

ABSTRACT
ANALYSIS OF INTRASEASONAL POTATO
PRICE MOVEMENTS

By Ivar Kristianslund

Potato prices are subject to very wide price fluctuations both from year to year and during any particular year. The intraseasonal price movements vary from year to year and are very difficult to predict. The major objective of the present study was to formulate econometric models that may explain short term fluctuations in potato prices, and to estimate the parameters of these models.

The estimated parameters of twelve econometric models have been presented, one model for each month of the year. Each model has been estimated on the basis of monthly data for the United States as a whole for the years 1952-66. The models all consist of a supply relation for potatoes, a demand relation for potatoes, and an identity. Each model was estimated by seven different estimation procedures, including ordinary least squares, two-stage squares, limited information maximum likelihood, three-stage least squares, and full information maximum likelihood.

A unique feature of the present work is that monthly sales data for potatoes for each state and for the United States as a whole for all of the sample period

have been estimated by the writer and used in the models. This estimation was based mainly on shipments and unloads data and on production and sales data for each seasonal crop, by states. The use of the estimated monthly sales data made possible the estimation of price elasticities of supply and demand for potatoes for each month of the year. Several other parameters were also estimated, among these coefficients showing the effects of changes in production of the various seasonal crops on supply in particular months.

Various economic models of the potato market were discussed, and the ones that were finally estimated were a result of a compromise because several of the desired data were lacking and others were deficient. The models may therefore be subject to specification errors and errors in variables that may have biased the results. Several of the estimated coefficients were not statistically significant different from zero, but in some cases the corresponding variables were still retained in the models on the basis of economic reasoning. The results presented in the following should therefore not be considered as final facts, but as preliminary insights that ought to stimulate new research in accordance with the principles initiated in this thesis.

The estimated demand elasticities had absolute

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values that were generally quite low compared to results from most of the earlier investigations. Reasons are given why many earlier results may be biased. Some of the supply and demand elasticities and some of the coefficients of the production variables in the supply relations had "unnormal" signs. Although single estimates may have wrong signs and magnitudes, heavy evidence is presented, both from economic reasoning and from earlier works, indicating that many of the "unnormal" results of the present work may be normal after all. If this is true, very important policy implications emerge. More research is therefore needed to test the results obtained. Several suggestions for research along these lines have been set forth in this thesis.

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CHAPTER I

INTRODUCTION

The Problem

Potato prices vary considerably not only between years, but often also from month to month within a given year. These intraseasonal price movements are a major object of the present study. Usually they follow different patterns in different years. This being the case, the following question arises quite naturally: Given a year with certain attributes or characteristics; what will be the resulting price pattern?

If the ideas of causal and interdependent relationships between potato prices and other variables are introduced, the question may, briefly speaking, be split into two new questions: (1) What are the major variables affecting potato prices during the year? (2) What are the quantitative relationships between changes in each of these variables and changes in potato prices? The first question can be analyzed by the combined use of economic theory and general information on or knowledge of how the industry operates. For an analysis of the second question, econometric theory and econometric methods are additional tools of great usefulness.

Importance of the Problem

If the two questions raised in the preceding section can be answered with some precision, this gives a basis for making relatively well-founded predictions of the price pattern that is likely to occur in a particular season. Such predictions are of considerable interest to potato growers and to others who are directly involved in the potato business. The availability of good price predictions or similar information will give them a basis for choosing a proper timing of their operations and transactions during the season. This means that they will be able to make a more efficient adjustment to the particular economic situation at a given point in time. The likely results of this are not only higher and more stable incomes to farmers and other groups, but also benefits to the rest of society.

Some knowledge of the economic structure by which potato prices are determined can be of considerable help in selecting a good program when governmental programs such as diversion programs are suggested. It can also be useful in predicting the effects of various other structural changes when such changes take place.

Objectives of the Study

The major objectives of the study were: (1) to formulate econometric models of the United States' potato economy that could explain potato price fluctuations from

period to period within a year and (2) to estimate the parameters of these models. A more subordinate objective was to investigate whether data from the United States Department of Agriculture on rail and truck shipments of potatoes could be used with benefit in analyses like the present.

It was the intention that the models with their estimated parameters should provide some basic knowledge needed to make predictions of potato prices at the farm level for various periods of a year. Still, since the investigator expected to solve only part of the prediction problem, he felt free to include in his analysis some variables for which no values are available early in the season. The very basic step in predicting potato prices is to learn how they are determined. Variables that are thought to be important must therefore be included until more is known about the price determination.

The models were formulated with the aim that they should increase our understanding of how some key variables pertaining to the potato market are determined. Thereby they should also give some guidance for choosing between policy measures.

The more detailed limitations on the objectives of the study will be clear from the section on procedure.

General Review of the Potato Economy

The following paragraphs contain some background information on the potato sector that seems relevant for a proper evaluation of the ideas, arguments, and results to be presented later.

Potatoes are grown commercially in every state of continental United States. In fact, however, the bulk of the production is highly concentrated to particular areas within certain states.¹ The most important states in terms of potato quantities sold, namely Idaho, Maine, California, and New York, accounted for 52% of total potato sales from the 1962 crop. Together with the next six states, the last of which was Michigan, they made up 77% of total sales.²

Harvesting of potatoes takes place somewhere in the United States in every month of the year. Because of differences in harvesting time and in storability of the potatoes, the group of states supplying the market is different in different parts of the year.

¹For an excellent colour map of principal potato producing areas in the United States, classified by six seasons, see August E. Kehr, Robert V. Akeley, and Geoffrey V. C. Houghland, Commercial Potato Production, Agriculture Handbook No. 267, Agricultural Research Service, U. S. Dept. of Agriculture (Washington: U. S. Government Printing Office, July, 1964), p. 10. This publication also contains other useful background information.

²Percentages computed from data in U. S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, Potatoes and Sweetpotatoes: Estimates by States and Seasonal Groups--Crops of 1962 and 1963 (Washington: August, 1964), p. 11.

The U. S. Department of Agriculture classifies the various potato crops according to the time when the bulk of the crop is usually harvested. There are six seasonal groups: Winter, Early Spring, Late Spring, Early Summer, Late Summer, and Fall. It may aid the memory to lump the early and late crops together and note that the bulk of the Winter, Spring, Summer and Fall crops are harvested during the first, second, third and fourth quarter of the calendar year, respectively. The early crop is harvested during the first half of the quarter while the corresponding late crop is harvested during the second half.

In most states one or two seasonal groups of potatoes are grown. For North Carolina and Texas the number is three. In California potatoes belonging to five different seasonal groups are grown at the present.¹

Since there is some overlapping and variation in harvesting time, the seasonal classification is necessarily somewhat arbitrary.² This is especially true for

¹The seasonal groups of potatoes grown in each state are listed in Reginald Royston, Oakley M. Frost, and Frasier T. Galloway, Potatoes and Sweetpotatoes: Usual Dates for Planting, Harvesting, and Marketing by Seasons, in Principal Areas, Agriculture Handbook No. 127, Crop Reporting Board, Agricultural Marketing Service, U. S. Dept. of Agriculture (Washington: U. S. Government Printing Office, June, 1957), p. 5. This publication has been a most valuable source of information for the present investigation. It contains dates for each individual state.

²Ibid., p. 3.

the distinction between Late Summer and Fall potatoes. The consumer has no way of distinguishing between these two crops, and the grower has a definite possibility for varying the harvesting time for the Late Summer crop in response to economic stimuli.¹

Potatoes from the Fall crop are marketed throughout most of the year. The usual marketing periods for the other crops, with the exception of some Late Summer potatoes, generally follow shortly after harvest.²

The Fall crop is by far the most important crop. In 1958 the percentages of total production accounted for by the various seasonal categories were as follows: Winter 2.2, Early Spring 2.1, Late Spring 10.3, Early Summer 6.2, Late Summer 13.5, and Fall 65.7.³

Potatoes are used fresh for food (54,3%), for processing (23,9%), for seed (7,9%), and for livestock feed, shrinkage and loss (9,2%). The percentages shown in parentheses refer to production in 1962. Minor quantities were also used for non-food industrial uses (starch) or were exported. Almost half of the processed

¹The content of this statement has been pointed out to the writer by several officials of the U. S. Dept. of Agriculture.

²Royston, Frost, and Galloway, op. cit., p. 4.

³Pinhas Zusman, "Econometric Analysis of the Market for California Early Potatoes," Hilgardia, Vol. XXXIII (December, 1962), p. 554. The organization of the present section is partly borrowed from Zusman's work.

quantity was used for potato chips. Almost two-thirds of the other half were used for frozen prepared potato products, mainly frozen french fries.

Potato utilization as well as production varies from year to year and has also been subject to certain trends in the past. Most remarkable is the rapid increase in processing. In 1951 18 million hundredweight or 9.2% of production was processed. The corresponding figures for 1962 were 64 million hundredweight or 23.9%. Fresh consumption has declined correspondingly so as to keep the level of total per capita consumption approximately constant since 1951.¹

Procedure

The present section gives an outlook over the approach that was taken to fulfill the objectives of the study. Some reasons why this particular approach was chosen are also given.

¹The figures in this paragraph and in the preceding one were quoted from or computed on the basis of figures from National Potato Council, U. S. Production, Utilization, and Use of Designated Crops. ([Washington]: National Potato Council, January, 1964).

For a more detailed discussion of trends and changes in consumption, production, marketing and utilization of potatoes, see Will M. Simmons, An Economic Study of the U. S. Potato Industry, Agricultural Economic Report No. 6, Economic and Statistical Analysis Division, Economic Research Service, U. S. Dept. of Agriculture ([Washington]: March, 1962), pp. 1-20 and pp. 24-29. See also U. S. Dept. of Agriculture, Potato Charts and Tables ([Washington]: [1965]), pp. 2-32.

Basic Concepts

Ample use was made of the well-known concepts of supply and demand. In principle the farm gate was considered the dividing line between suppliers and demanders. Now, some potatoes are used on the farms where they are grown: They are used for seed or livestock feed, they are consumed in households, or they disappear as shrinkage and losses. These potatoes used on farms where grown were not considered as demand in the present analysis, but they were taken into account in that they were allowed to affect supply from farms. Supplied quantity in this analysis is identical with quantity sold from farms. Foreign supplies were taken into account in that they were subtracted from exports to give net exports.

The demand concept used was demand at the farm level. Potatoes are demanded for several purposes: fresh use, various forms of processing and manufacture, seed, livestock feed, diversion by the government to inferior uses, addition to stocks held by local dealers and others, and net exports. The two last mentioned kinds of demands may be either positive or negative.

Potatoes are often bought and resold several times until they are finally demanded for one of the purposes listed above¹ and thereby removed from the

¹Stock changes excepted.

market. Conceptually, however, one may disregard most of these intermediate transactions and concentrate the attention on final demands and their determinants. Changes in the factors determining ultimate demands are then thought to be reflected backwards via the various marketing channels to the farm level.

The fact that some potatoes are sold to processors or others according to contract before they are harvested or even before they are planted caused some conceptual difficulties. Since no separate data are available on these sales, about the only thing that could be done, without going into an extensive amount of detail, was to assume that these sales, on the average, did not seriously bias the results of the analysis in any particular way. The bulk of the potatoes are sold in the open market.

Aggregation of Utilizations

It would have been very interesting to have separate demand equations for various utilizations such as fresh use, processing, seed, feed, etc. If demand elasticities are different, as they probably are, estimates of their magnitude would have provided useful information. Since the necessary data on utilization are not available except on a yearly basis, however, most demands had to be aggregated into one group in the models.

Geographical Aggregation

Potatoes are shipped very long distances: from one end of the country to another. Potato markets in different parts of the country are therefore directly or indirectly interrelated. At the same time, because of the bulk and weight of the commodity and the long distances, transportation costs are considerable, and prices for the same quality of potatoes may differ quite a bit between regions at times.

For some purposes it would have been useful to divide the country into a relatively small number of regions and to treat these simultaneously in one model. The complexity of the market and the unavailability of some crucial data series made this very difficult and time-consuming, however. It was therefore decided to deal with the U. S. as a whole. It is clear enough, however, that as far as supply is concerned, the use of short time periods in the analyses is to some extent a substitute for geographical disaggregation.

Time Unit

The relevant choices were to use models based either on monthly data, seasonal data,¹ or data for cer-

¹I. e. data pertaining to each of the six time periods used by the U. S. Dept. of Agriculture to define seasonal groups of potatoes. See above, p. 5.

tain aggregates of seasons. The more aggregated models are the easier ones to deal with, but they provide less information than the disaggregated ones.

Since the marketing periods for various seasonal groups of potatoes overlap, and especially since Fall potatoes are marketed in considerable amounts during the harvesting periods of most other potato crops, the total production or sales figures that are available for each seasonal group do not usually tell very much about total consumption or purchases of potatoes during each seasonal period. The stocks data that are available for the Fall crop give some information on the rate of disappearance of Fall potatoes during certain periods of the year, but there are two reasons why these data are not well suited for being used together with data on total sales to determine the rate of marketing of the Fall crop from farms:

(1) The stocks data include not only stocks held by farmers, but also stocks held by local dealers. (2) The stocks held by farmers include not only stocks intended for sale, but also stocks intended for use on the farms for seed, etc.

