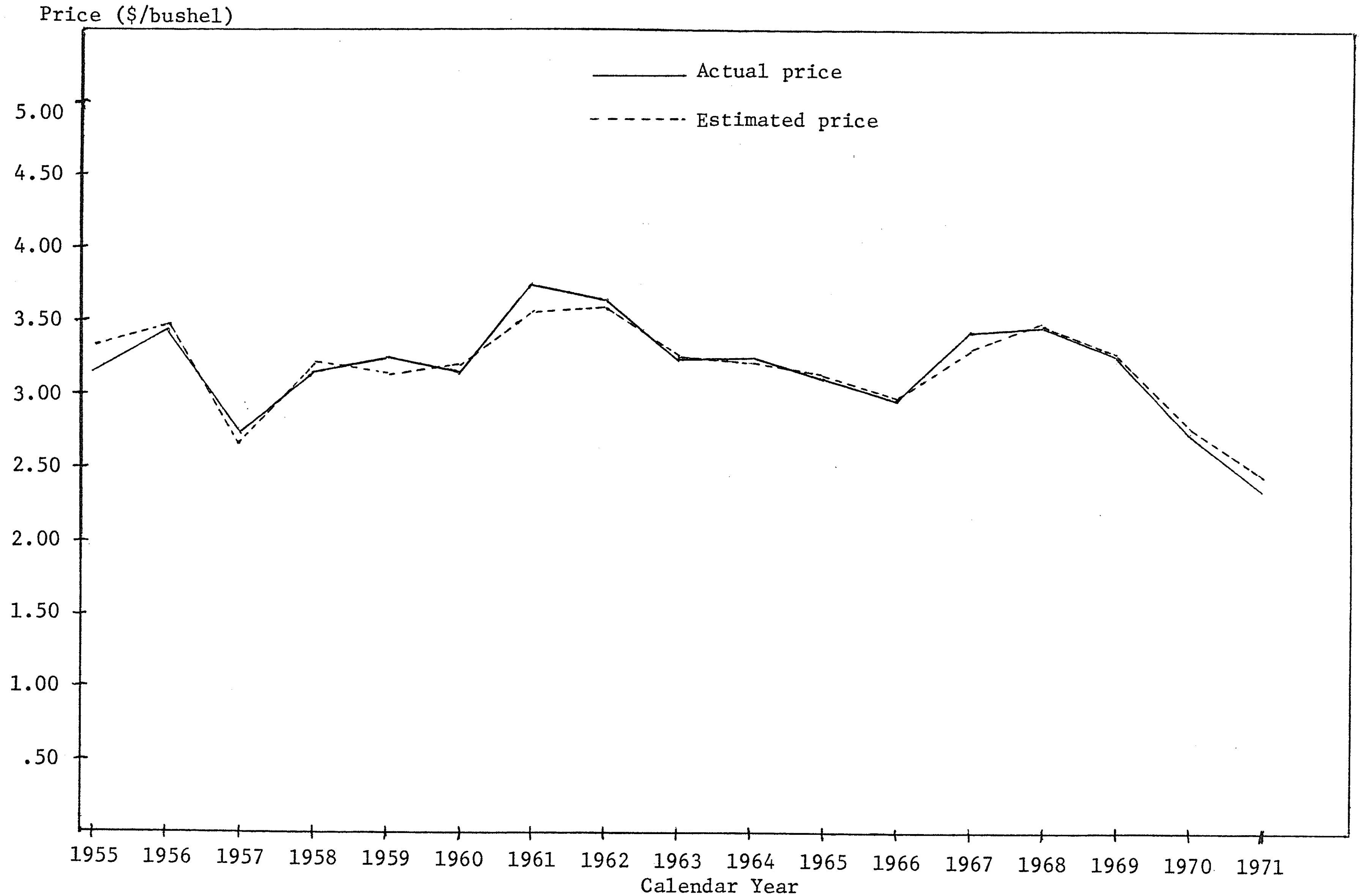


Figure 5.5 Comparison of actual and estimated price of flaxseed for the third quarter of the calendar year computed from O.L.S. estimates of equation 5.5, 1955 to 1971.

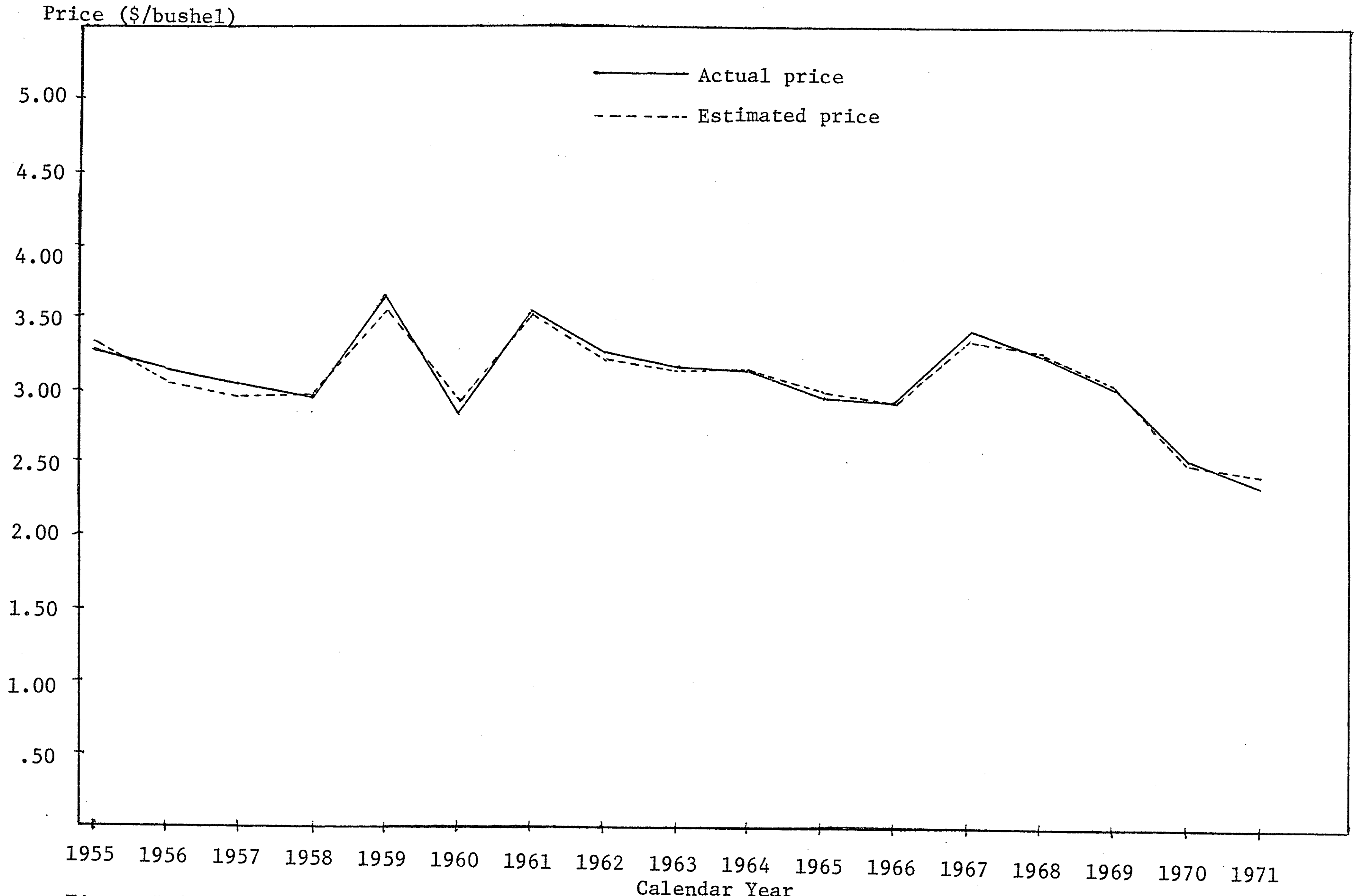


Figure 5.6 Comparison of actual and estimated price of flaxseed for the fourth quarter of the calendar year computed from O.L.S. estimates of equation 5.6, 1955 to 1971.

January

$$(5.7)\quad P_{JAN} = -0.680 + \underset{(0.003)}{0.003}\, S_C + \underset{(0.086)}{0.670^{*}}\, P_{DEC} + \underset{(0.088)}{0.479^{*}}\, P_E + \underset{(0.002)}{0.003^{***}}\, S_{US} + U_7$$

$$d = 1.96 \qquad S = 0.058 \qquad R^2 = 0.973$$

February

$$(5.8)\quad P_{FEB} = -0.897 + \underset{(0.003)}{0.005^{***}}\, S_C + \underset{(0.110)}{0.597^{*}}\, P_{JAN}$$

$$+\underset{(0.110)}{0.586^{*}}\, P_E + \underset{(0.002)}{0.004^{***}}\, S_{US} + U_8$$

$$d = 1.78 \qquad S = 0.062 \qquad R^2 = 0.974$$

March

$$(5.9)\quad P_{MAR} = -\ 1.002 + \underset{(0.003)}{0.007^{**}}\, S_C + \underset{(0.105)}{0.787^{*}}\, P_{FEB}$$

$$+\ \underset{(0.116)}{0.463^{*}}\, P_E + U_9$$

$$d = 1.81 \qquad S = 0.052 \qquad R^2 = 0.984$$

April

$$(5.10)\quad P_{APR} = -\ 0.352 + \underset{(0.003)}{0.003}\, I_S + \underset{(0.137)}{0.766^{*}}\, P_{MAR} + \underset{(0.166)}{0.317^{***}}\, P_E + U_{10}$$

$$d = 2.42 \qquad S = 0.070 \qquad R^2 = 0.972$$

May

$$(5.11)\quad P_{MAY} = 0.149 - \underset{(0.003)}{0.005^{**}}\, I_S + \underset{(0.108)}{0.867^{*}}\, P_{APR}$$

$$+\ \underset{(0.142)}{0.138^{***}}\, P_E + U_{11}$$

$$d = 2.16 \qquad S = 0.071 \qquad R^2 = 0.975$$

June

(5.12) $$P_{JN} = \underset{}{0.566} - \underset{(0.003)}{0.004^{***}} I_S + \underset{(0.080)}{0.271^{*}} P_{MAY} + \underset{(0.105)}{0.584^{*}} P_E + U_{12}$$

$d = 1.63 \qquad S = 0.076 \qquad R^2 = 0.960$

July

(5.13) $$P_{JY} = -0.164 - \underset{(0.558)}{0.661} P_{AMJ} + \underset{(0.485)}{0.434^{***}} P_F + \underset{(0.379)}{1.308^{*}} P_{JN} + U_{13}$$

$d = 2.23 \qquad S = 0.187 \qquad R^2 = 0.793$

August

(5.14) $$P_{AUG} = -0.117 + \underset{(0.167)}{0.180} P_{MJJ} + \underset{(0.174)}{0.318^{**}} P_F + \underset{(0.208)}{0.540^{**}} P_{JY} + U_{14}$$

$d = 1.39^{*} \qquad S = 0.147 \qquad R^2 = 0.859$

September

(5.15) $$P_{SR} = 0.005 - \underset{(0.089)}{0.033} P_{JJA} + \underset{(0.107)}{0.044} P_F + \underset{(0.127)}{0.979^{*}} P_{AUG} + U_{15}$$

$d = 3.137^{*} \qquad S = 0.082 \qquad R^2 = 0.956$

October

(5.16) $$P_{OCT} = 0.172 - \underset{(0.353)}{0.975^{**}} P_{JAS} + \underset{(0.135)}{0.392^{**}} P_F + \underset{(0.347)}{1.530^{*}} P_{SEPT} + U_{16}$$

$d = 1.82 \qquad S = 0.108 \qquad R^2 = 0.914$

November

$$(5.17)\quad P_{NOV} = 0.397 - \underset{(0.131)}{0.850^{*}}\, P_{OCT} - \underset{(0.006)}{0.008^{***}}\, S_C + \underset{(0.162)}{0.020}\, P_E + \underset{(0.005)}{0.005}\, S_{US} + U_{17}$$

$$d = 1.88 \qquad S = 0.105 \qquad R^2 = 0.927$$

December

$$(5.18)\quad P_{DEC} = -0.094 - \underset{(0.008)}{0.001}\, S_C + \underset{(0.178)}{0.402^{**}}\, P_E + \underset{(0.166)}{0.612^{*}}\, P_{NOV} + \underset{(0.005)}{0.001}\, S_{US} + U_{18}$$

$$d = 1.51^{*} \qquad S = 0.130 \qquad R^2 = 0.889$$

The estimated values of the monthly prices of flaxseed are compared with the actual values for the sample period in the twelve figures 5.7 through 5.18. The estimated relations of the monthly price of flaxseed indicate that recent past prices, a knowledge of the annual price, and supply can be utilized in order to estimate the price of flaxseed in a specific month of the year. In this manner, the seasonality of price variations can be expressed in a quantitative form. However, it should be recognized that the estimated relations are based on the past and that the introduction of new factors in the market may have an impact upon flaxseed prices during the year.

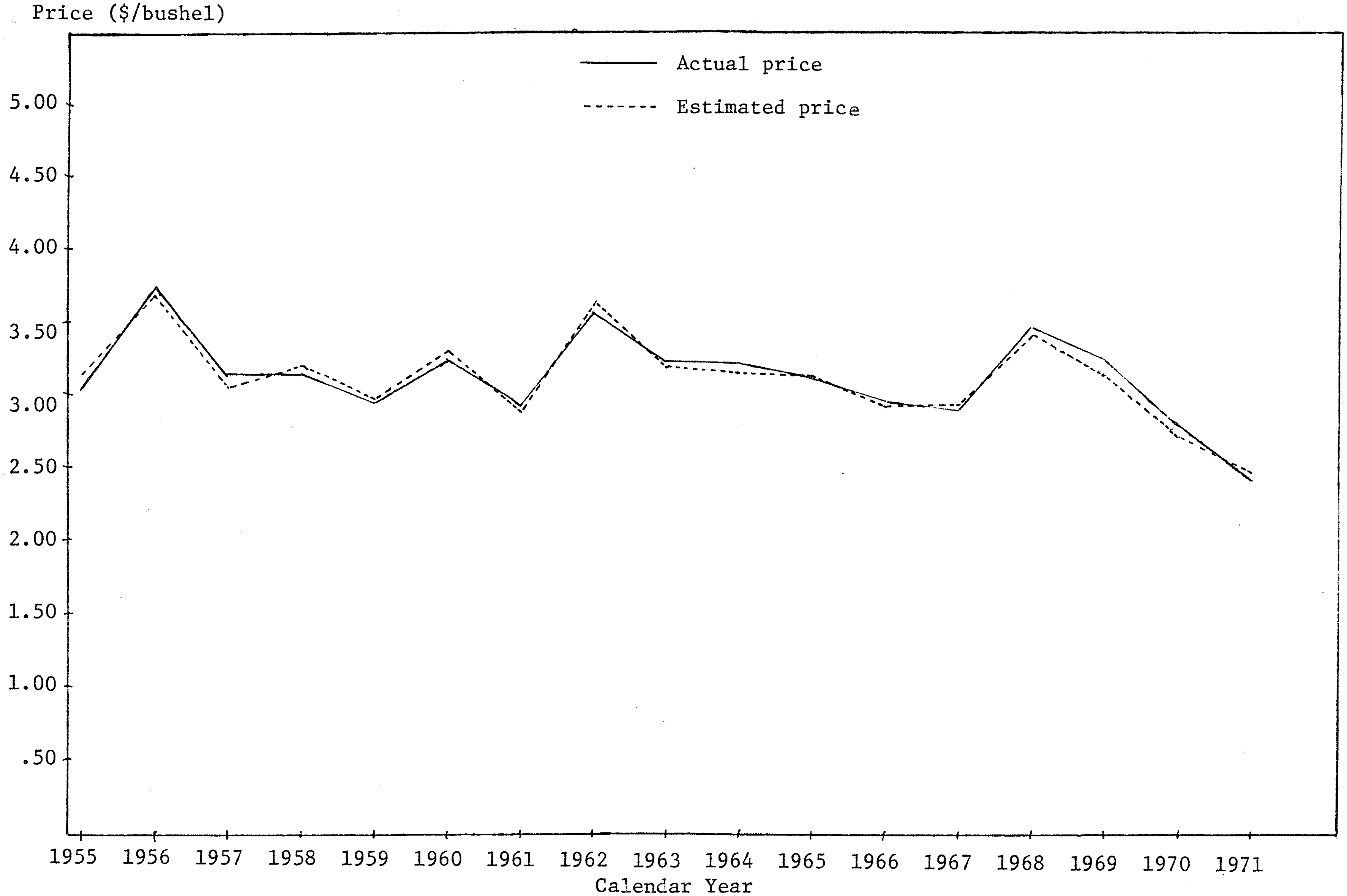


Figure 5.7 Comparison of actual and estimated price of flaxseed for January computed from O.L.S. estimates of equation 5.7, 1955 to 1971.

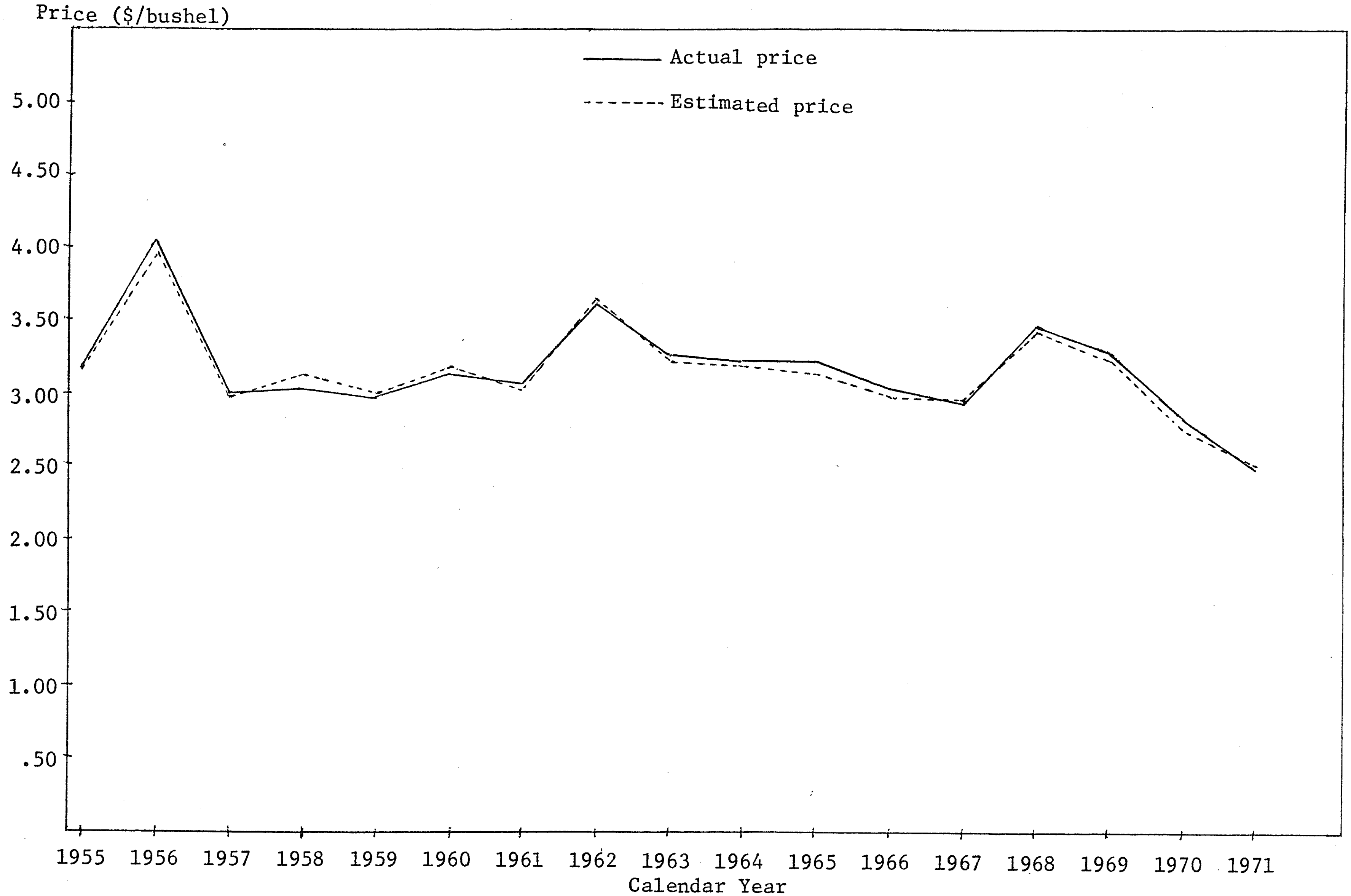


Figure 5.8 Comparison of actual and estimated price of flaxseed for Febuary computed from O.L.S. estimates of equation 5.8, 1955 to 1971.