In sum, the seasonal data were not very well suited for an analysis of supply and demand at the farm

level based on distinct time periods like quarters and half quarters. They seemed to be about equally well suited for a similar analysis based on months. No more information on utilization exists for seasons than for months.¹ In Chapter IV a method of converting seasonal sales data into monthly sales data by means of shipments data will be described. Provided that this method is basically sound, it seemed like the availability of data did not point strongly in the favour of a seasonal analysis rather than a monthly analysis. Since much information might be gained by a disaggregation, it was decided to work with monthly data.

Type of Model and Estimation Procedure

It was decided to aim at estimating what econometricians call structural parameters, insofar as the available data would permit this to be done.² Since the economic relationships under investigation involved more than one endogenous variable, it was clear in the light of

¹Except for farm utilization which is of less importance in this connection.

²For a classical discussion of the desirability of structural estimation, see Jacob Marschak, "Economic Measurements for Policy and Prediction," Studies in Econometric Method, ed., Wm. C. Hood and Tjalling C. Koopmans, Cowles Commission for Research in Economics, Monograph No. 14 (New York: John Wiley & Sons, Inc., 1953), pp. 15-26. See also Arthur S. Goldberger, Econometric Theory (New York: John Wiley & Sons, Inc., 1964), p. 365 and pp. 376-380.

economic theory that a simultaneous equation's model was called for if consistent estimates of the parameters were to be obtained.

Several estimation procedures were compared: ordinary least squares, two-stage least squares, limited information maximum likelihood, three-stage least squares, and full information maximum likelihood.

Sample Period

The years directly included in the initial analysis were 1952-64. For the lagged variables, values for 1951 were also used. There are several reasons why years prior to 1952 were not included in the analysis: The price support operations that took place earlier were ended in 1950.¹ Still, the acreage of Fall potatoes planted in 1950 was larger than in the following years, however, and this must have affected marketings in the first half of 1951. In 1951, price ceilings were also in effect.² Another reason for limiting the analysis to the period 1952-64 was that processing played a much more

¹For details regarding these operations and their ending, see Roger W. Gray, Vernon L. Sorenson, and Willard W. Cochrane, An Economic Analysis of the Impact of Government Programs on the Potato Industry of the United States, North Central Regional Publication No. 42 (University of Minnesota Agricultural Experiment Station, June, 1954), pp. 39-41.

²This fact came to the present writer's attention at the reading of Martin S. Simon, "Forecasting Potato Prices," 1961 American Potato Yearbook, ed., C. Stedman Macfarland, Jr. (New Jersey, By the editor), pp. 29-30.

important role in this period than earlier. If years prior to 1949 had been included, additional data problems would also have emerged.

The present investigation was almost completed at the end of 1965. For various personal reasons, the writing was not finished until 1971, however.

Most of the experimentation with various models, described later in this work, were based on data for the years 1952-64. At the end of 1967 and beginning of 1968 all data series were extended to cover the years 1965-66, however. At that time also some of the data for earlier years had been revised by the agencies collecting them, and the data series used in the computations were therefore revised accordingly. Thereafter the models that had been considered the final ones at the end of 1965 were reestimated in a slightly revised form, on the basis of the updated time series for 1952-66. All the numerical results presented in this work are thus based on updated time series.

CHAPTER II

SOME PREVIOUS STUDIES

In the present chapter a selection of earlier works on potato price movements during the year will be reviewed briefly. Space does not allow a recording of the numerical results from these studies. Attention will be concentrated on the relationships between the earlier studies and the present one in regard to methodology. Differences and similarities in scope and methods will be mentioned, and due credit will, as far as possible, be given to the earlier investigators for adopted information or ideas.

A very early analysis of factors affecting potato prices is found in a publication by Holbrook Working.¹ Since the methodology Working used in analyzing intra-seasonal price movements is representative also for other early investigations, it will be described in some detail. The following quotation is illustrative: "The best way to begin a study of the price of potatoes, is by considering

¹Holbrook Working, Factors Affecting the Price of Minnesota Potatoes, Technical Bulletin 29 (St. Paul: University of Minnesota Agricultural Experiment Station, October, 1925), pp. 1-40.

the factors which affect the average price for the entire season."¹ Having measured the average effect of five factors which explain most of the changes from one year to the next in the average price for the season, Working proceeds to deal with seasonal change in the following way: A table is presented that shows for each month price as a percentage below or above the average price for the season.² These percentages are averages based on data for several years. Given a price forecast for the season, a price forecast for a particular month can be obtained by applying the appropriate percentage.

The method just described represents a good early attack on the problem of seasonal price variation. Working himself was well aware of its inadequacy, however. The state of the problem at the time of his writing may be summarized by the following quotation:

It is not so easy to explain the changes in price during any one season. A general explanation of the causes of the changes can be given but no method has been found for determining what part of each change is due to each cause.³

¹Ibid., p. 4. It should be noted that Working was primarily interested in the price of potatoes in Minnesota for the nine-month season from September to May. At the time of his study, econometric theory and the available data were more inadequate than today. Even though a major idea behind the present work is that Working's statement is wrong in general, it is admitted that the statement may have been more appropriate under the circumstances when it was stated.

²Ibid., p. 25.

³Ibid., p. 24.

Frederick V. Waugh¹ and R. B. Heflebower² used essentially the same method as Working in dealing with seasonal prices changes. Heflebower, like Working, seems to have felt that much was still to be done:

The monthly estimates of prices are less accurate than the estimates of the season's average prices. The movement of prices throughout the season is very irregular and prices are often higher in the fall than in the spring.³

The later studies to be mentioned are based on somewhat different methodology. Some investigators split the year into a couple of seasons--usually aggregates of seasons defined by the U. S. Department of Agriculture--and deal with average prices for each of the seasons. Other investigators try to predict a monthly average price, but they deal with only one or a couple of isolated months, the price in which they feel is crucial.

D. Milton Shuffett analyzed the factors that affect the price of what he called (1) the Early commercial crop, and (2) the Late Surplus crop.⁴ Similar

¹Frederick V. Waugh, Forecasting Prices of New Jersey White Potatoes and Sweet Potatoes, Circular No. 78 (Trenton, New Jersey: State of New Jersey Dept. of Agriculture, July, 1924), pp. 16-18.

²R. B. Heflebower, Factors Relating to the Price of Idaho Potatoes, Bulletin 166 (Moscow, Idaho: University of Idaho, June, 1929), pp. 6-8.

³Ibid., p. 8.

⁴D. Milton Shuffett, The Demand and Price Structure for Selected Vegetables, Technical Bulletin No. 1105, Agricultural Marketing Service, U. S. Dept. of Agriculture (Washington: U. S. Government Printing Office, December, 1954), pp. 44-67.

studies on a more disaggregated basis, geographically, were made by Kenneth W. Meinken.¹

A study by Dana G. Dalrymple is different.² The purpose of Dalrymple's study was "to explore a method of statistically predicting average August prices in March, early enough to influence planting intentions."³ Although the statistical results did not turn out very well--another indication that much was still to be done--the publication serves as a useful reference work on the problem. Dalrymple has summarized the basic difficulties to be solved very clearly in the following statement:

It therefore appears that the big problem in predicting monthly potato prices will not necessarily be the problem of measuring year-to-year supplies of potatoes, but of measuring the more elusive variation in month-to-month supplies--greatly complicated by seasonal and economic variations in planting, harvesting and marketing. This problem is indeed a formidable one and one which will probably need much more study if monthly prices are to be predicted with accuracy.⁴

¹Kenneth W. Meinken, Factors that Affect Price and Distribution of New Jersey Potatoes, Bulletin 786 (New Brunswick: New Jersey Agricultural Experiment Station Rutgers in cooperation with Maine Agricultural Experiment Station, June, 1957), pp. 17-29.

²Dana G. Dalrymple, Predicting August Potato Prices at Planting Time, Progress Report 29 (Storrs, Connecticut: Storrs Agricultural Experiment Station and the Agricultural Extension Service, University of Connecticut, February, 1959. Reprinted 1962 by the Division of Agricultural Economics Programs, U. S. Dept. of Agriculture), pp. 1-47.

Ibid., p. 1.

⁴Ibid., p. 15.

In a study of the Michigan March price Ronald A. Hagaman followed an approach similar to the one of Dalrymple.¹ Again, the statistical results left much to be desired.

Among the works that will be dealt with here, the next one to appear was a work by Martin S. Simon.² Simon was interested in forecasting prices of fall crop potatoes, and he used price series for Maine. He worked with three seasonal periods, namely (1) September-November, (2) December-February, and (3) March-May.

As much as four simultaneous equations seem to have been employed in the first period, the corresponding endogenous variables being price, free-market disappearance, government-assisted disappearance, and December 1 stocks. Details regarding model-specification and estimation are not presented. A chart for the second period shows a good fit for the two years (1959-60) immediately following the sample period, as well as for the sample period itself. Since the analyses were based upon observations for only eight years, the results, as presented, are difficult to evaluate in a fair way. No results are presented for the first period. For the third seasonal period, actual

¹Ronald A. Hagaman, "An October Prediction of the Michigan March Price for Potatoes at the Farm Level," (unpublished Master's dissertation, Dept. of Agricultural Economics, Michigan State University, 1959), pp. 1-94.

²Simon, op. cit., pp. 27-33.

and computed prices are shown for the years 1955-60. The direction of price change from mid-January to March-May or to May was indicated correctly by the calculated prices or price forecasts for all the years shown (upwards in all but one year). Very much was left to be desired in regard to indicating the magnitude, however.

A report from the U. S. Department of Agriculture, by Will M. Simmons, was an important source of general information on the potato economy for the present work.¹ The report also contains interesting results from regression analyses of seasonal, regional and intraregional production-price interrelationships. Several equations are presented, but with the exceptions of the ones for Late Spring and Early Summer, they were all based on data for two or more seasonal groups pooled together. Among the results with implications for the present work was the fact that larger production of Winter and Spring potatoes was associated with higher prices for the Late Summer and Fall crops.²

The analyses considered so far, with the exception of Simon's work, were conducted by single equation techniques. In a study by Pinhas Zusman, a comprehensive econometric model was employed in analyzing the market for California early potatoes and the interrelationships of

¹Simmons, op. cit., pp. 1-83.

²Ibid., pp. 49-53 and pp. 79-83.

this market with the rest of the United States' potato market.¹ Zusman's model consisted of fourteen equations, but the nature of the system required only four to be estimated simultaneously. Only two seasonal markets were distinguished, namely September-February and April-August. The Winter crop, which is small, was disregarded, and some simplifying assumptions were made in order to arrive at certain identities. Consumption data could then be derived from production data and data on stocks, seed use, etc.

In spite of the seasonally aggregate nature of Zusman's study compared with the present one, the study offered several valuable suggestions for the present work. An experience of Zusman, worth noting, is the following:

An attempt to estimate a set of simultaneous demand relations at the farm level, for which separate price series [by seasonal groups] exist, failed to yield reasonable results. It also failed to recognize explicitly the locational aspects of the system.²

In the second part of his study, Zusman analyzes the static and dynamic properties of the estimated model. An interesting result is the suggestion that the large

¹Zusman, op. cit., pp. 539-668.

²Ibid., p. 574.

observed short-run fluctuations in prices and quantities are primarily due to random shocks and only secondarily due to erratic changes in exogenous variables. If this is true, one might expect it to be even more so for monthly data.

After the present work had been almost completed, a study by Olman Hee was published.¹ Since Hee's work became available so late, it will be commented on only briefly here.

Models were estimated for the following categories of potatoes: (1) Late Summer and Fall, (2) Winter and Early Spring, (3) Late Spring, and (4) Early Summer. The models were also tested for predicting ability by means of observations for three years beyond the period of fit.

The predictions of seasonal average prices presented for each of the four categories of potatoes were generally not bad. No attempt was made to attack the more intricate problem of predicting prices for shorter periods, such as months, however.

The works just reviewed and several other ones have thrown much light on the problem of price variation for potatoes during the year. Relatively little success

¹Olman Hee, Demand and Price Analysis for Potatoes, Technical Bulletin No. 1380, Economic and Statistical Analysis Division, Economic Research Service, U. S. Dept. of Agriculture (Washington: U. S. Government Printing Office, July, 1967).

has been experienced in dealing with monthly, or even with seasonal, data, however. The problem of overlapping among seasons, which is a very important difficulty in dealing with short seasonal periods, has still not been solved.

Drawing heavily on knowledge gathered by earlier investigators, the present writer attempts to approach this and the related problems in a principally new way. The road to follow was essentially pointed out by Dalrymple when he suggested measuring variations in month-to-month supplies.¹ One of the most serious hindrances for carrying out such a program is the lack of adequate data. The present writer attempts to build a bridge over this hindrance by systematically utilizing the available data on shipments, unloads, and sales of potatoes.

¹See quotation above.

CHAPTER III

MAJOR DATA SERIES AND THEIR SOURCES

Data from the United States Department of Agriculture

Shipments and Unloads Data

The shipments and unloads data are dealt with directly in three different places in this thesis. A recording of sources and general description of the data is given in this chapter. In Chapter IV the basic principles and procedures employed in using these data (together with data on total sales of potatoes by seasonal groups) for obtaining monthly sales data for potatoes are described. Appendix C contains some further details regarding the data and their use.

Shipments data

Monthly data on shipments of potatoes by various means of transportation (mainly rail and truck) are collected and reported for each state by the United States Department of Agriculture in an

annual publication.¹ Preliminary data for January through July, 1965 were obtained directly from the Department.² In 1967 when the data series were updated, preliminary data for January through July 1967 were provided in the same way.³ The rail shipments data through April were final.