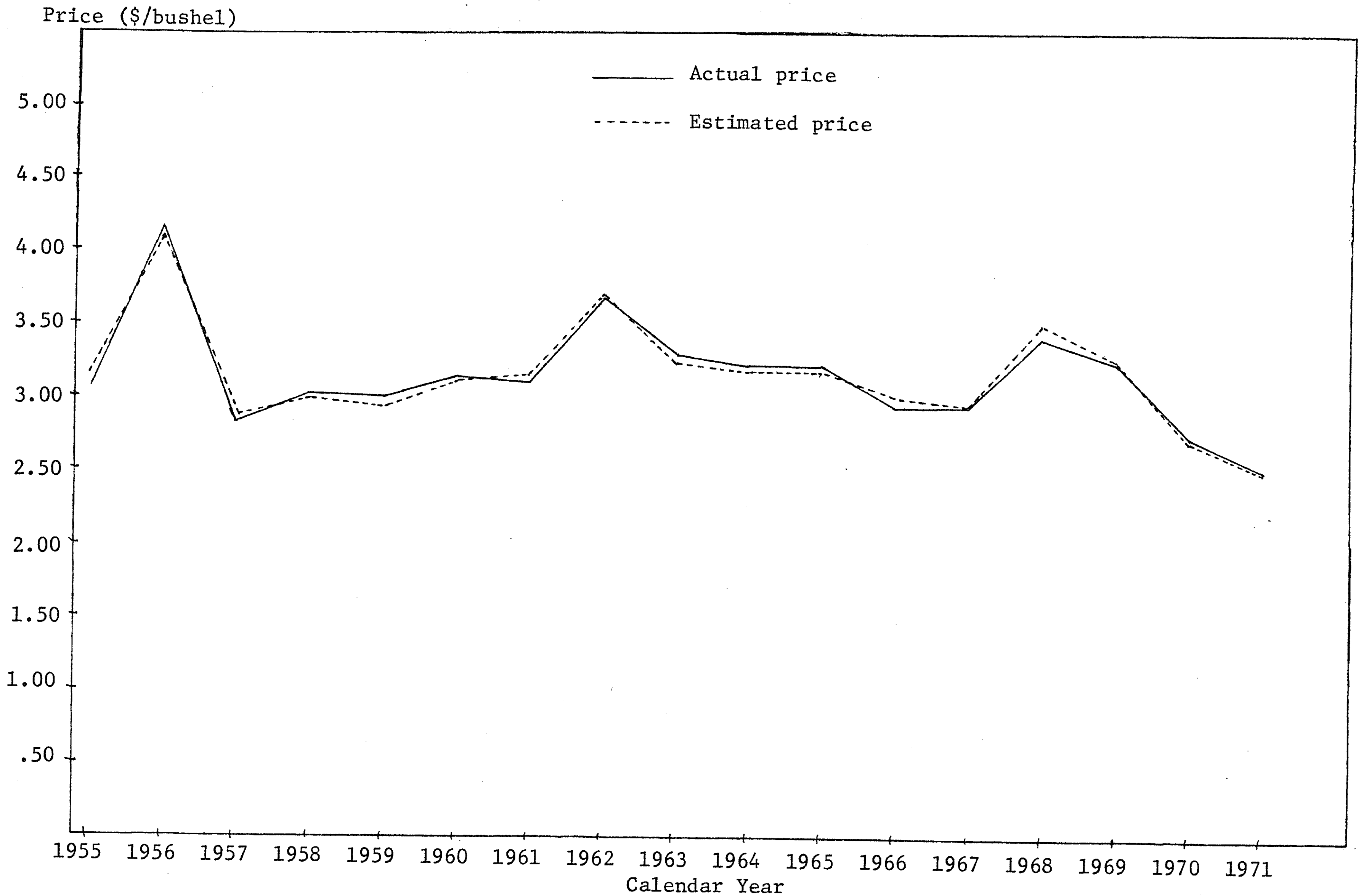


Figure 5.9 Comparison of actual and estimated price of flaxseed for March computed from O.L.S. estimates of equation 5.9, 1955 to 1971.

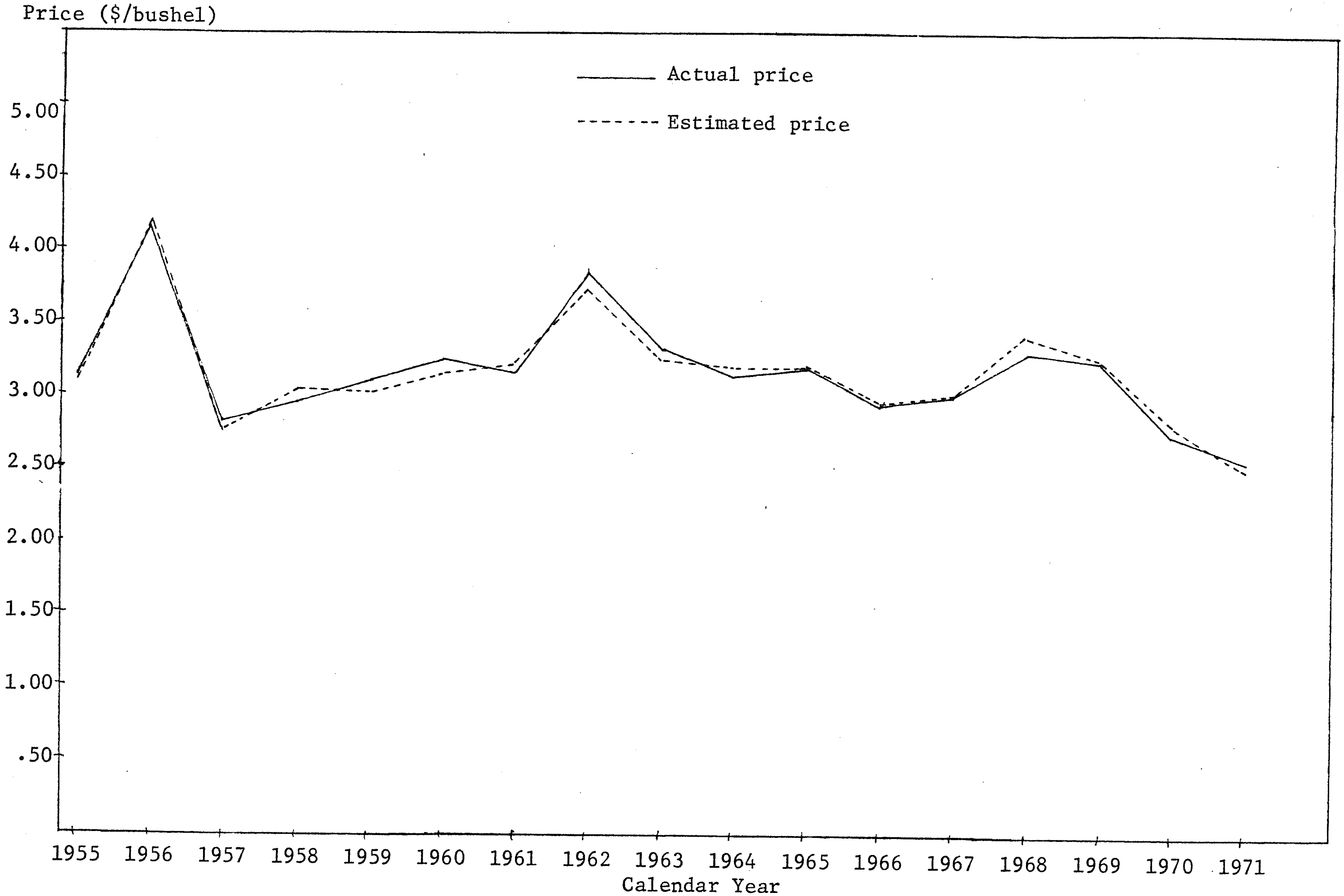


Figure 5.10 Comparison of actual and estimated price of flaxseed for April computed from O.L.S. estimates of equation 5.10, 1955 to 1971.

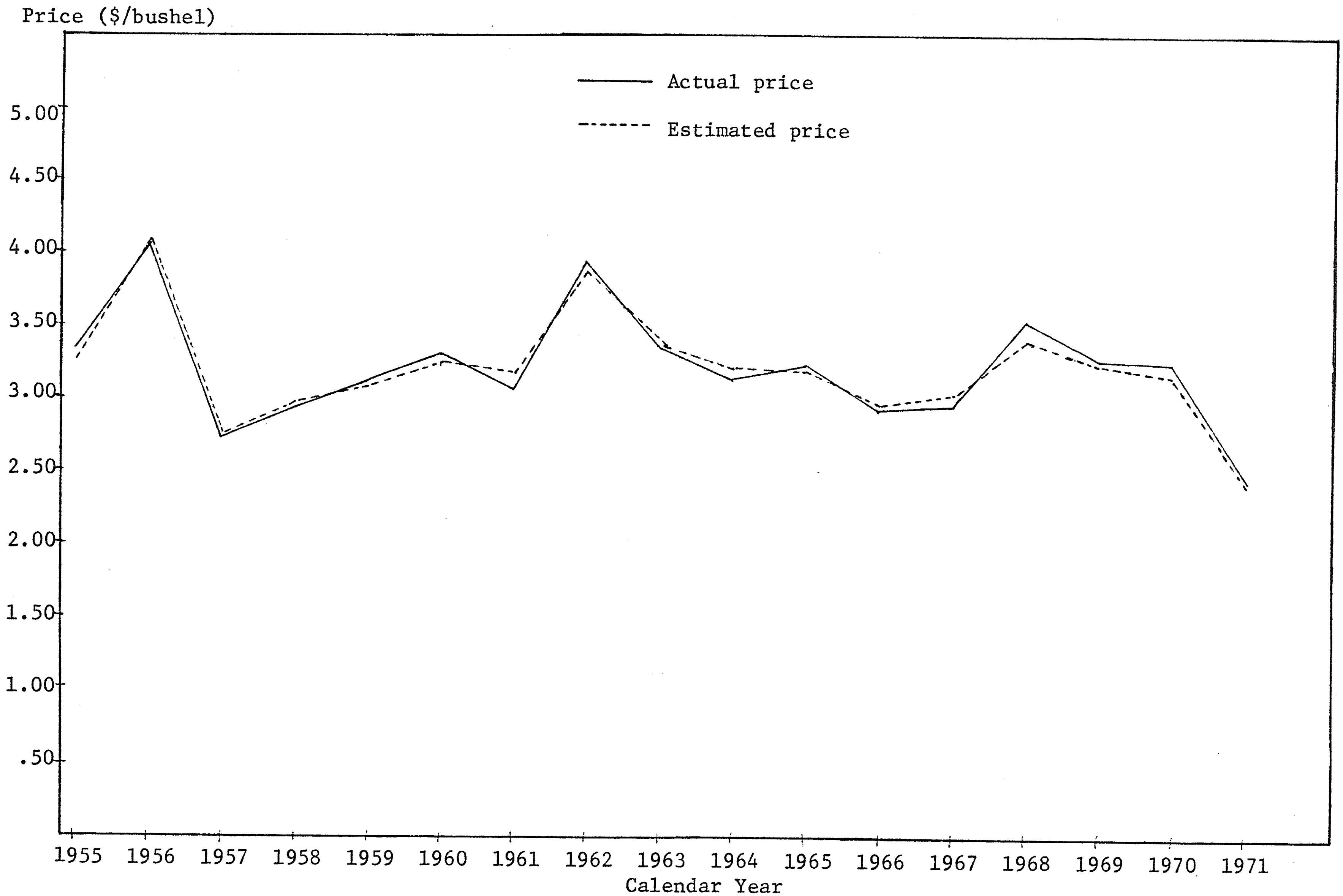


Figure 5.11 Comparison of actual and estimated price of flaxseed for May computed from O.L.S. estimates of equation 5.11, 1955 to 1971.

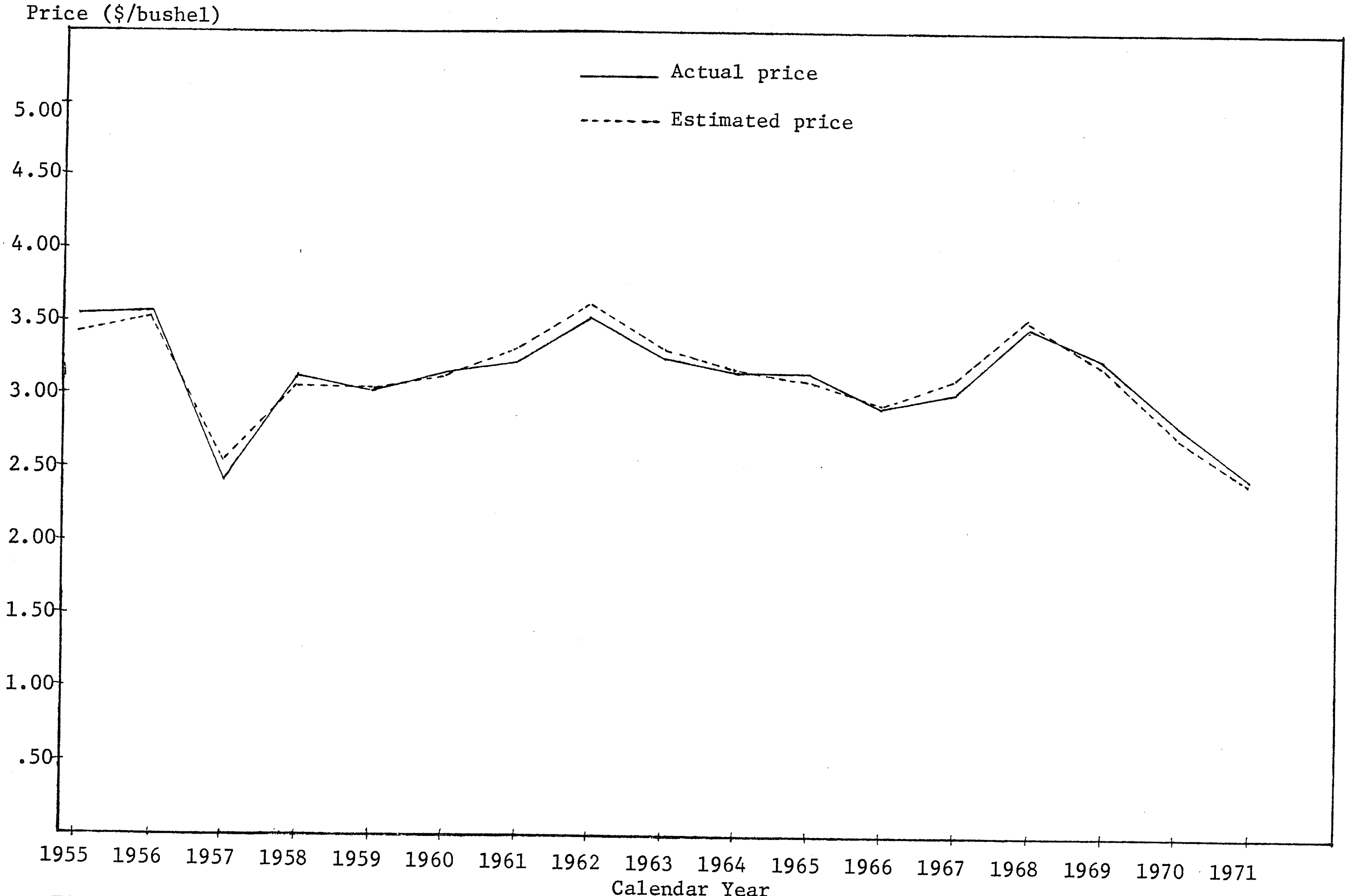


Figure 5.12 Comparison of actual and estimated price of flaxseed for June computed from O.L.S. estimates of equation 5.12, 1955 to 1971.

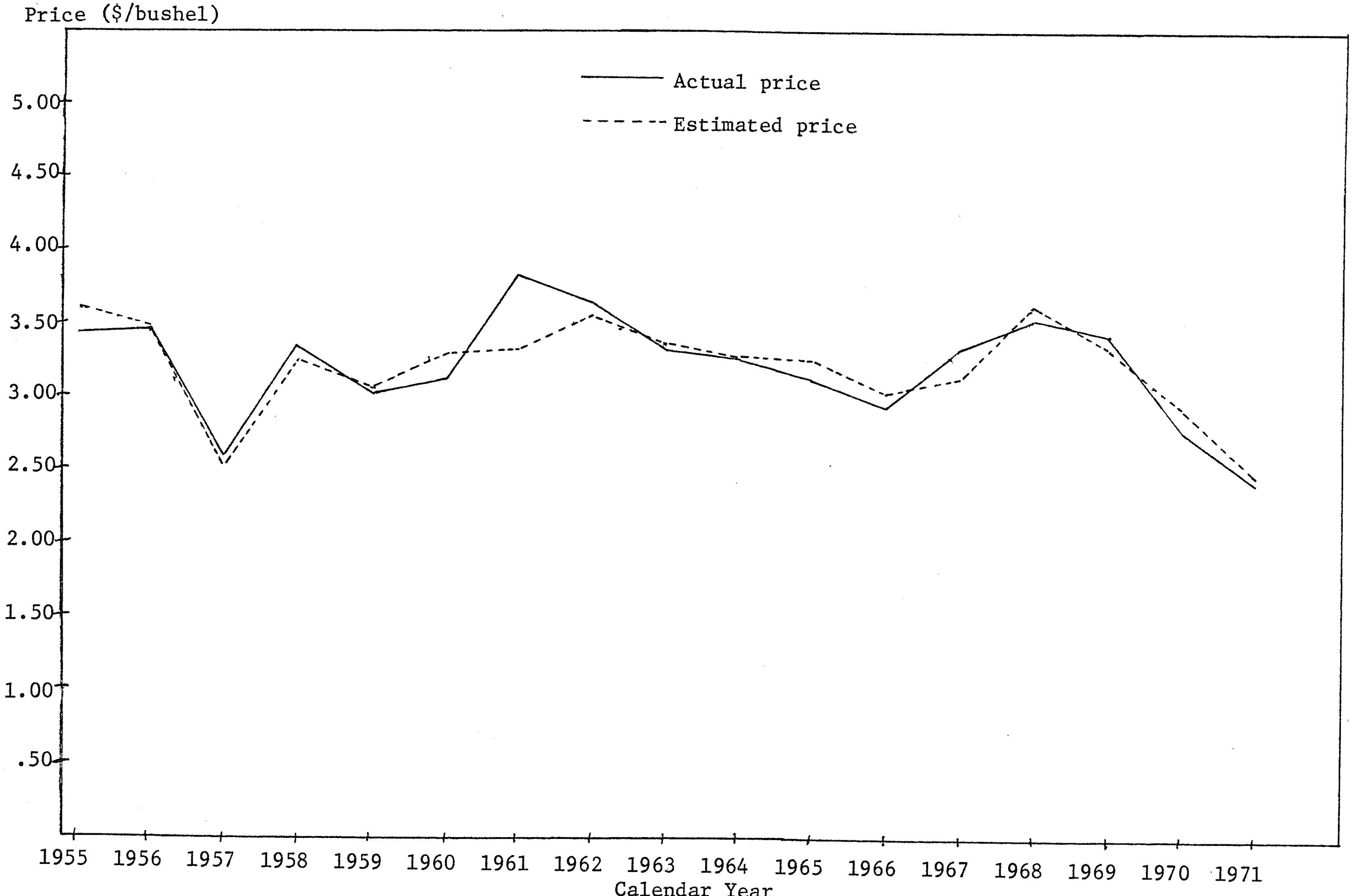


Figure 5.13 Comparison of actual and estimated price of flaxseed for July computed from O.L.S. estimates of equation 5.13, 1955 to 1971.