The shipments data were used very extensively (essentially as weights) in the present work in constructing hitherto unavailable monthly sales data for potatoes. These sales data were used as primary data in the econometric analyses. Other research workers may be interested in using the same data or in constructing similar data by an improved method. In the following the shipments data will therefore be dealt with in more detail than the other data used in the analyses.

¹See U. S. Dept. of Agriculture, Consumer and Marketing Service, Fruit and Vegetable Division, Market News Branch, Fresh Fruit and Vegetable Shipments by Commodities, States, Months, Calendar Year, 1966 (Washington: June, 1967), p. 17. Annual issues for 1950-66 by variously denominated agencies of the Dept. of Agriculture were used in the present work. Some data that are more disaggregated over time and geographically are also available.

²Letter from J. M. Saylor, In Charge, Transportation Reports, Fruit and Vegetable Division, Agricultural Marketing Service, U. S. Dept. of Agriculture, Washington, October 6, 1965.

³Idem, letter, November 9, 1967.

The major sources for the information given in this thesis regarding the shipments data were the prefaces to the annual publications and the footnotes to the table in these.¹ Since it was difficult to determine, in some cases, whether information given for one year, for a series of years, also pertained to the rest of the sampling period, and since also some other questions remained unanswered, a list of questions was sent to Mr. J. M. Saylor of the Fruit and Vegetable Division. The received letter with answers to these questions served as a supplementary source.

A summary description of the data, based on the sources just mentioned, is given below. Where the given information is somewhat uncertain, terms are used that indicate this.

The nature of the sources of the shipments data is indicated in the following quotation:

Arrangements are maintained with all originating railroads in the United States to report all shipments of certain fresh fruits and vegetables moving in commercial wholesale channels. We can, therefore, assume that rail shipments reported in our summaries are 100% complete. Similar arrangements for reporting motortruck movements are not feasible. The Market News Service maintains seasonal shipping point offices in all principal producing areas during the main shipping seasons. Officers in charge report the truck shipments. There are two principal sources for these data.

¹U. S. Dept. of Agriculture, Agriculture Marketing Service, Fruit and Vegetable Division, Market News Branch, op. cit.

The Federal-State Inspection Service reports the quantities of potatoes they have inspected which are scheduled for truck movement. The market reporter contacts shippers direct for the quantities moving via truck which are not inspected. We do, therefore, feel that we have a fairly high percentage completeness for motortruck movements. We are not in position, however, to affirm the percentage completeness of motortruck shipments for any State.¹

Actually, four means of transportation are distinguished, namely rail, truck, truck-to-boat, and rail-truck (piggy back). Rail-truck shipments are reported only under rail and have been treated as rail in the present study. The distinction between rail and rail-truck need therefore not be upheld. Truck-to-boat shipments are in some cases included in truck shipments without identification. This is as it should be for the purpose they are used in the present work. In other cases they are reported under rail shipments, but then they are identified by "Boat" or "BT" after the name of the state. In the latter cases these shipments were separated from the rail shipments in the present work and added to the truck shipments. After this had

¹Letter from J. M. Saylor, In Charge, Transportation Reports, Fruit and Vegetable Division, Agricultural Marketing Service, U. S. Dept. of Agriculture, Washington, August 13, 1965. It should be noted that, according to this letter, "no detailed analyses of the shipments data are made by the Market News Service other than the introductory comments carried in the preface of each publication." Certain questions regarding the data can therefore not be answered in an exact manner. Mr. Saylor was asked to give the best information or judgement he could provide.

been done, only two groups, in the following called "rail" and "truck", had to be dealt with. The important thing to notice is that in no case are rail-truck and truck-to-boat shipments reported more than once.

Insofar as possible there are no duplications whatsoever, neither in rail, nor in truck shipments. Potatoes produced in one state and shipped from the neighbour state are counted in total shipments only once. Rail shipments represent only carlots moving on initial line-haul waybills.

Truck shipments, as well as rail shipments, represent only domestic shipments during the whole period. Imports are reported separately.

All the data, as they come from the United States Department of Agriculture, are expressed in carlots, or for truck, actually carlot equivalents. The weights of the truck shipments are presumably known originally, and these shipments are converted to carlot equivalents by means of conversion factors expressing the number of pounds of potatoes necessary to make up one carlot equivalent. A set of conversion factors for various groups of states and, in some cases, for different parts of the year, were established from January 1, 1950. These were revised, effective January 1, 1960, and were revised again, effective January 1, 1966. The reason why such revisions are necessary is illustrated

in the following quotation:

Conversion factors are based upon the "most usual" rail loadings from principal producing areas in effect at the time the factors were established. Rail loadings increased during intervening years as larger rail cars became available and improved packaging and loading methods were devised. Another factor accounting for heavier loadings was establishment of incentive rates made on graduated scales of multiple carload minimum weights, with the per cwt. rate being lower as the carload minimum weight increases.¹

In effect, rail shipments are expressed in a unit that may vary all the time in any way consistent with loading practices.

Truck shipments, on the other hand, are expressed in a unit that contains a constant number of pounds as long as a certain period, a certain group of states, and (in some cases) a certain part of the year is dealt with. When these specifications are relaxed, the magnitude of the unit may change quite drastically.²

The completeness of the data was mentioned earlier.³ This question has three important aspects: (1) Are any data reported at all for a certain state in a given year? (2) If data are reported, what percentage do the reported figures make up of total shipments? (3) Given that only a part of total shipments are in-

¹Ibid.

²The conversion factors established in 1950, 1960 and 1966 are listed in Appendix C.

³Above, p. 24.

cluded in the reported figures, do all categories of shipments (shipments for fresh use, seed, processing, shipments from various seasonal crops, and so on) make up approximately the same percentage of reported shipments as of total shipments, or are certain kinds of shipments under-represented or not represented at all in reported shipments? The first question can always be answered, and the second one will be dealt with later. The third question is difficult to answer. The following quotation gives part of the answer:

Rail and truck shipments include potatoes intended for fresh consumption, seed (these sometimes are diverted to fresh consumption), and government purchases. Potatoes to chippers are also reported. No shipments to processors or for manufacture have been reported since 1955.¹

Some minor omissions and irregularities in the shipments data and adjustments for these are dealt with in Appendix C.

Unloads Data

Truck unloads data were used in the present study

¹Saylor, letter, August 13, 1965. Similar information has also been received in letter from Clarence E. White, Agricultural Statistician in Charge, Statistical Reporting Service, U. S. Dept. of Agriculture, Boise, Idaho, September 28, 1965. From this letter we quote the following: "All fresh shipments and all seeds are included. Apparently 'long haul' shipments to processors (mainly chippers) are included. About the only thing excluded is short haul rail movement to processors. One of the reasons all processor shipments are not excluded is inability to identify them."

as a substitute for truck shipments data in cases when the latter were not available. The unloads data that were used are of a similar nature as the shipments data, but they show quantities of potatoes unloaded in certain selected cities by month and state of origin rather than quantities shipped from the same state. Since unloads data cover a limited selection of cities, they are in general less complete in coverage than the corresponding shipments data when the latter are available.

A question also arises as to how representative they are for the shipment pattern of a given state. Fortunately, the number of included cities is quite large, and the cities are spread all over the United States. One may therefore expect the seasonal pattern of unloads in these cities to be similar to the pattern for total unloads, although there is a possibility, of course, that certain kinds of unloads, like unloads of seed, are not included to the same extent, relatively, in the unloads data as in total unloads.

Another reason why unloads data may not be quite comparable with shipments data is the fact that transportation takes time. A few shipments that take place, say, in the end of October are therefore reported as unloads in November. On the other hand, this is compensated for more or less in that some September shipments are unloaded in October. Since truck transportation mostly is

used for relatively short distances, the time lag is usually only a few days, and the possible bias is probably not important.

The unloads data were obtained in several different ways. Data for 1950-57 had to be taken from individual city reports and then added together for each state.¹ For the years 1958-62 data were obtained directly from the Department of Agriculture.² Data for 1963-66 were taken from four annual publications.³ In 1965, data for January through July, 1965 were extracted from an IBM run showing potato unloads by cities and states of origin.⁴ In 1967 when the time series were updated, data for January through July, 1967

¹See U. S. Dept. of Agriculture, Agricultural Marketing Service, Fruit and Vegetable Division, Detroit: Unloads of Fresh Fruits and Vegetables, 1957, p. 23. Annual issues for 1950-57 were used. Corresponding publications were also used for the other cities (about 15-25 cities).

²Letter from J. M. Saylor, In Charge, Transportation reports, Fruit and Vegetable Division, Agricultural Marketing Service, U. S. Dept. of Agriculture, Washington, August 25, 1965.

³See U. S. Dept. of Agriculture, Consumer and Marketing Service, Fruit and Vegetable Division, Market News Branch, Fresh Fruit and Vegetable Unload Totals for 41 Cities, Calendar Year 1966 (Washington: U. S. Government Printing Office, March, 1967), pp. 35-36. The annual issues for 1963-66 were used.

⁴Saylor, letter October 6, 1965.

were again obtained directly from the Department of Agriculture.¹

Price Data

The price data that were used for potatoes in the present study are essentially monthly average prices received by farmers in the United States as a whole. These prices are reported by the United States Department of Agriculture. Prices for 1950-55 were obtained from a supplement to Agricultural Prices.² Prices for 1956-58 were taken from monthly issues of Agricultural Prices.³ For the years 1959-66, prices were obtained from the annual issues of Agricultural Prices.⁴ The latest available revised figures were used in each case.

The prices refer to all potatoes being sold in a given month, regardless of the year harvested.⁵ They

¹Idem, letter, November 9, 1967.

²U. S. Dept. of Agriculture, Agriculture Marketing Service, Crop Reporting Board, Agricultural Prices, January 1957, Supplement No. 2, Potatoes: Monthly and Season Average Prices Received by Farmers, by States and United States, 1949-56, p. 10.

³See Agricultural Prices, February 1957, p. 19; January 1958, p. 20; and January 1959, p. 20.

⁴See U. S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, Agricultural Prices: 1966 Annual Summary (Washington: U. S. Government Printing Office, June, 1967), pp. 22-23. The annual summaries for 1959-66 were used.

⁵Ibid.

also refer to the first point of sale.¹ Some further details regarding the price data and their comparability over time are given by Dalrymple.²

Farm-Retail Spreads

Monthly data on farm-retail spreads for potatoes for the United States as a whole were received directly from the United States Department of Agriculture.³ These data are closely related to the difference between retail prices for potatoes reported by the Department of Labor and prices received by farmers, reported by the Department of Agriculture.⁴

Utilization Data

Data on quantities (hundreweight) of potatoes processed from the crops of each of the calendar years

¹Ibid., p.4

²Dalrymple, op. cit., pp. 18-19.

³Letters from Forrest E. Scott, Leader, Marketing Resources and Cost Group, Marketing Economics Division, Economic Research Service, U. S. Dept. of Agriculture, Washington, July 1, 1965, and November 9, 1967.

⁴For further details regarding the farm-retail spreads, see U. S. Dept. of Agriculture, Agricultural Marketing Service, Marketing Research Division, Farm-Retail Spreads for Food Products, Miscellaneous Publication No. 741 (Washington: U. S. Government Printing Office, November, 1957), pp. 1-95.

1956-66 were obtained from the Department of Agriculture.¹ Similar data for the crops of the calendar years 1951-56 have been reported by the National Potato Council.² These data were converted to hundredweight, assuming that one bushel = 0.6 hundredweight. Still, the data from the two sources did not agree for the overlapping year 1956.

Basically, two time series on potato processing for the period 1951-66 were used in the present work. The first one was intended to express total quantity of potatoes processed, except for starch and flour. The second one was an expression for quantities of potatoes processed as chips and shoestrings. Both series were constructed by linking data from the two sources together and by using the actual data from the Department of Agriculture for the years 1957-66.

Data on total processing for the years 1951-56 were obtained in the following way: For the years 1951-55 it was assumed that data on processing as ships from

¹See U. S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, Irish Potatoes: Utilization of 1966 Crop with Comparisons (Washington: September 7, 1967) p. 3. The annual publications for each of the crops of 1960-66 were used.

²National Potato Council, "U. S. Production, Utilization, and Use of Designated Potato Crop," National Potato News, Vol. IV (January, 1957), p. 11.

the National Potato Council and the figure for total processing from the Department of Agriculture was used.

Data on processing for chips for the years 1951-56 were obtained by multiplying the series of data from the National Potato Council by a constant factor (less than one). This factor was determined in such a way that the product for 1956 was equal to the corresponding processing figure from the Department of Agriculture.

Data on Diversion of Potatoes to Starch,
Flour, and Livestock Feed Under
Government Programs

Weekly data on total quantities of potatoes diverted in the United States as a whole were received directly from the United States Department of Agriculture. Corresponding data, not by weeks but for the whole Fall crop or Late Summer and Fall crops combined, were obtained for each state from the same source.¹ The weekly data were converted to monthly data. Data for weeks beginning in one month and ending in another were distributed on the two months in proportion to the number of its working days belonging to each month.

¹Letters from E. J. Holcomb, Acting Chief, Vegetable Branch, Fruit and Vegetable Division, Consumer and Marketing Service, U. S. Dept. of Agriculture, Washington, September 9, 1965, and November 9, 1967.

Data on Production, Sales from Farms, and Related Magnitudes

Several data series related to production were used in the present work. Some were included directly in the econometric analyses, while others provided information on trends, variabilities, and relative magnitudes of various variables, thus aiding the construction of relevant models.

Data on production; quantities sold from farms; acreages planted; stocks; and quantities used on farms where grown for (1) seed, (2) feed, shrinkage, and loss, and (3) household use, were obtained from publications from the Department of Agriculture.¹ All these data, except the stocks data, are available by seasonal groups, and by states. The stocks data refer to total stocks of Fall potatoes held by growers and local dealers in the 26

¹See U. S. Dept. of Agriculture, Agricultural Marketing Service, Crop Reporting Board, Potatoes: Estimates in Hundreweight by States 1866-1953, Statistical Bulletin No. 251 (Washington: U. S. Government Printing Office, June, 1959), pp. 3-95. Data for 1954-59 were taken from U. S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, Potatoes, Sweetpotatoes, by States and Seasonal Groups, Crops of 1954-1959, Statistical Bulletin No. 291 (Washington: August, 1961), pp. 5-35. For the years 1960-64, annual publications were used as sources in 1965. See idem, Potatoes and Sweetpotatoes: Estimates by States and Seasonal Groups--Crops of 1963 and 1964 (Washington: August, 1965), pp. 4-13. When the time series were updated in 1967, a corresponding annual publication was used to provide data for 1965 and 1966, while revised data for 1959-64 were obtained from idem, Potatoes, Sweetpotatoes: By States and Seasonal Groups--Crops of 1959-1964, Statistical Bulletin No. 409 (Washington: U. S. Government Printing Office, July, 1967).

states where Fall potatoes are grown. These data are available for December 1, January 1, February 1, and March 1, respectively. Total stocks consist of production less total disappearance to date.¹

In 1965, indicated acreage and production figures were used instead of the unavailable actual figures for the Winter, Late Spring, and Early Summer crops of California that year. The Winter and Early Spring crops of Florida were treated the same way.² Data on total sales were also needed and were estimated by assuming that the ratio of sales to production was the same as in the preceeding year. When the time series were updated in 1968 the unavailable sales data were obtained by a similar procedure. But this time actual production and acreage figures were used for the last year for which data were needed.³ The effects on the econometric results of the manipulations described in this paragraph are probably negligible.

¹Ibid., P. 34.

²The data were taken from U. S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, Crop Production, United States Crop Summary as of October 1, 1965 (Washington: October 11, 1965), p. 53.

³The production and acreage figures were taken from idem, Crop Production, 1967 Annual Summary, Acreage, Yield, Production, by States (Washington: U. S. Government Printing Office, December 19, 1967), p. 95 and p. 98.

Certain reclassifications between the Late Summer and Fall crops have taken place during the period 1952-66, but these are of little significance for the present work.

Space does not permit a treatment of the methods by which the data are collected and prepared.¹

Data From Other Sources

Exports and Imports by Months

Data on total exports and total imports of potatoes by months were used to compute a series of net export figures. These data are reported by the Bureau of Census.²

¹These questions are dealt with in U. S. Dept. of Agriculture, Statistical Reporting Service, Statistical Reporting Service of the U. S. Department of Agriculture: Scope, Methods, Miscellaneous Publication No. 967 (Washington: U. S. Government Printing Office, December, 1964), pp. 62-74. See also Thirteenth National Potato Utilization Conference, Proceedings (Riverhead, New York, 1963), pp. 16-18.

²U. S. Dept. of Commerce, Bureau of the Census, U. S. Exports: Commodity by Country, December, 1966 (Washington: U. S. Government Printing Office, March 1967, p. 40. Corresponding variously denominated monthly publications from the Bureau of the Census were used for the whole period 1951-66. For import data, see U. S. Dept. of Commerce, Bureau of the Census, United States Imports of Merchandise for Consumption: Commodity by Country of Origin, January, 1964 (Washington: U. S. Government Printing Office, April, 1964) p. 16. Corresponding monthly publications were used for each month back to January 1951. The way of recording has been somewhat different since February, 1964. See U. S. Dept. of Commerce, Bureau of the Census, U. S. Imports of Merchandise for Consumption, December, 1966 (Washington: U. S. Government Printing Office, April, 1967), p. 22. Data for February, 1964 through October, 1966 were obtained from corresponding monthly publications.

Income and Population Data

The income variable used was based upon disposable personal income. (Seasonally adjusted quarterly totals at annual rates). The income data are reported by the Department of Commerce.¹ As was the case for other data, the latest available figures were always used.

The quarterly income data were divided by interpolated population for the middle of the quarter.² The interpolations were based upon population figures for

¹See U. S. Dept. of Commerce, Office of Business Economics, Business Statistics, 1965, Biennial Edition. A Supplement to the Survey of Current Business (Washington: U. S. Government Printing Office, August, 1965), p. 7. Earlier Editions were also used: 1955, p. 4; 1957, p. 4; 1959, p. 4; 1961, p. 5; and 1963, p. 7. A source for the later part of the period was idem, Survey of Current Business, Vol. IIIL (July, 1967), p. S-2. See also the same issue, p. 9 and the July 1964 issue, p. 11.

²Population data for 1952-64 were obtained from U. S. Dept. of Agriculture, Economic Research Service, Economic and Statistical Analysis Division, Food Consumption and Utilization Section, U. S. Food Consumption: Sources of Data and Trends, 1909-63 (Washington: June, 1965), p. 187. The figure for January 1, 1965, was first taken from U. S. Dept. of Commerce, Bureau of the Census, Current Population Reports: Population Estimates (Washington: U. S. Government Printing Office, July 16, 1965), p. 2. When the time series were updated in 1967, population figures for January 1 and July 1 of the years 1965-67 were taken from idem, Current Population Reports; Population Estimates (Washington: U. S. Government Printing Office, August 21, 1967), p. 2.

January 1 and July 1. Population referred to number eating out of civilian supplies. From 1960 on, the populations of Alaska and Hawaii were included.¹

Rail Conversion Factors

Quarterly data from the railroads on revenue freight of potatoes originated, by eight regions, expressed in both tons and carloads, were used to derive quarterly rail conversion factors by regions. The data have been published by the Interstate Commerce Commission.² Interpolations or extrapolations were used for certain quarters since published data were not available. These quarters were: Third and fourth quarters 1951; second and third quarters, 1953; the whole year 1954; and the whole years 1964 and 1965.³ The quarterly figures are subject to corrections of errors in carriers

¹Since 1960, national income is defined to include Alaska and Hawaii. For further details see Survey of Current Business, July 1961, p. 5. The inclusion of Alaska and Hawaii in the population series from the same year on seemed to give the most comparable per capita income series over time. These states are not included in the other time series used in this work, however.

²See Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Freight Commodity Statistics of Class I Railroads in the United States, Tons of Revenue Freight Carried and Freight Revenue of Large Class I Railroads, Fourth Quarter, 1963, pp. 4-22. Corresponding issues were used for other quarters in the period 1950-63. Since 1963, no quarterly publications of this kind have been issued.

³When the time series were updated in 1967, other conversion factors were used for the last part of the period. This is described in Appendix C.

reports under correspondence (revised figures are used in annual summary), but this could not be taken into account.

Various Price Index Numbers from the United
States Department of Labor

Six different series of price index numbers from the Department of Labor were used in the present study, namely the Consumer Price Indices for (1) all items; (2) total food at home; (3) cereals and bakery products; (4) meats, poultry and fish; (5) fruits and vegetables; and finally the Index of Wholesale Prices for all commodities except farm products and foods.¹ Index numbers with base, 1957-59 = 100 were used for the whole period. Since the published indices for the earlier part of the period did not have this base, they were linked to the corresponding indices with base 1957-59 = 100.

The Consumer Price Index for all items was used as a general deflator for all other price index numbers, and also for prices of potatoes and for per capita income. An average index for each quarter was used in deflating income.

¹See U. S. Dept. of Labor, Bureau of Labor Statistics, Monthly Labor Review, Vol XC (August, 1966), pp. 117 and 120. Data for the whole period 1951-66 were obtained from various monthly issues.

CHAPTER IV

ESTIMATION OF MONTHLY SALES DATA
ON THE BASIS OF SEASONAL SALES
DATA AND MONTHLY SHIPMENTS
DATA

Introduction

The published monthly shipments data are more or less incomplete, and they are expressed in units that may vary drastically over the years, between seasons, and geographically. Time series of United States totals arrived at by simple additions of these data over states could therefore not be used in the monthly supply and demand analyses of the present work. Instead, monthly sales data were constructed in a different way. Basically the approach taken was to distribute on months the data on sales from farms that are available for seasonal groups. The shipments data served essentially as distributive weights.

Although this approach appears simple, a large number of problems were involved. Among these were the following: (1) Except for states where only one seasonal category of potatoes is grown (twenty-six states), there

is in general no way of knowing what percentage of the potatoes shipped in certain months originate from various seasonal crops. (2) Should both rail and truck data be used as distributive weights, and if so, how much mutual weight should be given to each of the two series? (3) How should states and years for which few or no shipments data are available be handled? (4) Should all or only part of total sales from farms be distributed on months according to the pattern of shipments? (5) How could unloads data be utilized to make the data more complete?

Many decisions had to be made where subjective judgement was unavoidable. In order to secure similar treatment of similar cases and to make it possible for other research workers to check the procedure followed, certain guiding principles that seemed reasonable were established.

Space does not allow a discussion of the various alternative approaches that might have been followed. Neither is it possible here to give the reasons for all the decisions that were made. The present chapter contains mainly a description of the procedure followed.

Description of Method

The estimation of monthly sales data was carried out for individual states in most cases. Only after this

had been done were the state data added up to United States totals. The monthly data for a few relatively unimportant states were very poor. These states were not treated individually. Instead they were pooled together with other states having similar production conditions.¹

The problem of overlapping of marketings from different seasonal groups in certain months was dealt with by pooling together sales data for all seasonal groups of potatoes grown in each state.² Thus yearly rather than seasonal sales data were used. The crops were not always added up for calendar years, however. For each state the year was defined in such a way that all or most of the potatoes shipped during any single year could be assumed to have originated from the crop of the same year. In many states there are some months when no potatoes are shipped. For such states the choice of definition of the year was easy to make. In other states potatoes are shipped in every month of the year. In a few such cases, and especially for California, the definition was of necessity somewhat arbitrary.³

¹For details, see Appendix C. Table 18 gives the state groupings.

²If total reported shipments make up approximately the same percentage of total actual shipments in every month of the marketing period, this method will give a satisfactory result.

³The year used in each case is indicated in the second column of Table 18 in Appendix C. Calendar year was used whenever satisfactory, since this facilitated the treatment of the unloads data.

Except for the information that can be derived from the shipments data themselves, little is published on the relative importance of rail and truck transportation in various states or for various categories of potatoes.¹ It was therefore decided to use both truck and rail data and to give each of the means of transportation weights according to their importance in the recorded data.²

In cases when truck shipments data were not recorded, or when these apparently were incomplete for part of the year, truck unloads data were used as a substitute if they were available.³ The cities for which unloads data were looked up were the same for all states and for all months of any year, but in order to utilize as much as possible of the available information, they were allowed to vary from year to year.⁴ In general, there was

¹For a treatment of this question, see Ivon W. Ulrey, Fresh Potato Transportation to Large Markets from Five Major Producing Areas, Marketing Research Report No. 687, Marketing Economics Division, Economic Research Service, U. S. Dept. of Agriculture (Washington: November, 1964), pp. 1-31.

²I.e. the rail and truck data were simply added after having been converted to a common unit.

³The term "year" is used in the rest of this chapter to designate a year as defined for the state or states in question.

⁴Even though the reports for the same cities were used in all months and for all states, this does not necessarily mean that data were actually recorded for all months and all states.

an increase over time in the number of cities included. In 1957/58, the number of cities could not be kept constant because totals rather than individual city figures were used for 1958. Certain adjustment then had to be made.¹

Some minor adjustments of the movement data were made for other reasons: mainly in order to correct for irregularities in the reporting of the data or to provide some convenience in the handling of the data. In a few relatively unimportant cases it was also necessary to use data for other years or for other similar states since no data were available for the years in question.² When the various adjustments and substitutions had been carried out, the truck data were multiplied by the official truck conversion factors, and the rail data were multiplied by quarterly rail conversion factors derived from railroad statistics, and the two series were added.³

The next decision to be made was whether all or

¹For further details regarding the use of the unloads data, see Appendix C.

²The adjustments, etc. mentioned in this paragraph are further described in Appendix C.

³The truck conversion factors are listed in Appendix C. The rail conversion factors are described in Chapter III and in Appendix C. According to Saylor, letter, August 13, 1965, use of conversion factors derived from railroad statistics give the most reliable tonnage figures for rail movements for each year.

only some sales should be distributed on months according to the shipments pattern. Potatoes diverted to livestock feed are to a large extent used on farms where grown or on nearby farms. In most cases, these potatoes are probably not included in the shipments data.¹ Also diversions to starch and flour are probably excluded from the shipments data in most cases. Shipments for manufacture have not been reported since 1955.² Before 1955 diversion operations were rather limited,³ and it is likely that potatoes for starch and flour were to a large extent excluded from shipments in that period too.⁴ Altogether it was believed that the best result would be obtained by assuming that potatoes for diversion purposes were excluded from the shipments data during the whole period. Total yearly diversions were therefore subtracted from the yearly sales data, and the remaining sales were distributed on months according to the shipments

¹This argument is also used in James Harold Cothorn, "The Importance and Impact of the 1955 and 1956 Government Potato Diversion Program on the Potato Industry" (unpublished Master's dissertation, Dept. of Agricultural Economics, Michigan State University, 1957), p. 50.