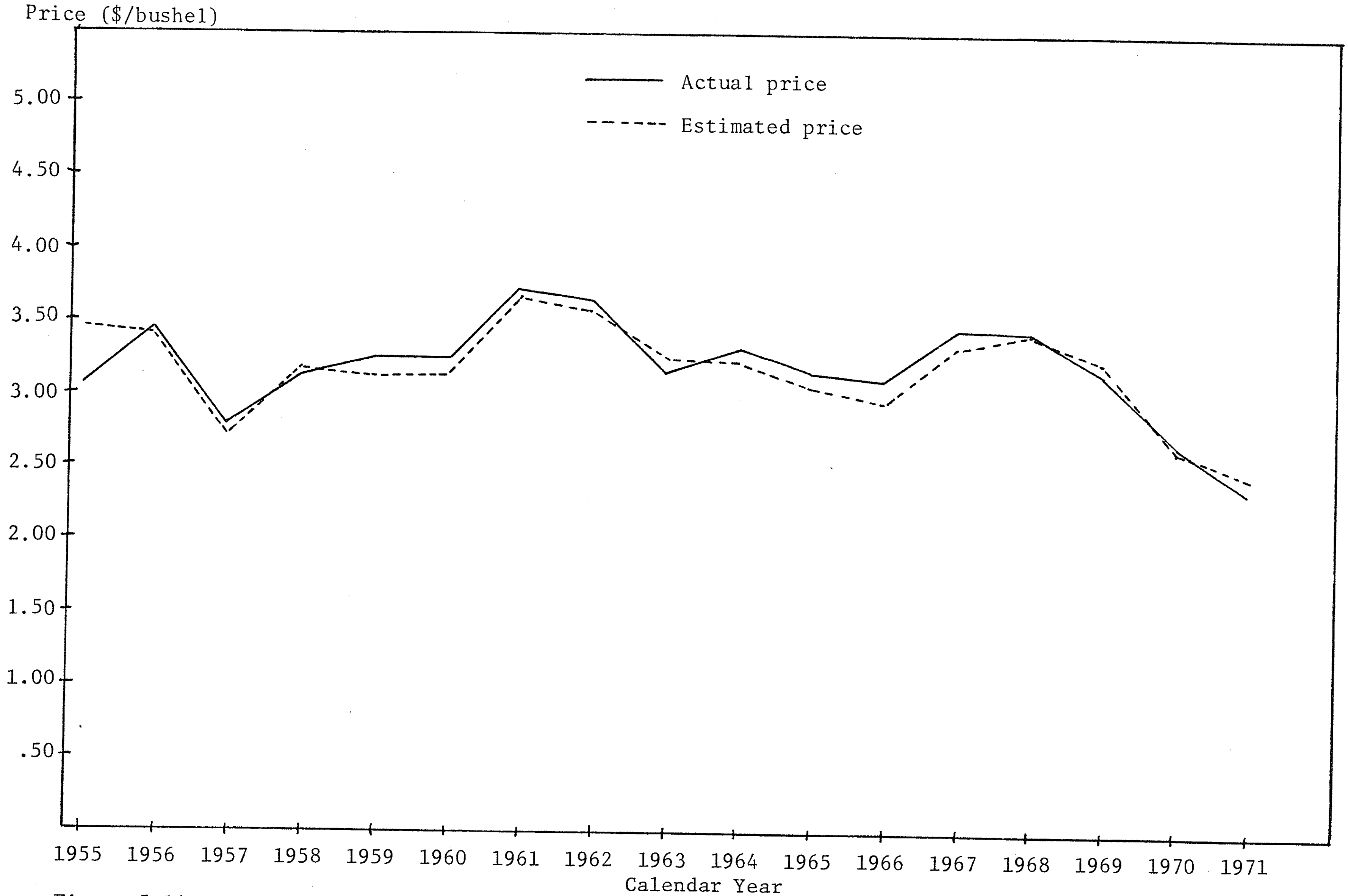


Figure 5.14 Comparison of actual and estimated price of flaxseed for August computed from O.L.S. estimates of equation 5.14, 1955 to 1971.

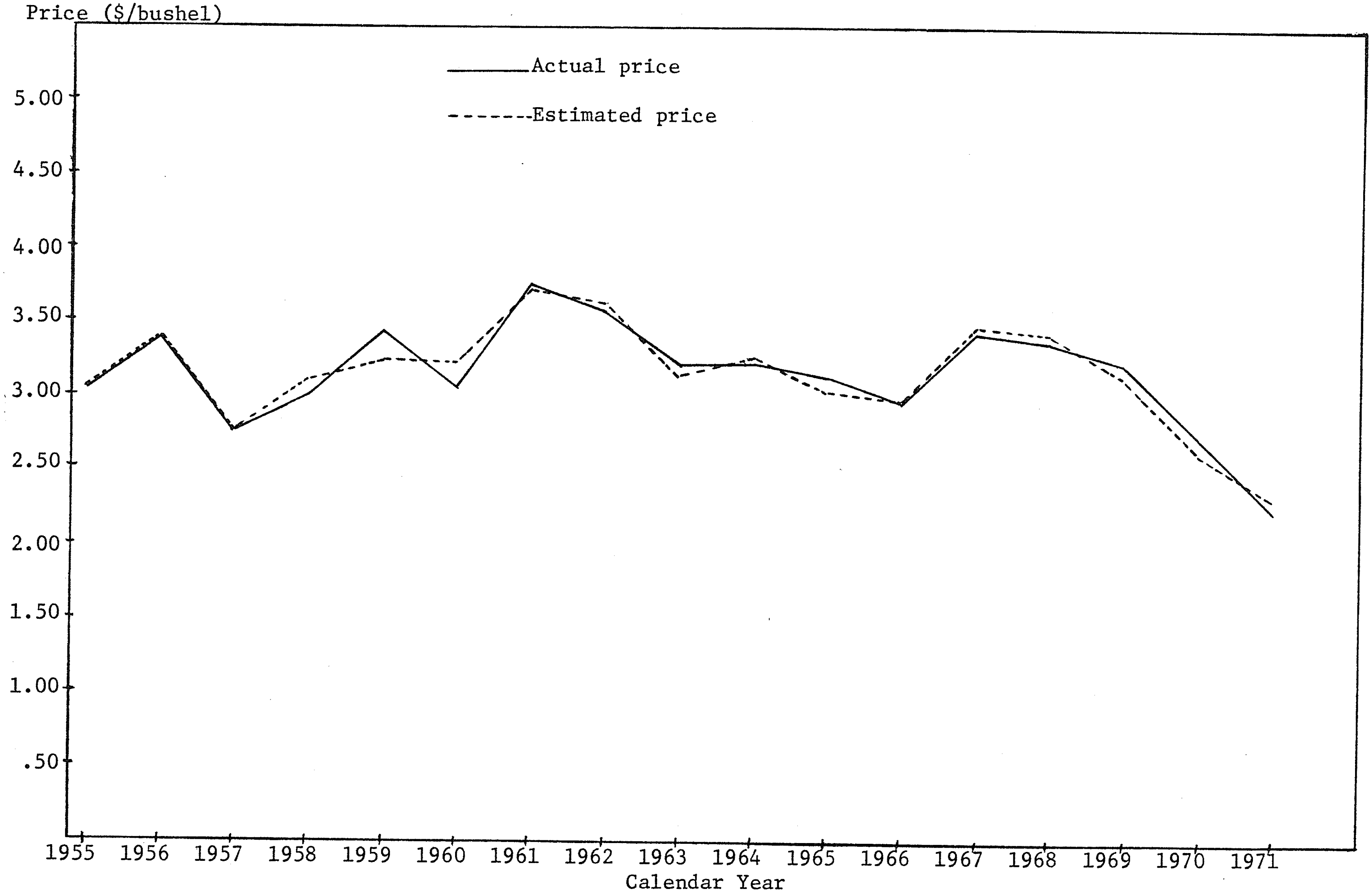


Figure 5.15 Comparison of actual and estimated price of flaxseed for September computed from O.L.S. estimates of equation 5.15, 1955 to 1971.