²Above, p. 30.

³See table 7, Appendix C.

⁴Up to 1955, footnotes to the tables on shipments show yearly rail shipments for manufacture for Idaho, Maine, and a couple of other states.

pattern.¹ When monthly data on sales including diversion were needed in the econometric analyses, the monthly diversion data were added to the estimated monthly data on other sales.

Since appropriate data were lacking, it was not found practical to apply similar procedures for other categories of sales. In effect then, all sales except diversion were assumed to be distributed on months proportionally to total shipments.

Evaluation of the Estimated Data

It has been shown elsewhere in this work that the shipments data have certain deficiencies. Accordingly, one might argue that the reliability of the estimated monthly sales data is somewhat doubtful. Various adjustments and substitutions were made to improve the data, however. For instance, in some cases when the shipments data cover only a part of the season because the shipping point offices have been closed during the rest of the season, unloads data have been used.

¹This procedure also assumes that potatoes diverted to livestock feed on farms where grown are regarded as sold for statistical purposes. An inquiry sheet sent from the U. S. Dept. of Agriculture to farmers in 1964 indicates clearly that this was the case for that year, and it was therefore assumed that it was true for the whole period. See U. S. Dept. of Agriculture, Statistical Reporting Service, Disposition of 1963 Potato Crop and Acreage for 1964 (June, 1964).

In some instances the manipulations that have been undertaken may seem drastic. In evaluating these cases it should always be kept in mind that the shipments data have been used only as distributive weights. Their relative distribution on months rather than their absolute magnitude is therefore the thing that counts. The principle followed was to estimate monthly sales data for all states, even if doubtful weights had to be used for a few states. Since the final figures of interest were U. S. totals, this procedure was deemed more satisfactory than to disregard these states completely. The yearly sales data for these states are probably about as good as for other states. In any case these states account for only a very small percentage of total potato sales.

The three most important potato producing states, Idaho, Maine, and California, are covered with seemingly very good rail and truck shipments data every year. These three states accounted for 42.2% of U. S. potato production in the years 1958-62. Quite satisfactory movement data are also available for several other important states such as North Dakota, Minnesota, Washington, Colorado, Wisconsin, Oregon, and Michigan. The ten states mentioned made up for 71.4% of U. S. potato production in 1958-62. Even several of the less important states are covered with satisfactory movement data.

The states for which the data for one or more years were really deficient, namely Arkansas, Georgia, Illinois, Iowa, Kentucky, Mississippi, New Hampshire, New Mexico, Oklahoma, Rhode Island, Vermont, and West Virginia, accounted for only 2.2% of total U. S. potato production in 1952-62.

The estimated monthly sales figures for the U. S. as a whole are shown in table 7 in the beginning of Appendix B.

A question one might raise is the following: What percentage of these estimated sales were actually recorded as shipments by the U. S. Department of Agriculture? This question is partly answered in table 18 in the end of Appendix C. The figure shown in the table for each state and year expresses the yearly sum of the distributive weights as a percentage of the corresponding total recorded sales, excluding diversion. As has been described elsewhere, the distributive weights include rail shipments and in addition either truck shipments or truck unloads. In most cases the percentages therefore give a pretty good picture of the yearly coverage of the movement data. In some special cases the distributive weights have been constructed in a somewhat artificial way by using data for other states or other years, etc. In such cases the percentages are of little value, and they may even exceed 100. The pre-

ceding section of Appendix C should therefore be consulted when table 18 is being studied. For example, the percentage of 140 for Oklahoma in 1966 is probably due to the fact that the distributive weights were constructed by adding the movement data for Arkansas to the Oklahoma data. The reason why some percentages for Alabama and Arizona exceed 100 may be inappropriate rail conversion factors. Loading practices may vary somewhat within regions. If the rail conversion factors that were used are proportional to the actual ones, the estimated sales will not be affected significantly by this error, however.

A crude check of the overall coverage of the shipments data can be made in the following way: In 1963 rail and truck shipments together for the U. S. as a whole amounted to about 250,000 cars. Assuming the weight of each car to be 45,000 pounds, this equals 112,5 million hundrewrights. Since total sales that year amounted to about 245 million hundrewrights, the coverage was about 46%. The actual coverage is considerably higher, since we have not included in the 250,000 cars the truck unloads data that have been utilized.

The estimated sales data are not equally reliable for all years. The data for 1957/58, for example, were adjusted in several cases. Most of these

adjustments affected only the truck unloads data, however.

The number of cities covered by the truck unloads data has been increased over the years, and the reliability of the data has therefore increased also. To some extent a similar development has taken place for the shipments data.

Since crop year was used in several cases, some data for 1951 and 1967 had to be used even though the econometric analysis cover only the period 1952-66. Some of the data used for 1967 were preliminary. The data for the last part of 1966 is to some extent influenced by this, but the effect is probably small.

In conclusion, we must admit that the estimated sales data have certain deficiencies. However, the data are believed reliable enough to be capable of producing several meaningful econometric results. The data play a crucial role in the type of models explored here. If such models prove to be of considerable value, there are several ways of improving the data in the future.¹

¹Some suggestions for improving the data are set forth in the last section of Chapter IX.

CHAPTER V

THE SUPPLY OF POTATOES

DURING THE YEAR

As mentioned previously, the concept of supply employed in the present study is supply from farms at the farm gate, so to say.¹

In order to understand which factors affect supply during a certain period, it is necessary to realize what alternatives the farmers have to selling the potatoes in the market during that period.

In the following, we shall discuss these alternatives with a view to sorting out variables that may be useful as "supply shifters" in the estimated supply functions. In the course of doing this, we shall also discuss whether the variables in question may be considered exogenous or must be treated as endogenous variables.

As a guiding framework for our discussion, we shall assume that the farmers act as profit-maximizing economic units.

¹See above, p. 8.

The Question whether Potato Yields and
Potato Production are Endogenous

A natural starting point in discussing supply of potatoes is the acreage planted of each seasonal crop. If we make the very reasonable assumption that the seasonal classification of any field of potatoes is predetermined at the time of harvesting and marketing, it follows that the planted acreage of any seasonal category of potatoes is predetermined during the marketing period of that crop.

What we are interested in, however, is whether also production can be considered predetermined during the marketing period. There is a possibility that farmers may leave some acreages of potatoes unharvested for economic reasons. If we use production figures based on total acreage (as has been done in this study) rather than on harvested acreage, we do not have to worry about this possibility, however.

Another possibility that must be considered is that farmers, during the marketing period of a crop, may influence the yield of that crop by better growing practices, in response to higher prices.

The present writer is of the opinion that this possibility is not important enough to take into account when we deal with prices for periods as short as months.

Still another possibility of interest is that

farmers may be in a position to influence yields by varying the time of harvest. For certain crops that usually are harvested before maturity, such variations no doubt take place in many cases. Again, since we deal with prices for periods as short as months, yields of the crops harvested during these periods may, as an approximation, be assumed to be unrelated to prices during these periods. Yields are namely influenced by several other factors, among which we also find prices in other months. It is also somewhat doubtful whether the recorded yields and production figures actually reflect variations in yields due to variations in harvesting time. The published figures may more nearly reflect some kind of potential yields that would have materialized under the assumption of a "normal" or "average" harvesting time.

In summary, we may assume that the recorded total production of any crop of potatoes is unrelated to the price of potatoes in any single month during which the same crop is marketed. Whereas this is assumed for production, it is important to note that the marketed quantity of any crop during any month of the marketing period of that crop may very well be influenced by the potato price that month. This is true both for storage potatoes and other potatoes since larger or smaller parts of the available acreages of the latter may be

harvested during any month of their potential harvesting period, depending on prices.

The Effects of Production on Marketings

We have now arrived at the conclusion that during each month of the year there is available on farms a fixed quantity of potatoes that potentially may be marketed. Other things equal, one would usually expect more potatoes to be marketed when this quantity is large than when it is small. The available quantity that potentially may be marketed is related to the production estimates for all crops that may be marketed during the month in question. Our discussion thus provides a rationale for including total production of certain seasonal categories of potatoes as variables in the supply function for potatoes each month. For the Fall crop, estimates of total stocks may also be used as a substitute for production estimates. The stocks data have the handicap, however, that they also include stocks held by local dealers. If we can assume that farmers hold a constant percentage of these stocks, the data can still be used.¹

¹In Chapter VI it is shown that the estimated sales data can be interpreted in two alternative ways. According to one interpretation, the estimated sales data are regarded as sales not only from farmers, but also from other shippers. If this interpretation is adopted, the fact that stocks also includes stocks held by local dealers ceases to be a problem.

In most cases one would expect large production figures to be associated with large marketings, but there are several exceptions to this. It should namely be kept in mind that the estimated monthly data on marketings include marketings from more than one seasonal crop. As an example, let us consider marketings in January. One would expect a large Fall crop to be associated with large marketings in January. But will also a large Winter crop be associated with large marketings this month? Not necessarily. The Winter crop is planted from August through the first half of January. During that period the size of the current Fall crop is pretty well known. If a large production of Fall potatoes is anticipated, growers will possibly plant less Winter potatoes than usual. Since marketings in January are dominated by the Fall crop, marketings will still be high, and as a result a small Winter crop will be associated with large marketings in January.

This hypothesis implies a negative correlation between Fall production and Winter production. In the period 1952-64 the correlation coefficient between the two variables was 0.02, however. We may therefore conclude that the above hypothesis is of more theoretical than practical interest. This may be due to a scarcity of alternatives to Winter potato growing.

Another hypothesis implying a negative relation-

ship between, say, Winter production and January marketing should also be considered. According to this hypothesis the Fall and Winter crops play roles that are the opposite of what was the case above.

Fall potatoes are marketed from the time when the Winter potatoes are planted till long after the last Winter potatoes have been marketed. Producers of Fall potatoes are therefore in a position to follow the development of the Winter crop and to take this development into account in their marketing plans. It is reasonable, then, to expect that when a large Winter crop is expected, producers of Fall potatoes will tend to limit their marketings during the marketing period of the Winter crop, and rather increase marketings before January and after March. True enough, a large Winter crop will lead to increased marketings of Winter potatoes, but when producers of the much larger Fall crop restrict their marketings, an "overcompensation" may very easily occur so that a large Winter crop will be associated with small total marketings in January, February, and March.

The discussion above pertains to the Fall and Winter crops, but it is clear enough that similar relationships also exist between other crops. We may therefore conclude that the signs of the coefficients of the production variables in the supply functions may be either positive or negative. What is the actual sign is an empirical question.

So far, we have shown that an approximately fixed quantity of potatoes is available for possible marketing each month and that total production of the various seasonal categories of potatoes are among the variables determining actual marketings. In order to determine which other variables should be included in the supply relations, we must consider what alternatives the farmers have, other than marketing the potatoes during the current month. We will first consider potatoes that have not yet been harvested. Later we shall consider potatoes in stock.

The Determination of the Time of Harvest and Marketing

Potatoes to be Marketed Shortly after Harvest

Usually, potatoes are harvested when they are mature or when the potato field has to be cleared either because the field is to be used for another crop, or because cold weather or snow is expected. There are situations, however, when harvesting before maturity is contemplated and when such factors as price and yield expectations are decisive. In some instances determination of the appropriate harvesting time is of considerable economic importance to the grower. The decision may also be very difficult because prices, as well as yields and quality, may change rapidly.

The following theoretical analysis is intended

to illustrate the principles that may be operating when a profit-maximizing grower determines when to harvest a potato crop. Even though it is impossible to follow the grower's decision-making process in detail, it may be possible to set up a theoretical model that fairly well accounts for the principles underlying his decision.

Let us consider an arbitrary field of potatoes that is of such a homogeneity, magnitude, etc. that it will be harvested as a unit.

At the time when the potatoes have reached a stage of development at which the possibility of harvesting them comes to the grower's mind (in the following called "today") we suppose that he has estimated several functions of time each covering the interval from the present till the point in time when the potatoes obviously have to be harvested if losses are to be avoided. The dependent variables in these functions are the following: (1) Expected yields of each quality or grade of potatoes from the field in question. (2) The grower's price expectations for the corresponding qualities and grades of potatoes. (3) The expected net increase (or decrease) in total costs attributable to the potatoes from this field from now on, if they are to be harvested on some future day rather than today.

It does not matter how the grower obtains all this information. Of course, he will use his experience

and notes from earlier years, all kinds of information available from experiment stations, and his own judgment. He will probably take yield samples from his field at various points in time. He will certainly also have to take into account the opportunity costs of his labor force, transportation equipment, etc. in other enterprises.

On the basis of the functions listed above, the grower can compute a new function showing the expected net increase or net decrease in profit that he will experience by delaying the harvesting to some future date. This net increase is expressed as a function of all potential future harvesting dates (including today).

If the last mentioned function has a maximum today, the grower will decide to harvest the potatoes today; if not, he will plan to postpone the harvesting till the day when this function has a maximum. As time goes on, however, the grower may obtain various new information that leads him to revise one or more of the estimated functions underlying the profit increase function mentioned above. Accordingly, the planned harvesting date may also be changed. Expectations may even change in such a way that the grower some day finds himself in a situation where he concludes that profit would have been maximized if he had harvested the potatoes in the past. Rapid price declines or unnormal

weather conditions are probably the main reasons why he might have such an experience. To make the picture complete, however, we must add that the grower may also experience larger profit increases by postponing the harvesting time than he had originally expected.

The possibilities mentioned in the last part of the preceeding paragraph show that the analysis so far is not quite adequate except for growers who look only at the expected value of the profit increase function above and do not pay any attention to its variance. One possible way of modifying the analysis for growers with a different attitude towards uncertainty would be to apply a set of discount factors in order to convert each of the future values of the profit increase function to values comparable with certain profit today.

Storage Potatoes

The problem that has been discussed above is in principle identical with the problem of optimizing the marketing rate of potatoes from storage for a single producer. Potatoes in storage usually deteriorate both in quantity and quality as time passes away, but at the same time prices are often increasing. We may therefore assume that the point in time at which a given lot of storage potatoes is sold is determined in a way similar to the point in time at which potatoes to be sold direct-

ly from a given field are harvested.

A more detailed discussion of the economy of potato starge will be found in Zusman's work.¹ We see no reason to repeat his discussion here.

Conclusion

Our treatment has revealed that expectations play an important role in the supply of potatoes both from the field and from storage. Unfortunately, we have no appropriate variables to represent the expectations themselves. All we can do, at best, is to include in the supply functions variables on which the expectations are based. Clearly enough, only a very tiny selection of the relevant variables can for practical reasons be included. The price of potatoes in the current period is one such variable that probably has some effect on expectations. One may for instance expect that when prices are high, ceteris paribus, growers do not expect further significant price increases and vice versa. In addition, prices of potatoes must also be considered a priori to have a direct influence on marketings. The price coefficient of an estimated supply relation therefore measures the combined effect of expectations associated with price, and the direct price

¹Zuzman, op. cit., pp. 576-79.

response.

Another variable that was used in the present investigation as a possible variable associated with expectations is the price increase for the relevant crop during the preceeding season. This price increase is the grower's immediate experience regarding price increases for the crop in question and one might assume that this experience forms a basis for his expectations for the current season. In the following this price increase variable will be labeled the lagged price variable. The value of the lagged price variable for a certain month, m , in an arbitrary year, t , was formed as the price increase from month m in year $t-1$ till a particular month m' later in the same marketing season. The month m' may belong to year $t-1$ or to year t . The price increases were computed on the basis of deflated average prices paid to farmers for potatoes.

The months, m' corresponding to the various months, m are listed below.

For January, February, March, and April m' was chosen to be May of the year $t-1$. For May, June, July, and August, m' was chosen to be June, July, August, and September, respectively. The latter months all refer to year $t-1$. For September-December m' was chosen to be May of year t .

The various factors associated with yield expectations and cost expectations were not taken into

account in the empirical analyses of this work. Variations in yields due to variations in harvesting time are accounted for indirectly insofar as prices are assumed to affect marketing rates which in turn are assumed to affect individual yields.

The effects of interest rates on marketings were not taken into account since it was believed that interest rates have varied too little during the sampling period to warrant their separate inclusion in the supply functions.

It seems reasonable to expect that there is some dependence between marketings in various months. If the quantity of potatoes marketed early in a season is unusually large, one might expect, ceteris paribus, that quantity of potatoes marketed later in the season will be unusually small. A variable, labeled as a lagged supply variable, was designed to allow for such effects. The lagged supply variable for a particular month was constructed as the sum of the supplies in certain earlier months up to the month in question. In the following the additions will be described for each month of the year.

The lagged supply variables for January-June were formed by adding up supplies for the preceeding months, starting with August and ending with December-May, respectively. For July and August the additions started with May and ended with June and July, respective-

ly. The lagged supply variables for September-December were constructed by adding the earlier supplies, starting with June and ending with August-November, respectively.

The Influence of Home Use for Food, Seed; Feed, Shrinkage, and Loss, and Their Variations

In addition to the possibility of selling the potatoes early or late, growers also have the alternative of not selling the potatoes at all.

First of all they may leave potatoes unharvested. This may occur when prices are low compared to harvesting costs. Among the relevant variables determining the quantity of potatoes left unharvested are the price of potatoes, the size of the crop, and the harvesting costs. Our approach is to let the supply of potatoes be a function of (among other variables) the price of potatoes and of total production, including production left unharvested.¹ Thus the only important variable not included in the analysis is harvesting costs, but these costs do not vary violently from year to year. The trend in this variable may be assumed to be taken into account by the trend variable.

¹In the final analyses after the time series had been updated, total production less home use for food was used instead of total production as a production variable. (See later).

Shrinkage and loss are probably related to prices of potatoes, to the size of the crop, and possibly to time. The potatoes are likely to have better care when prices are high. When the crop is small, only the best storage space and the best facilities for harvesting, transportation, etc. need to be used. Shrinkage can then be kept at a minimum. Over time the methods and facilities utilized in handling potatoes may have improved. Again, since our approach is to let supply be a function of total production, price, and a time variable, shrinkage and loss are automatically accounted for insofar as our model is correct.

The quantity of potatoes fed on farms is not recorded separately, but is lumped together with shrinkage and loss in the statistical publications. The quantity fed is probably in some sense, and to some extent, a residual. Except when feeding of potatoes is planned in an irreversible way or when the potatoes fed are of inferior quality, feeding occurs when the profit from feeding potatoes exceeds the profit from selling potatoes for other uses. Accordingly, one would expect the quantity fed on farms to be a function of such variables as market prices of potatoes, prices of other concentrated carbohydrate feeds, and possibly of an index of the number of certain kinds of livestock animals in the potato growing regions. Since feeding of potatoes is

actually not very important in most of the U. S., and since the approach outlined involves several problems, only the price of potatoes and a trend variable have been included as variables describing feeding of potatoes in the present analysis.

Consumption of potatoes in households on farms was regarded as predetermined in this analysis. The writer believes that potato growers' households usually consume the quantities of potatoes they like to consume regardless of potato prices in particular, and also independent of other prices, incomes, yields, etc. The possible gains from consuming less are very small. Potatoes are a very cheap food at the farm level, and commercial potato growers are generally not poor.

The consequence of this is that these potatoes ought to be subtracted from total production in forming the production variable. Since it was assumed that the change in consumption on farms can be approximately described by a linear trend variable, this was not actually done, in the initial analyses. It was done in the final analyses after the time series had been updated, however.

The use of potatoes for seed on farms where grown is probably to a large extent determined by the same factors as the use of seed in general.¹ The distri-

¹For a Discussion of the demand for seed potatoes, see Chapter VI.

bution of total seed requirements on home produced and purchased seed is partly determined by habit and is also subject to gradual change over time. The price of potatoes and a trend variable should probably take care of a substantial part of the variation in home use for seed. In addition an acreage variable to be described in Chapter VI may be used as an explanatory variable for certain months.

Relative to total seed consumption for the crop in question, home use for seed plays a very modest role for all crops except the Fall crop.

Foreign Supply of Potatoes

The foreign trade in potatoes is small and relatively unimportant. Essentially it amounts to some border trade and seed imports from Canada. Even though it actually represents an oversimplification, net exports (or imports) of potatoes were treated as a predetermined variable in the present analysis.

Stocks

There exists a separate supply of potatoes from stocks, as well as a special demand for potatoes for storage. The supply of potatoes from stocks has been discussed already, and the demand will be treated later.

CHAPTER VI

THE OFF FARM DEMAND FOR POTATOES

DURING THE YEAR

Demand for Seed Potatoes

The quantity of potatoes utilized for seed depends on the planted potato acreage and the quantity of seed potatoes used per acre. The yearly variations in planted acreage depend on several factors among which prices of potatoes may be of considerable importance.¹ The relationship is such that high potato prices may induce increased plantings and increased demand for seed potatoes. The quantity of seed potatoes used per acre for a certain crop has to be within certain limits for biologic reasons, but there is also some room for variations in seeding rates in response to variations in potato prices. Smaller or bigger seed potatoes may be used, and the seed may also be cut or not.

For certain seasonal crops there has been a gradual increase in the use of purchased seed due to in-

¹According to Simmons, op. cit., p. 56, "actual planted acreage in the late crop States corresponds closely with acreage estimated on the basis of previous year's price".

creased use of certified seed and other changes in growing practices. Almost all seed potatoes that are sold come from the Fall crop.

For each seasonal crop of potatoes the total quantity of potatoes used for seed and the quantity used on farms where grown is known.¹ When we deal with monthly models, the matter is complicated by the fact that we do not know at which rates the seed is shipped throughout the marketing season for each crop. The shipment pattern is probably to some extent fixed from year to year, but there are certainly also irregular variations in seed shipments.

On the basis of information regarding the usual planting time for the various crops, a variable was constructed to express the demand for seed potatoes in various months.² The variable was constructed as the sum of the acreages of certain seasonal crops, the plantings of which were assumed to take place partly during or shortly after the month in question.

The crops whose acreages were added to form an acreage variable are listed below by months.

For January and February: Early Spring. Late

¹U. S. Dept. of Agriculture, Agricultural Marketing Service, Crop Reporting Board, op. cit.

²Planting dates are listed in Royston, Frost, and Galloway, op. cit.

Spring, and Early Summer. For March and April: Late Spring, Early Summer, Late Summer, and Fall. For May and June: Early Summer, Late Summer, and Fall. For July: Late Summer and Winter the following year. For August, September, and October: Winter the following year. For November: Winter the following year and Early Spring the following year. For December: Winter, Early Spring, and Late Spring, all crops being the crops of the following year.

The actual shipment pattern of potatoes for seed is also reflected more or less through two other monthly sets of data that are available, namely imports of certified seed potatoes (mainly from Canada), and shipments of certified seed from Maine. These data are shown in Appendix B, Tables 13 and 14. Neither of these series are representative of total seed shipments, but they might reflect pretty well the shipment pattern for Fall potatoes. This is especially true for shipments from Maine, which is a very important Fall producing state. Imports from Canada may be somewhat misleading as an indicator of seed shipments, because potatoes imported as seed sometimes are used for other purposes.

When the data series had been updated in 1967, a variable intended to explain demand for seed was constructed on the basis of Maine certified seed shipments in the following way: For each month a variable was

formed by taking actual shipments as a percentage of total shipments during the crop year July-June. The primary data that were used are shown in Appendix B, Table 13.¹

Demand for Feed Potatoes

In the models of the present work, potatoes fed on farms where grown have the effect of decreasing supply, while potatoes fed on other farms are taken into account as a category of demand.

Potatoes are used for feed mostly in the West. As mentioned when home use for feed was discussed, the variations in the demand for potatoes for feed are probably related to variations in prices of potatoes and prices of other concentrated carbohydrate feeds. Also an index of the number of certain kinds of livestock animals in certain regions might be used to explain feed demand. There is certainly a limit to the quantity of potatoes that can be profitably fed to livestock. Potatoes for feed are also cheap and bulky and thus unable to bear high transportation costs. For these reasons

¹In Table 13 data for certain months such as May and June are not recorded separately. The combined data were treated as if they pertain to a single month, and the percentages obtained were used directly as common percentages for the months in question.

For the months January and May-June data were lacking for the year 1952. The arithmetic means of the corresponding percentages for 1953 and 1954 were used to replace the lacking data.

the number of livestock in the growing areas may be of some importance. Most likely, however, the relevant index number does not vary very much, and besides, the possible effects of such variations are probably overshadowed by other influences.

In the estimated models it was assumed that the price of potatoes, and possibly also a trend variable, are the only variables related to feed that can be profitably included. The variations in prices of feed concentrates were supposed to be too small to influence the total demand for potatoes appreciably.

Demand for Potatoes Fresh for Food

This demand can be divided into two categories: potatoes demanded by the growers' own households and off farm demand. As mentioned earlier, demand on farms was regarded as being predetermined in the final models.

The off farm demand for potatoes is derived from consumer demand. Variables that determine consumer demand are therefore relevant in the demand equations. In addition, certain variables pertaining to the operation of the marketing system may need to be included in order to explain demand at the farm level.

According to economic theory, one would expect the demand for potatoes to be related to such variables as prices of potatoes, prices of various substitutes for

potatoes, and consumers' incomes.

Some of the most important substitutes for potatoes are probably macaroni, spaghetti, noodles, rice, and various vegetables, notably the kinds suggested in an earlier publication.¹

Since appropriate monthly data on prices of substitutes for potatoes were not available, it was decided to use various index numbers from the Bureau of Labor Statistics. But these indices are very crude approximations to the variables of real interest. The Consumer Price Indices for cereals and bakery products and for fruits and vegetables were used to represent the substitutes already mentioned. In addition the Consumer Price Indices for meats, poultry and fish were used. As an alternative to all of these price indices the Consumer Price Index for total food at home was used in some analyses.

Because of the very limited number of observations it was impracticable to include a whole series of different potato prices in our model. The main price variable that was used for potatoes is a weighted average of prices received by farmers (from Agricultural Prices). As already mentioned, the price variables used for other

¹See U. S. Dept. of Agriculture, Potato Preferences Among Household Consumers, (Miscellaneous Publication Number 667 (Washington: August, 1948), pp. 18-21).

commodities were price indices of retail prices.