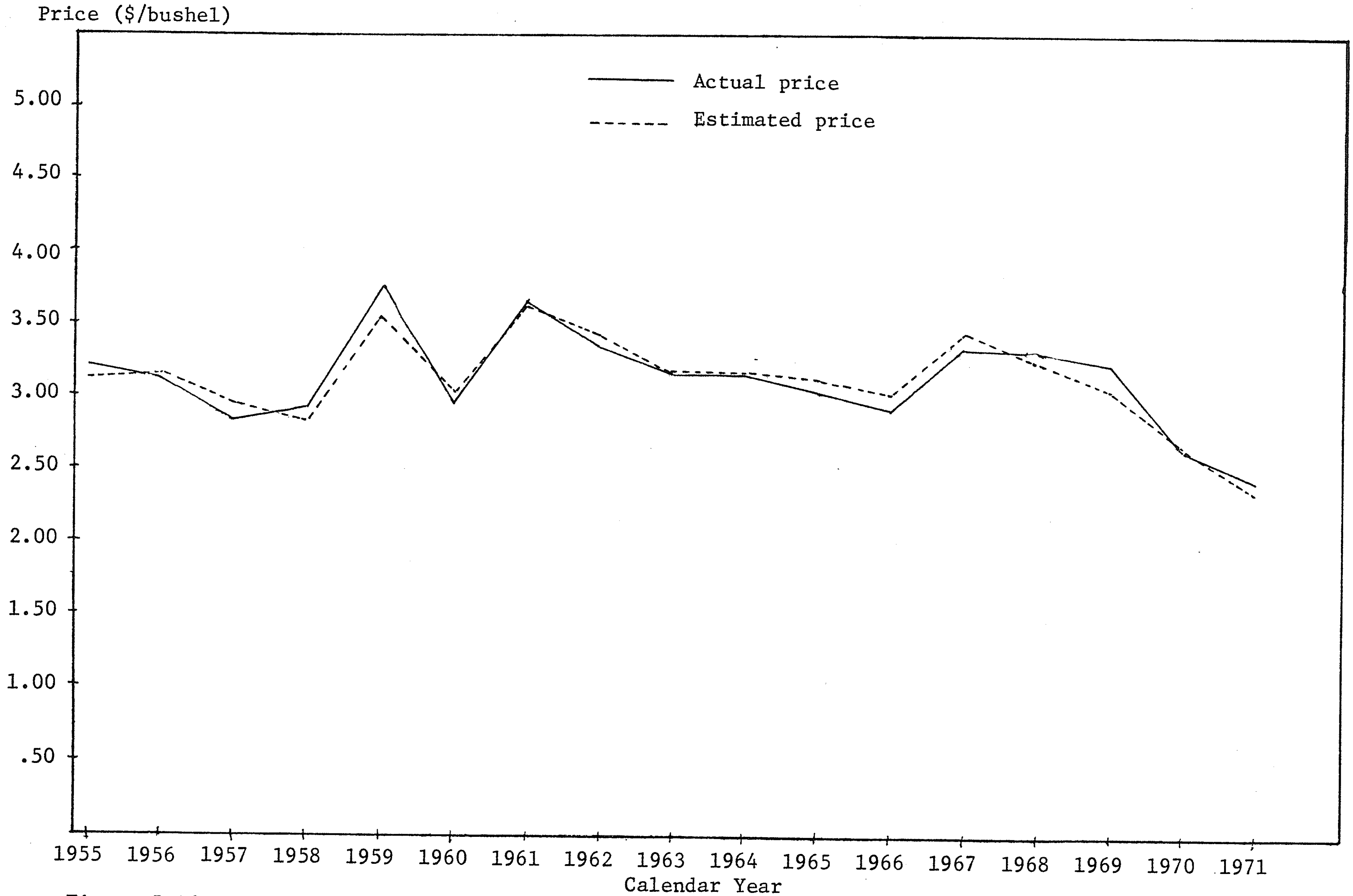


Figure 5.16 Comparison of actual and estimated price of flaxseed for October computed from O.L.S. estimates of equation 5.16, 1955 to 1971.

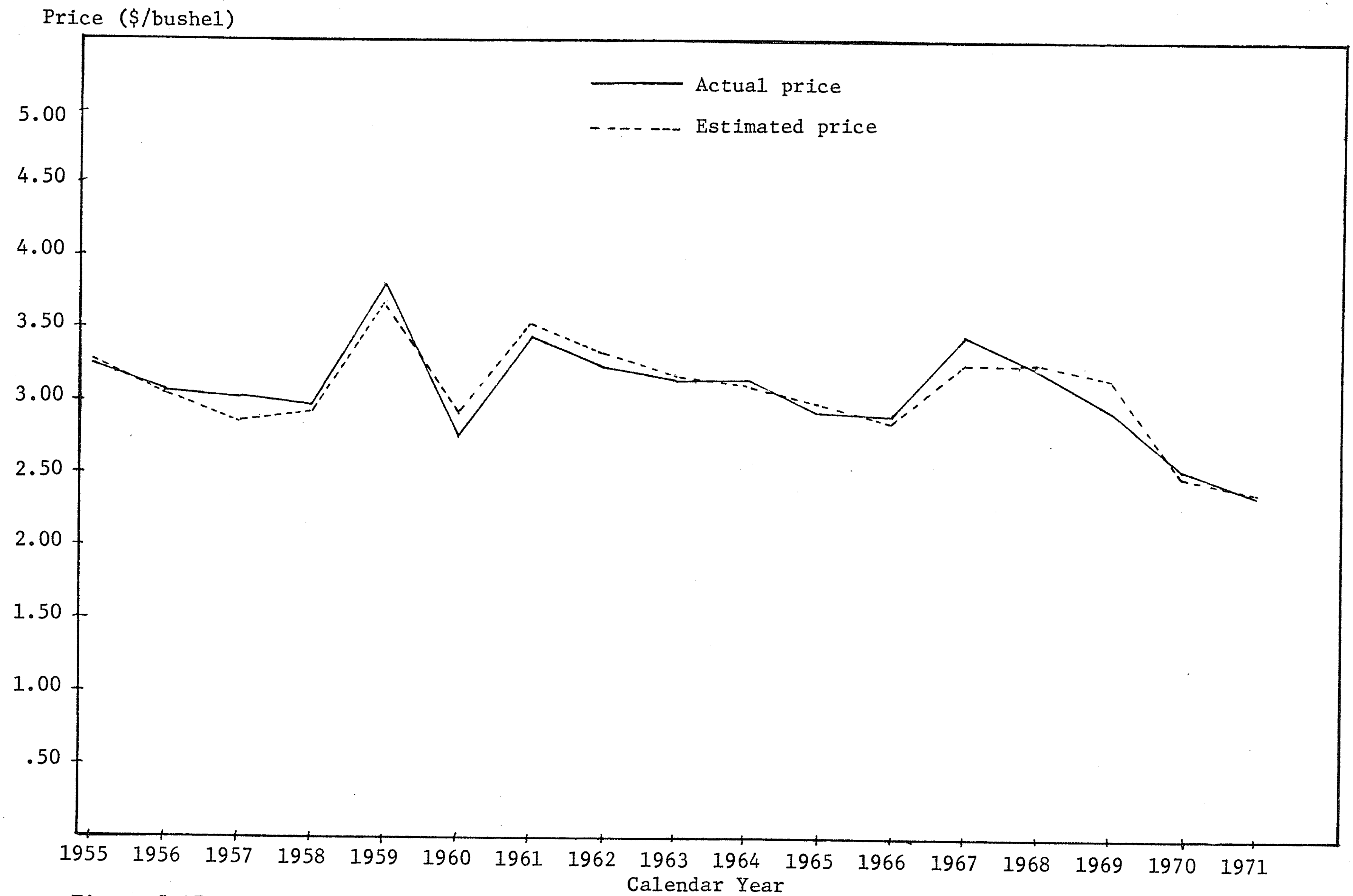


Figure 5.17 Comparison of actual and estimated price of flaxseed for November computed from O.L.S. estimates of equation 5.17, 1955 to 1971.