In order to take the costs of marketing potatoes into account, farm-retail spreads were included as a variable in the demand equations. Farm-retail spreads are, however, very complex magnitudes which depend on profits as well as costs. The sign to be expected for the coefficient of the farm-retail spread variable is therefore somewhat ambiguous. If, say, farm-retail spreads are high because the profits earned by marketing firms from selling potatoes are high, one would expect retailers and dealers to do more to sell potatoes in competition with other goods. If such situations are prevalent, the sign of the coefficient may be positive. On the other hand, if spreads are high because costs (other than profits) are high, prices of potatoes will be high without this being compensated by greater efforts among marketing firms to sell potatoes. The result could then be a negative coefficient.

A detailed knowledge of marketing conditions is required in order to find out what is the typical situation in various months. It is well known that marketing costs have accounted for substantially more than one-half of the retail price during our sampling period. According to Simmons, it is also a fact that "marketing costs such as grading, washing, packing, transportation, and wholesale and retail handling costs change slowly

over time, and generally change little in the short run."¹

Quality may also be an important demand shifter. If some differentiated kind of potatoes such as, say, Idaho potatoes are of significantly higher quality and price than the rest, and if the relative supply of such potatoes varies much from year to year, then the use of an average price may tend to give the result that a high price is accompanied by a large quantity demanded, in the estimated demand relations. The reason for this is that the effects of quality differences on prices and demand are not recognized in such a formulation.

One way of dealing with this difficulty is to include, as a variable in the demand function, the percentage of production which is Idaho potatoes. This quality indicator or demand shifter may then explain, say, a high demand in spite of high prices. In the general case, when we have several different qualities, we might use some weighted percentage.

Since there is such a host of different qualities of potatoes and since quality specifications differ for various uses, such a procedure was not attempted in the present work. The available data are also deficient for this purpose. One difficulty in using, for instance,

¹See Simmons, op. cit., p. 34 and p. 17.

the percent of total production which is Idaho potatoes is that in some seasons Idaho potatoes are not produced, but supplied out of stocks, and the percentage of Idaho potatoes purchased may not be proportional to the percentage produced. If we use purchases instead of production we still have a problem since purchases are endogenous.

Deflated per capita disposable personal income was used as an income variable. (Seasonally adjusted quarterly totals at annual rates). This variable was assumed to be predetermined. According to the following quotation from Fox, this should be a safe procedure. "With reference to a system centering on the supply and demand curves for potatoes, disposable income might as well be treated as a predetermined variable."¹

A change in tastes for potatoes may have occurred over time. In order to take this into account to some degree, a time variable was included in the demand functions. This variable may also partly take care of possible changes in buying and storing habits and other characteristics of the market. The use of a linear time variable is of course only a first approximation, but with the limited number of observations and the many

¹See Karl A. Fox, Econometric Analysis for Public Policy, (Ames, Iowa: The Iowa State College Press, 1958), p. 15.

potentially useful variables to be tried out, this was considered sufficient.

The demand for potatoes for fresh consumption could profitably have been expressed on a per capita basis since this variable no doubt is approximately proportional to population. In this way we could have eliminated population as an explanatory variable in the demand functions. But the complete model also contains supply and other quantity variables which are linked together with demand by means of an identity. If demand had been expressed on a per capita basis, it would have been inconvenient to express the other quantity variables differently. The use of per capita quantities may not be good theory for all of these other quantity variables, however. There was also another reason for not deflating demand with population. The population trend had been approximately linear during the sampling period. Since time was included as an explanatory variable in the demand equation, it was anticipated that it would not be necessary at all to retain population as an explanatory variable in the same equation, and so it also turned out.

Demand for Potatoes for Processing¹

The demand for potatoes by processing firms is complex, and in this section we only intend to separate out some key variables or indicators that can be used to approximately explain this demand. Unfortunately, very few pertinent data are available, especially on a monthly or seasonal basis. Some monthly data on potato processing in Idaho and Maine are shown in Tables 15 and 16. These data seem to indicate that there is no extreme seasonality in potato processing.

The price paid by processors for potatoes is obviously a variable related to processing demand, but unfortunately prices paid for potatoes for processing have not been available.² The price received by farmers for all sales should be a workable approximation for these prices, however. An average price for all sales is especially relevant when the corresponding demands are treated together, as was the case in this thesis.

Another group of variables that would seem to be relevant are the prices the processors expect to receive for the finished products. An index of current

¹The various technical, biologic, and economic aspects of potato processing are ably described in William F. Talburt and Ora Smith. Potato Processing (2d. ed.; Westport, Connecticut: The Avi Publishing Company, Inc., 1967), pp. 1-588.

²Simmons, op. cit., p. 27.

prices received by processors for their products might be used as an indication of these expectations.

Processing costs might also be important, especially costs of labor and of raw materials other than potatoes. Costs of equipment, machinery, and buildings will probably affect demand very little in the short run, although they will affect replacement of worn equipment and the speed of starting up new plants in a period of expansion of processing. As long as there is unused capacity, only variable costs are important. Since most processing activities have been rapidly expanded during our sampling period, capacity has probably been fully utilized, and even costs of more durable means of production may have influenced short run demand for potatoes to a limited extent. Unused capacity may have existed in certain seasons, regions, or kinds of plants, but it is virtually impossible to obtain meaningful data on this. The data on stocks of frozen French fries reflect to some extent the state of the market for this product from 1955.¹

Since most cost items other than the cost of the potatoes are of such a nature that they are common for this industry and several other industries (labor costs, transportation costs, costs of buildings, admini-

¹These data, for the United States as a whole, are listed in Appendix B, Table 17.

stration, etc.), there might be some doubt whether an index of processing costs would turn out to be significant in the demand relation for potatoes for processing. The prices of such general items tend to move together with the general price level in such a fashion that other observable movements in these prices are comparatively small. The proportions in which these items are used in various industries must of course also be taken into consideration in addition to their prices. The proportions tend to be roughly similar in broad groups of industries, however. Therefore the corresponding costs also tend to be similar for groups such as food processing industries. Since these costs tend to move together for competing industries, and since they will tend to be passed over to consumers through higher prices, the present writer would not expect them to significantly influence the demand for potatoes by processing firms.

Prices and costs are not the only variables determining processors' demand for potatoes. The demand for the finished products, i. e. the quantity that can be sold at each price, is another determinant. Stocks of processed products may be an indicator of deficient demand, but probably an unreliable one, since stocks can also be built up to meet an increasing demand or can have other functions.

Among the other possible demand shifters, con-

summers' income, prices of close substitutes for processed potato products, and costs of marketing from the processing firms to the retail level might be considered. Consumers' income is presumably important, but it may be difficult to separate the effect of this variable from other causes such as changes in tastes and eating habits. A time trend may therefore work just as well.

Marketing costs affect the prices consumers have to pay and therefore the quantity they demand. It is a question, however, whether they change so much that it is worthwhile to include them. In a study like the present, one can afford to include only a few of the most important variables because of the few observations to our disposal.

Prices of substitutes may be important. The question is whether we can find any substitutes that are close enough and important enough to really affect the demand for processed potato products. In this connection one may also ask whether fresh potatoes and processed potato products substitute for each other to any substantial degree. The answer to this question has important policy implications for potato growers. It would seem that, fortunately for potato growers, fresh potatoes and potato chips are not close substitutes for each other at the retail level. For other processed potato products the situation is different and there probably is consider-

able substitutability.

An important factor that directly affects processors' demand for potatoes is the quality of the potatoes that are supplied. Since so very few pertinent data are available, it is very difficult to take this factor quantitatively into account, however,

The conclusion of this discussion is that there are several variables that probably affect processing demand, but very few data are readily available, and relatively little is known a priori. A thorough analysis of this demand on a monthly basis will require very much work and is best left to a separate analysis.

In the present work the only explanatory variables used to explain the demand for potatoes for processing are (1) the deflated average price of potatoes received by farmers for potatoes, (2) a time trend, and (3) two alternative time series or variables relating to annual processing activities.

The first of the alternative variables mentioned in the preceeding paragraph has been denoted as the total quantity of potatoes processed and the other as the quantity of potatoes processed as chips and shoestrings. The two time series are described in Chapter III. The two time series relate to the crops of a series of calendar years. In applying each of these annual series in the models for particular months, the following procedure

was adopted to take into account the fact that potatoes are stored: For the months January-April the processing figures were used with a one year lag. For May and June the arithmetic mean of the lagged and the current processing series was used. For July-December the current processing series were used.

The rationale for including these variables in the demand functions is, of course, that when processing activity on an annual basis is high, there may be a tendency for the demand for potatoes for processing in a single month also to be high.

The processing variables were assumed to be pre-determined. This assumption is probably approximately fulfilled.

Demand for Potatoes by the Government
for Diversion Purposes

In some years during our sampling period a government program has been operated by which certain quantities of potatoes have been diverted to inferior uses such as starch and feed.¹

The prices and quality requirements for such potatoes have been determined by the government. If the government had had perfect knowledge, the fixing of prices

¹The quantities diverted during the sampling period of the present work are shown in Appendix B, tables 10 and 11.

would have resulted in a quantity that would have been known beforehand. In such a state of affairs, it would make no difference whether we say that price is determined by the government or we say that quantity is so determined.

Since knowledge is less than perfect, the fixing of prices is not equivalent to fixing quantities. The difference between these procedures amounts to an uncertainty as to the exact quantities resulting from certain prices. For our purpose it seems satisfactory to regard the diverted quantities as fixed by the government.

Another question is whether these quantities can be regarded as truly exogenous. In setting up the program, the government of course takes into account the state of the market. If the government changes the program during the marketing season, we may say that the government not only affects the market but that it is also affected by the market as far as diversion programs are concerned. To specify in the model how the government is affected is practically impossible, however. We must therefore be content to treat diversion as an exogenous variable.

Demand for Potatoes for Storage

The demand for potatoes for storage and the supply out of stocks is very complex and difficult to

handle. In the models of the present work, the way of dealing with stocks was dictated by the particular layout of the investigation and of the available data.

It will be recalled that the data on sales of potatoes are not actually recorded data, but rather data constructed on the basis of certain proportionality assumptions. The fact that the data were constructed leaves some room for alternative interpretations of them. Especially in regard to stocks, a couple of alternative interpretations are possible. One interpretation is the following:

Since the data on sales are based on shipments, and since the group of shippers includes not only farmers but also local dealers and other owners of storage potatoes, the estimated sales data must be interpreted as sales from farmers and local dealers, cooperatives, etc. Our former assertion that the farm gate is the dividing line between supply and demand must therefore be modified to the extent that potatoes are stored by local agencies other than farmers. It might be more appropriate, then, to say that the shipping points are the dividing line between supply and demand. According to this point of view, farmers and various local agencies participating in the storing of potatoes with a view to later shipment are treated as a single group, the suppliers. More specifically we may say: The potatoes held in storage

by farmers and the potatoes held in storage by local storing agencies are all regarded as potatoes for potential supply. Trade between farmers and these local agencies is not dealt with at all in the models. The supply functions of both these groups are treated as a unit. If the importance of each group as suppliers is uniform over time, or is changing according to a linear trend, this interpretation and the models that have been used are in complete harmony.

Contract pricing has been practiced to some extent for potatoes. This phenomenon may cause disturbances in a model based on the assumption of free market pricing within each time period. If the above mentioned interpretation of the sales data is adopted, contract pricing ceases to be a problem to the extent that it takes place between farmers and other local shippers.

An alternative interpretation of the estimated sales data is the following: The farm gate is upheld as the dividing line between the suppliers (the growers) and the rest of the market. The fact that the shipments data on which the derived sales data are based also include shipments from local dealers is taken into account by assuming that shipments from farmers are always roughly proportional to shipments from other agencies. This interpretation seems natural when we recall that the sales data for each crop that were distributed on months

according to shipments pertain to sales from farms. But this does not exclude the first interpretation, for sales from farms must be the basis for sales from shipping points in any case.

Each interpretation has something to say for it, but since sales data are based on shipments data and shipments are made not only by farmers but also by others at the local level, the first interpretation seems preferable. According to this view, supply in the models is regarded as a supply from growers and other local owners of potatoes. These local owners of potatoes (cooperatives, dealers operating farms, etc.) are often closely related to the farms. Their behavior as far as storing and shipping of potatoes is concerned, can be assumed to be very similar to that of farmers since they are performing a function that is very often performed by the farmers themselves. There are of course differences between the two groups that may cause different behaviour, but these differences are probably not very important.

When we adapt this point of view, the demand for potatoes for storage by local shippers does not enter into our models as demand at all. On the contrary, since these shippers and their suppliers are treated as a single group of suppliers, their demand for potatoes for storage is taken into account in the supply

function.

According to this interpretation the demand for potatoes for storage is regarded as demand only when the demanders belong to one of the following groups: (1) local dealers or consumers that are not shippers and that do not sell to shippers, (2) dealers and consumers in the terminal markets. In the following, the expression "demand for storage" will then include only demand for storage by these. In this way a large proportion of the more speculative storage demands are excluded from consideration.

Stocks of potatoes are held by the demanders just mentioned either for speculative purposes or in order to meet future demands. The latter reason for holding stocks is probably the most important one.

To some extent the demand for potatoes for storage is a derived demand. In the context of a model to be estimated on the basis of monthly data, the demand for potatoes to be stored by marketing firms for a few days or weeks is determined partly by the same variables that determine demand for current use. Changes in marketing practices and market structure may also affect storage demand. Such changes are difficult to measure, but a time trend may account for some of the effects of these changes.