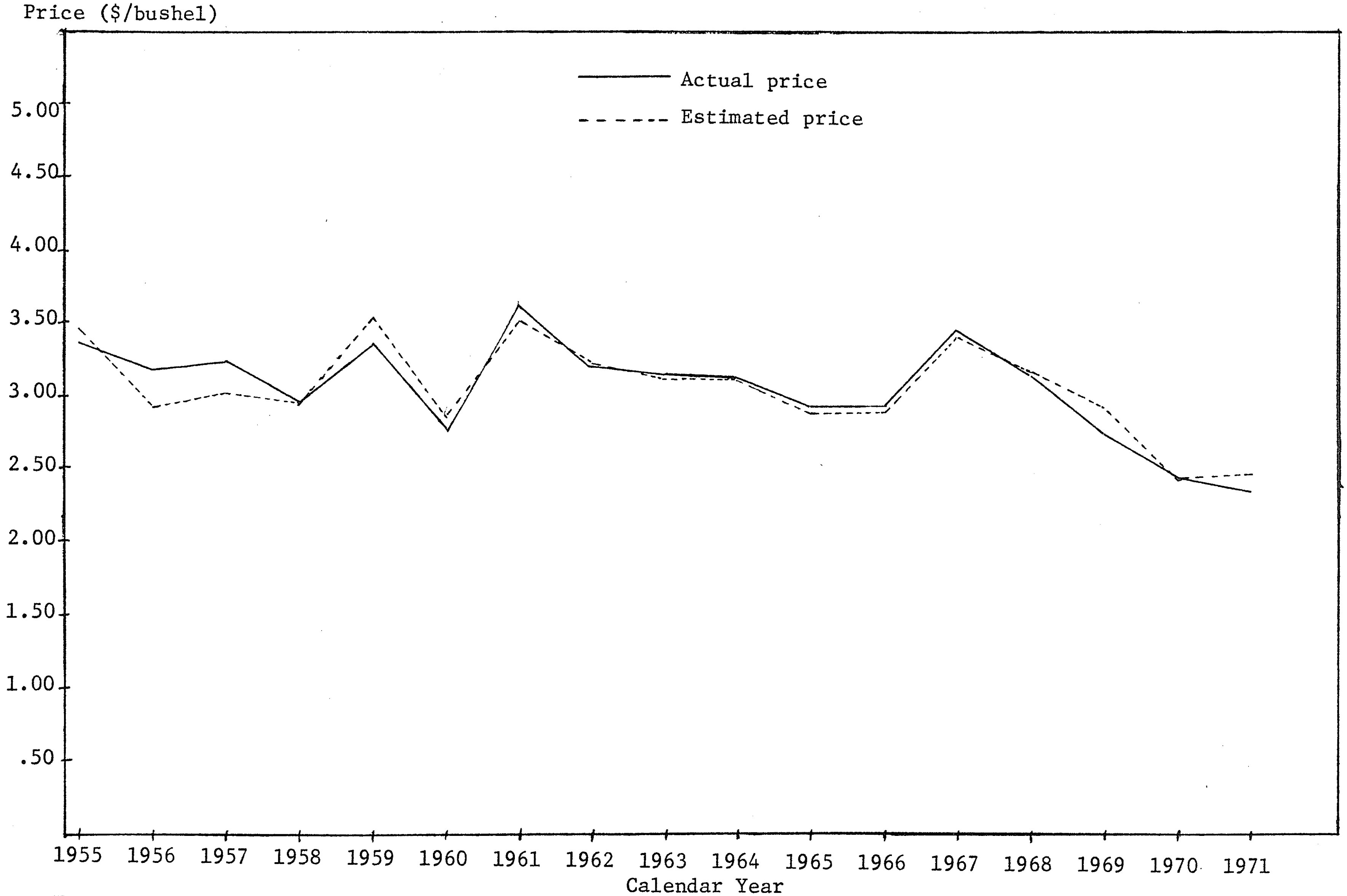


Figure 5.18 Comparison of actual and estimated price of flaxseed for December computed from O.L.S. estimates of equation 5.18, 1955 to 1971.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The title of this final chapter indicates that its purpose is to present a brief overview of the discussion in the previous five chapters and to state the conclusions from the study which appear to be justified on the basis of the results found in chapter five. The chapter also serves to remind the reader about the problem being considered in the thesis and its relationship to the stated objectives of this study. In addition, certain limitations of the study will be pointed out and the possibility of future research in the topic will be outlined.

The introduction to this thesis pointed out that a major characteristic of the agricultural industry in Canada is the variability of farm income from year to year. Although year-to-year fluctuations in farm output has decreased, the wide fluctuations in price continue to contribute to the level and variability of farm income. Since many agricultural commodities, particularly field crops, are heavily dependent upon export markets, the level of farm cash receipts will be influenced by the price and quantity of the commodity sold by exporters. Flaxseed is one of the crops which experiences substantial fluctuations in the price and quantity exported. This thesis examined the problem of the level and variability of flaxseed farm cash receipts from year to year. The objective of the study was to examine the factors which influence the quantity of flaxseed exported and the price level of flaxseed for the crop year. The variability of flaxseed prices during the crop year is also examined. Quantitative information of such factors could be utilized within the flaxseed industry in order to improve the decision-making process, thereby contributing to a more efficient agricultural industry.

Chapter II provided a descriptive analysis of the flaxseed industry. Flaxseed is the source of two major products, namely linseed oil and linseed meal. In the past, flaxseed was cultivated primarily because of the importance attributed to linseed oil as an industrial oil. Flaxseed is an important oilseed crop in Canada with the major portion of domestic production being exported in the raw form.

The price of flaxseed on the international market is influenced by both the oil and meal markets. The fact that linseed oil constitutes a market with a larger amount of specific demand has contributed to larger price differentials between linseed oil and other oils than those existing between most other oils. However, the increased level of interchangeability between oils and the development of synthetic materials has increased the level of competition in the linseed oil market. Consequently, the price differentials between linseed oil and other oils has decreased. In addition, the meal market has become more prominent within the flaxseed industry recently. The value of protein appears to be an important factor in determining flaxseed prices. Hence, it would appear that flaxseed prices are influenced by the international market for linseed oil and linseed meal.

The statistical figures of flaxseed production and trade indicate that the pattern has not changed a great deal in the past twenty years. Linseed oil dominates the export trade of some countries while flaxseed is more dominant in other countries. The organization of international trade is complex. It is dependent upon the governmental policies of both importing and exporting countries around the world. These policies may include such measures as tariffs, quotas, price support schemes, export taxes, and export tariffs. These interventions in the market do not allow supply and demand to interact freely. Hence, a change in the number or intensity of these various interventions may have a substantial impact upon the competitive position of countries which supply flaxseed and/or linseed oil as well as countries which demand these products from other countries. The difficulties encountered in quantitatively expressing these interventions has been recognized in the past. However, since the pattern of production and trade has not changed a great deal during the period in the analysis, these factors are considered non-significant.

The supplies of flaxseed and linseed oil, which are dominant in world trade, are produced in three principal countries, namely Argentina, Canada and the United States. Argentina exports a large amount of linseed oil while Canada and the United States chiefly export flaxseed in an unprocessed form.

Flaxseed production in Canada attained prominance during the early 1950's and has maintained a significant position in Western Canadian agriculture during the past twenty years. It is only during the past five years that flaxseed has become a secondary oilseed crop in Canada. The production and marketing of flaxseed in Canada was described briefly in the latter part of Chapter II. A flow chart indicates the complexity of the Canadian flaxseed industry within the international market.

Chapter III discusses the development of the field of price research and outlines important studies related to various agricultural commodities. The notable absence of research related to flaxseed was a significant aspect of the review of past research in the field. Although several recent econometric studies have focused on the soybean market in the United States, no known studies have been published which consider the flaxseed market in Canada or the United States.

Chapter IV goes on to discuss the various aspects of formulating models and presents the econometric models used in the study. The objective of theoretical economic analysis is to set forth the important and consistent features of an economy or a sector as an organized, logical mechanism. In order to express any economic activity in theoretical terms that can be understood and manipulated, simplification by assumption must be introduced. If the vital features and relationships of the real world can be transferred to the theoretical expression, then this abstraction from reality need not be damaging or unreasonable.

Empirical estimation of theoretical relationships requires even further simplification and assumption. Limitations on applicable statistical techniques, lack of data, and inaccuracies in available data are major factors restricting the measurement of theoretical formulations. These limitations become particularly apparent when a short observation period is considered in the analysis. However, useful approximations are possible even though the statistical models used are much less complex than either theory or practical experience would suggest. Chapter IV presents the theoretical models hypothesized in the study.

The results of the statistical estimation are presented in Chapter V. The sample period considered in the analysis was the marketing or crop years from 1955-56 to 1971-72. The statistical models in this thesis used marketing year average prices and quantities in the analysis. These factors combined with recent past prices were used as proxies for seasonal and other short-term influences in the operation of the pricing mechanism. Actual observations on the dependent variables and the predetermined variables were used in computing statistical estimates of the coefficients of the models. The unknown parameters of the models were estimated by ordinary least squares.

In general, the results of the estimation process were satisfactory. The statistical fits on several of the functions were fairly good in terms of the coefficient of determination value and the level of significance of the regression coefficients. Most of the regression coefficients displayed expected signs and were of appropriate magnitude.

The export function indicated that the level of Canadian flaxseed exports is influenced by both Canadian flaxseed supplies and the price level. As expected, the level of annual exports of flaxseed is inversely related to the annual price. In addition, the level of exports is positively related to available flaxseed supplies. Due to the limits of interchangeability, an increase in Canadian flaxseed supplies is accompanied by a smaller proportionate increase in exports as flaxseed supplies become larger.

The annual price function indicated that historically, Canadian flaxseed prices have been influenced by the total supply of flaxseed available in three principal exporting countries, namely, Canada, Argentina, and the United States. In addition, the trend variable indicates that flaxseed prices have been declining over time. Although the trend variable appeared to be an appropriate device, it does not explain the factors and relationships underlying the trend. However, it is possible that the increased interchangeability among oils and the introduction of synthetic materials may have caused a reduction in specific demand for flaxseed with a resulting downward trend in prices.

The quarterly price models were based on all a priori information of prices and supply. The first quarter price relation provided a good statistical fit; however, the estimated coefficients related to Canadian and American flaxseed supplies displayed signs which were contrary to those expected on the basis of theoretical consideration. However, since seasonal considerations during this period of the year may have a strong influence upon the price, the positive signs may be justifiable.

The second quarter price equation indicated that a negative relationship exists between estimated Canadian flaxseed production based on intended acreage and average yields, and the average price in this quarter. This relation is accounted for by the fact that the level of storage demand increases if anticipations indicate a smaller crop and decrease if a larger crop is foreseen.

The third quarter price function indicated that a negative relationship exists between the estimated supply of Canadian flaxseed for the new crop year and the average price in this quarter. The inclusion of the remaining variables which relate to price, aid in explaining the seasonal variation in the price during this period of the year.

The fourth quarter price function indicated that a negative relation exists between Canadian flaxseed supplies and the price. Consequently, a larger Canadian flaxseed crop will have a depressing effect upon price during this quarter.

The monthly price relations provided a good statistical fit; however, several of the estimated coefficients displayed theoretically inappropriate signs. The positive relationship estimated between price and several supply variables probably reflects the influence of unaccounted for variables such as price anticipations. The econometric model cannot quantitatively express the varied and complex factors which influence the short-term prices in a futures market such as the flaxseed market. It merely relates previous supply and price levels to the dependent variable in order to determine whether price variations have an economic basis. If a statistical model of this type is to be improved, the relationships among the components of the fats, oils, and meal sector should be analyzed more closely than the scope of this thesis permitted.

Since the study is based on the single-equation regression technique, it has various limitations of which the user should be aware. Since regression studies are necessarily tied to the past and are reflections of historic relationships, they cannot predict in light of new variables and structures, previously unencountered but known to exist for the future. No satisfactory method is in sight for incorporating major changes in technology, institutions, and government policy into regression approaches. The problem is one of projecting into the future when there are weak links with data and coefficients of the past. In addition to the problem of structural change occurring over time, there are various statistical problems encountered in the application of regression analysis to time-series data.

The use of statistical techniques for estimating the export and price relationships places certain limitations on the use of the results which are obtained. For various statistical reasons, it is possible to introduce only a few of the variables which are relevant in light of the complexity of the international flaxseed market. It is assumed that the econometric models include the independent variables which are most important in determining the value of the dependent variable. However, it must be recognized that certain factors which were not important in the past in influencing the dependent variable, and therefore were not included in the model, may become very influential in the market at some point in the future.

In order to obtain an estimate for the dependent variable specified in the model, specific values for the various independent variables must be specified in the model. However, since the value of an independent variable may not be known at the time of the forecast, it may be necessary to estimate a value which can be used to obtain a forecast for the dependent variable. An error in the estimated value of an independent variable will be reflected in an error in the predicted value of the dependent variable. The quarterly and monthly price models use information regarding the expected annual price. An error in the expected annual price will affect the accuracy of price forecasts using these models. In addition, it should be noted that official estimates of supply are subject to revision over time as more complete information becomes available. Hence, an inaccurate estimate of the value of the independent variable may have a substantial impact upon the estimated value of the dependent variable some time in the future.

The reaction of producers to anticipated flaxseed prices may influence the actual level of flaxseed prices in the future. The estimated level of flaxseed prices may be based on independent variables which use estimated levels of production based on intended acreage and average yields. The estimated or predicted value may influence producer decisions on flaxseed acreage so that the original estimate of production is incorrect, thereby influencing flaxseed prices and making the forecast appear incorrect.

The user of the econometric models should recognize that it is impossible to remove all uncertainty; in fact, a central problem in modern decision theory is how to find good or even best decisions when uncertainty is unavoidable. Nevertheless, uncertainty is undesirable in this case, so that one would like to minimize it. Forecasting is one of the instruments in this minimization process. The user must recognize that a forecast does not take the place of decision-making but supplements it by providing information which will be useful in making the correct decision.

Therefore, it is hoped that by examining the export and price relations discussed in the thesis, an understanding of the price determination and export determination of flaxseed and similar commodities has been advanced. The relative success of the empirical estimation indicates that the market operates in a systematic manner. The ultimate value of these models depends upon their ability (1) to make useful predictions in future years, or (2) to serve as the framework for a more comprehensive formulation which will be a useful predictive device. Possibly, this thesis has indicated the need to analyze the flaxseed market and represents an additional step toward a more complete analysis of the markets for oilseeds, oils, and fats.

BIBLIOGRAPHY

A. Books

1. Davenant, Charles. Balance of Trade. British Press, London, 1699.

2. Eckey, E. W. Vegetable Fats and Oils. Reinhold Publishing Corporation, New York, 1954.

3. Foote, Richard J. Analytical Tools for Studying Demand and Price Structures. Agricultural Handbook No. 146, U.S.D.A., Washington, D.C., 1958.

4. Fox, Karl A. Intermediate Economic Statistics. John Wiley and Sons, Inc., New York, London, Sydney, 1968.

5. Heady, Earl O. "Uses and Concepts in Supply Analysis", Agricultural Supply Functions -- Estimating Techniques and Interpretations, ed. Heady, Earl O., Iowa State University Press, 1961.

6. Johnston, J. Econometric Methods. second edition, McGraw-Hill Book Company, New York, 1972.

7. Moore, Henry Ludwell. Economic Cycles, Their Law and Cause. The MacMillan Company, New York, 1914.

8. ______________________. Forecasting the Yield and Price of Cotton. A. M. Kelley, New York, 1917.

9. Petty, Sir William. Discourses on Political Arithmetic, R. Clavel, London, 1691.

10. Schultz, Henry. The Theory and Measurement of Demand. The University of Chicago Press, Chicago, Illinois, 1938.

11. Shepherd, Geoffrey Seddon. Agricultural Price Analysis. The Iowa State College Press, Ames, Iowa, 1941.

12. Shepherd, Geoffrey S. Agricultural Price and Income Policy. third edition, The Iowa State College Press, Ames, Iowa, 1952.

13. Suits, Daniel B. The Theory and Application of Econometric Models. Center of Economic Research, Athens, Greece, March, 1963.

14. Thomsen, Fredrick Lundy. Agricultural Prices. first edition, McGraw-Hill Book Company Inc., New York and London, 1936.

15. Wallace, H. A. Agricultural Prices. Iowa State University Press, Des Moines, Iowa, 1917.

B. Research Reports

16. Board of Grain Commissioners for Canada. Canadian Flax and Rapeseed. Grain Research Laboratory, Crop Bulletin No. 64, November, 1956.

17. Cassels, J. M. "History of Research in Prices", Research in Prices of Farm Products. Social Science Research Council Bulletin 9, New York, 1933.

18. Coral, Inc. A Study of the Japan Market for Rapeseed and Rapeseed Oil Meal, Winnipeg, (Mimeo), November, 1968.

19. Food and Agricultural Organization of The United Nations. Approaches To International Action On World Trade In Oilseeds, Oils, and Fats. 22 F.A.O. Commodity Policy Studies, Rome, Italy, 1971.

20. Haas, G. C. and Ezekiel, M. Factors Affecting the Price of Hogs. Bulletin No. 50, U.S.D.A., Washington, 1926.

21. Heddon, W. P. Measuring the Melon Market. United States Department of Agriculture (mimeographed), 1924.

22. Houck, James P. Demand and Price Analysis of the United States Soybean Market. Technical Bulletin 244, St. Paul, Minnesota, University of Minnesota, Agricultural Experiment Station, June, 1963.

23. Houck, J. P. and Mann, J. S. An Analysis of Domestic and Foreign Demand for U.S. Soybeans and Soybean Products, Technical Bulletin 256, St. Paul, Minnesota, University of Minnesota, Agricultural Experiment Station, 1968.

24. Jordon, G. L. What Determines Soybean Prices? Agricultural Experiment Station Bulletin No. 546, University of Illinois, 1951.

25. Killough, H. P. What Makes the Price of Oats? Bulletin No. 1351, U.S.D.A., Washington, D.C., 1925.

26. Meinken, K. W. The Demand and Price Structure for Wheat. Technical Bulletin No. 1136, Agricultural Marketing Service, U.S.D.A., 1955.

27. Scoville, G. P. The Demand for Potatoes, Cornell University Department of Farm Management (mimeographed), 1919.

28. Smith, Bradford B. Factors Affecting the Price of Cotton. Bulletin No. 50, U.S.D.A., Washington, D.C., 1928.

29. Taylor, H. C. The Marketing of Wisconsin Potatoes. University of Wisconsin, Madison, Wisconsin, 1915.

30. Warren, G. F. and Pearson, F. A. Interrelationships of Supply and Price, A.E.S. Bulletin No. 466, Cornel University, Ithaca, New York, 1928.

31. Waugh, F. V. Factors Influencing the Price of New Jersey Potatoes on the New York Market. Circular No. 66, New Jersey Department of Agriculture, 1923.

32. Working, Holbrook. Factors Determining the Price of Potatoes in St. Paul and Minneapolis. Minnesota Technical Bulletin No. 10, St. Paul, Minnesota, University of Minnesota, 1922.

C. Periodicals

33. Cassels and Malenbaum. "Doubts About Statistical Supply Analysis, Journal of Farm Economics, Volume 20, April, 1938.

34. Durbin, J. and Watson, G. S. "Testing for Serial Correlation in Least Squares Regression", Biometrika, Volume 37, pp. 409-428, 1950, and Volume 38, pp. 159-178, 1951.

35. Ezekiel, M. "A Statistical Examination of Factors Related to Lamb Prices", Journal of Political Economy, Vol. 35, April, 1927.

36. __________. "Cobweb Theorem", Quarterly Journal of Economics, Vol. 52, February, 1938.

37. Lemon, H. W., Lips, A. and White, W. H. "Flavour Reversion in Hydrogenated Linseed Oil", Canadian Journal of Research, 23F, 1945, pp. 295-303.

38. Schultz, Henry. "The Statistical Measurement of the Elasticity of Demand for Beef", Journal of Farm Economics, Volume 6, 1924, pp. 254-278.

39. Taylor, Alonzo Englebert. "The Decline Of Price Of Cereals", Journal of Farm Economics, Vol. 4, October, 1922, pp. 193-208.

40. Tinter, Gerhard. "The Theory and Measurement of Demand", Journal of Farm Economics, Volume 21, August, 1939.

41. Walsh, Robert M. "Statistics and Research in the Field of Price Analysis", Journal of Farm Economics, February, 1949.

42. Working, E. J. "What Do Statistical Demand Curves Show?" Quarterly Journal of Economics, Vol. 41, February, 1927.

43. Working, Holbrook. "Practical Application of Correlation Studies of Prices", Journal of Farm Economics, No. 2, April, 1926.

D. Government Publications

44. Canada Department of Agriculture. The Variability Of And The Sources Of Farm Cash Income, Canada and Provinces 1926-1960. Economics Division, Ottawa, Canada, March, 1963.

45. Department of Trade and Commerce. Report on the Canadian Oilseeds Trade Mission to Japan. April 18 - May 3, 1964, Ottawa, Canada, (Mimeo), May, 1964.

46. Dominion Bureau of Statistics. Canada Yearbook. The Queen's Printer for Canada, Ottawa, Canada, 1927-71.

47. Dominion Bureau of Statistics. Farm Cash Receipts. Catalogue Number 21-001, Ottawa, Canada.

48. Dominion Bureau of Statistics. Grain Trade of Canada. Catalogue Number 22-201, Ottawa, Canada, 1953-73.

49. Dominion Bureau of Statistics. Trade of Canada - Exports. Catalogue Number 65-202. The Queen's Printer, Ottawa, Canada, 1952-71.

50. Report of the Federal Task Force on Agriculture. Canadian Agriculture in the Seventies, The Queen's Printer, Ottawa, Canada, December, 1969.

51. Royal Commission On Agriculture And Rural Life. Agricultural Markets and Prices. Report No. 8, Printed by Lawrence Amon, 1955.

52. Statistics Canada. Farm Cash Receipts, Catalogue Number 21-001, Ottawa, Canada, December, 1972.

53. Statistics Canada. Oilseeds Review. Catalogue 22-006, Ottawa, Canada, March, 1974.

E. Other

54. Food and Agricultural Organization, Production Yearbook. Rome, Italy, 1960-72.

55. ____________. Trade Yearbook. Rome, Italy, 1960-72.