The more speculative demand for potatoes for

storage over a longer period must be explained by variables that are related to future price expectations. Costs are also important, but these are to a large extent fixed costs or variable costs that are either stable or increasing over time in such a way that they can be approximately described by a trend variable. Speculative storing of potatoes over periods as long as a couple of weeks or more probably take place mostly on farms or nearby. The demand for potatoes for such storage is thus an internal phenomenon that will not be considered as demand in the present context.

CHAPTER VII

THE MODELS

Some General Considerations

The conceptual framework of the present investigation is a simultaneous equation's model containing separate demand equations for potatoes for (1) seed, (2) feed, (3) fresh food, (4) processing, (5) diversion, (6) exports, and (7) stocks. It is clear from the preceding discussion that the total market for potatoes is very complex, and that monthly data for an analysis where these demands are treated separately are lacking at the present. The necessity for simplification of the models is thus obvious.

The lines along which the conceptual model was simplified will be explained in the following.

In earlier econometric investigations of the potato market, exports and imports of potatoes have been ignored altogether. In the present work exports and imports were recognized, but they were treated as exogenous variables. In the models, exports and imports were combined to a single variable called net exports. The monthly net exports are sometimes positive and sometimes

negative. They were explicitly recognized in the models as a separate source of demand.

Also government diversion of potatoes to inferior uses was treated as a separate exogenous source of demand. Diversion is actually different from net exports in several ways. While net exports remove potatoes completely from the market, diversion results in the potatoes being used within the country, either for feed or for starch. Diversion may therefore, to a very small extent at least, affect commercial demand for potatoes.

In the models of this thesis net exports and government diversion were both treated equivalently, namely as exogenous demand, but they were not combined to a single variable.¹

Since separate monthly data are lacking, the following demand functions were aggregated into a single demand function: Demand for (1) seed from farms other than where grown, (2) feed on farms other than where grown, (3) fresh food, except demand on farms where grown, (4) processing, and (5) storage, as defined above.

The quantities of potatoes demanded for each of these purposes have not been separated, since this is

¹Whether these variables are combined to a single variable or not makes some difference when simultaneous equations methods are used for estimation.

practically impossible. It was recognized, however, that the various demands have their separate demand determinants, and these have, as far as possible, been included as explanatory variables in the aggregated demand function. Data are available only for very few explanatory variables pertaining to each type of demand. Also, only a limited number of explanatory variables could be included in the aggregated demand function due to the short sampling period at disposal. For both these reasons, some of the explanatory variables in the aggregated demand function were chosen so as to pertain to more than one kind of demand.

An example of such a variable is the price of potatoes. Ideally, different price series should be used to explain the demand for seed, feed, food, and processing. Separate price series are not available, however. Instead, the average price received by the farmers was used in the aggregate demand function as a common indicator of prices for the various kinds of potatoes. Since this price actually is an average price for approximately just these demands, the procedure probably is sound. Moreover, this price is also the appropriate one to use on the supply side. The price variable is probably a relevant explanatory variable in all the demand equations.

Another example of such an explanatory variable

is the time trend. The coefficient of the trend variable may be different in different demand functions. It may even be positive in some functions and negative in others. A priori one would expect a time trend to be present in all or most of the demand equations. The use of a common time variable in the aggregated demand function takes this possibility fully into account. The coefficient of the time variable in the aggregated demand function will be a weighted average of the coefficients of the time variable in the individual demand equations.

Farm-Retail Spread Relations

As mentioned earlier, the only price of potatoes that was used in the entire model is the average price received by farmers. This price is appropriate in the supply function. It is also suitable in the demand functions for seed, feed, and processing.

The demand at the farm level for potatoes for fresh use is derived from consumer demand. In the corresponding demand function the retail price should therefore possibly be included. Since all demand functions mentioned above were conceptually added up to an aggregate demand function, both the price received by farmers and the retail price probably ought to have been included in this function. The two prices are correlated, however, and their difference is roughly equal to the farm-

retail spread. Instead of letting the retail price appear together with the price received by farmers in the aggregated demand relation, it was therefore decided to substitute the farm-retail spread for the retail price in this relation.

One would expect a priori that the farm-retail spread is an endogenous variable. The farm-retail spread is determined in a very complex market involving supply and demand for marketing services for potatoes. This market again, is related to the supplies and demands for other products and marketing services.

It was not our purpose to explore and describe econometrically this complex structure. Only a very crude farm-retail spread relation was formulated with the aim to take care of some major interrelationships. In setting up the farm-retail spread relation, a publication from the United States Department of Agriculture was of much help. In this publication the farm-retail spreads are also defined and described in detail.¹

The Economic Model

The first economic model that was constructed

¹U. S. Dept. of Agriculture, Agricultural Marketing Service, Marketing Research Division, Farm-Retail Spreads for Food Products, Miscellaneous Publication No. 741 (Washington: U. S. Government Printing Office, November, 1957).

for estimation consisted, for each month, of four relations containing four endogenous variables. The four relations were (1) a supply relation, (2) a demand relation, (3) a farm-retail spread relation, and (4) an identity.

The variables used in the following are defined in the beginning of Appendix A. For easy reference, the symbols are also explained briefly in the text. Variables denoted by X have been assumed to be exogenous. The subscript m denotes month number ($m = 01$ for January, 02 for February, . . . , 12 for December), while the subscript t signifies the number of the year ($t = 1952, 1953, . . . , 1966$). (The subscript m is omitted for variables that do not refer to a particular month). The superscripts serve to identify the variables.¹

The four endogenous variables that were included in the first model to be estimated were the following: (1) Total domestic supply of potatoes, Y_{mt}^{SU} , i. e. estimated shipments plus government diversion, X_{mt}^{GO} . (2) Total domestic commercial demand for potatoes, Y_{mt}^{DE} , i. e. estimated shipments minus net exports, X_{mt}^{NX} . (3) Deflated farm-retail spreads for potatoes, Y_{mt}^{FR} . (4) Deflated monthly average prices received by farmers for potatoes,

¹For one variable, X_t^{Yq} , the symbol q was used in the superscript to denote quarter number ($q = 1, 2, 3, 4$).

y_{mt}^{PP} .

The identity expresses the fact that total domestic supply equals total domestic commercial demand plus government diversion plus net foreign demand. The identity is common for all months and can be written as follows:

$$(VII.1) \quad y_{mt}^{SU} = y_{mt}^{DE} + x_{mt}^{GO} + x_{mt}^{NX}.$$

Also the farm-retail spread equation was common for all months. It can be written in the following way:

$$(VII.2) \quad y_{mt}^{FR} = f^{FR}(y_{mt}^{DE}, y_{mt}^{PP}, x_{mt}^{WH}, x_t^{TE}).$$

The argument runs as follows. The farm-retail spread, y_{mt}^{FR} , might be related to the quantity of potatoes moving through the marketing channels that have produced the spreads. y_{mt}^{DE} is an approximate expression for this quantity. The reason why y_{mt}^{DE} is only an approximation is that y_{mt}^{DE} also includes potatoes for seed, feed, processing, and stocks. Potatoes for these purposes are only to a limited degree involved in the farm-retail spreads. Another reason is that there is a time lag which might be disturbing. The potatoes do not always move the entire way from the producer to the consumer during a single month.

y_{mt}^{PP} , the price of potatoes received by producers, was included in the farm-retail equation because this

price often is the basis for calculating various marketing costs, such as interest, insurance, and certain marketing margins.

The wholesale price index, X_{mt}^{WH} , was included as an indicator of various costs that are too numerous to be mentioned individually. We may mention such broad groups as package, transportation, and equipment. The index in itself is probably also correlated with labor costs.

The time variable, X_t^{TE} , is included to take into account possible linear changes in farm-retail spreads over time.

Next, let us turn to the supply relations. Some explanatory variables are present in the supply relation for every month, namely (1) the price of potatoes, Y_{mt}^{PP} , (2) a lagged price variable, X_{mt}^{PL} , (3) a lagged supply variable, X_{mt}^{SL} , and (4) the time variable, X_{mt}^{TE} . In addition, the supply function for each month contains a group of explanatory variables that are particular for that month or for some adjacent months. This group of variables consists of a production variable for each seasonal crop that is usually marketed partly during the month in question. In deciding which crop to include each month, Agriculture

Handbook No. 127 was very helpful.¹

The crops that had production variables included as explanatory variables in the supply relations for the various months, are the following (the symbol of each production variable is given in parentheses).

January and February: Fall (X_t^{FL}) and Winter (X_t^{WR}).

March: Fall, Winter, and Early Spring (X_t^{EP}). April:

Fall, Winter, Early Spring, and Late Spring (X_t^{LP}). May:

Fall, Early Spring, and Late Spring. June: Fall, Early

Spring, Late Spring, and Early Summer (X_t^{EU}). July:

Late Spring, Early Summer, and Late Summer (X_t^{LU}).

August: Late Spring, Early Summer, Late Summer, and Fall

(new crop). September and October: Early Summer, Late

Summer, and Fall. November and December: Late Summer and Fall.

The supply function for January or February looks like the following:

$$(VII.3) \quad Y_{mt}^{SU} = f^{SU}(Y_{mt}^{PP}, X_t^{FL}, X_t^{WR}, X_t^{TE}, X_{mt}^{PL}, X_{mt}^{SL}, X_{mt}^{AE}).$$

The Supply functions for the other months look the same, except that the production variables are different.

The variables in the demand functions for the various months were common for all months. These variables and the reasons for including them are listed in the following.

¹Royston, Frost, and Galloway, op. cit.

The price, Y_{mt}^{PP} , of potatoes received by farmers was included as an explanatory variable in the demand function for obvious reasons. This price is the one that supposedly is important for demands at the farm level. The farm-retail spread, Y_{mt}^{FR} , is another variable that supposedly affects demand since it reflects costs and profits imposed on the potatoes on their way from the farm to the consumer. The next three explanatory variables included in the demand functions were the Consumer Price Indices for (1) cereals and bakery products (X_{mt}^{PB}), (2) fruits and vegetables (X_{mt}^{PV}), and (3) meats, poultry, and fish (X_{mt}^{PM}).

A time trend was included to take care of possible linear changes in demand over time. An acreage variable X_{mt}^{AE} , was included to contribute to the explanation of the demand for potatoes for seed. This variable was an index based on the acreages of the potato crops the seed for which is usually shipped partly during the month in question. Finally, a variable related to the demand for potatoes for processing was included. This variable (X_t^{TP}) was essentially the total quantity of potatoes used for processing during the year in question.

The demand function for an arbitrary month then can be written as follows:

$$(VII.4) \quad Y_{mt}^{DE} = f^{DE}(Y_{mt}^{PP}, Y_{mt}^{FR}, X_{mt}^{PB}, X_{mt}^{PV}, X_{mt}^{PM}, X_t^{TE}, X_{mt}^{AE}, X_t^{TP}).$$

Functional Form and Statistical Assumptions

Very little knowledge is available that can be used to decide which functional forms the structural equations have. The choice of assumption on this point therefore was directed to a considerable degree by practical considerations.

First of all the reader is reminded that the use of non-linear functions, like n 'th degree polynomials, reduces the number of degrees of freedom. Since the sampling period is very short, such reductions ought to be avoided, if possible.

Most econometric analyses that have been undertaken have been based on relations that are linear either in the original variables or in their logarithms. Once a decision has been made to use one of these functional forms, the choice between the two is really not a big problem since these functional forms seldom produce significantly different results.

In the present work it was decided to work with functions that are linear in the original variables. "Linear equations give results which, when translated into total value-supply curves, make more economic sense at the extremes than do the results obtained from logar-

itmic equations".¹ This argument has some force in the present case since the supply of potatoes vary extremely from year to year, but actually the choice is probably not important.

Another reason for not using logarithms is that the logarithm of a negative number is not defined. Net exports are sometimes negative. Furthermore, if logarithms had been used, also the identity (VII.1) would have caused some trouble.

A compelling argument for choosing to use linear functions can not be given. In any case, however, linear functions can be regarded as approximations to the true functions for values of the variables within certain limits.

The statistical model for January can then be written as follows:

$$\begin{aligned}
 \text{(VII.5)} \quad y_{01t}^{\text{SU}} = & \beta_{01}^{\text{SU}} + \beta_{01}^{\text{SUPP}} y_{01t}^{\text{PP}} + \beta_{01}^{\text{SUFL}} x_t^{\text{FL}} + \beta_{01}^{\text{SUWR}} x_t^{\text{WR}} \\
 & + \beta_{01}^{\text{SUTE}} x_t^{\text{TE}} + \beta_{01}^{\text{SUPL}} x_{01t}^{\text{PL}} + \beta_{01}^{\text{SUSL}} x_{01t}^{\text{SL}} \\
 & + \beta_{01}^{\text{SUAЕ}} x_{01t}^{\text{AE}} + \epsilon_{01t}^{\text{SU}}
 \end{aligned}$$

¹Richard J. Foote, Analytical Tools for Studying Demand and Price Structures, Agriculture Handbook No. 146, Agricultural Marketing Service, U. S. Dept. of Agriculture (Washington: U. S. Government Printing Office, August, 1958), p.37.

$$\begin{aligned}
 \text{(VII.6)} \quad Y_{01t}^{\text{DE}} &= \beta_{01}^{\text{DE}} + \beta_{01}^{\text{DEPP}} Y_{01t}^{\text{PP}} + \beta_{01}^{\text{DEFR}} Y_{01t}^{\text{FR}} + \beta_{01}^{\text{DEPR}} X_{01t}^{\text{BP}} \\
 &+ \beta_{01}^{\text{DEPV}} X_{01t}^{\text{PV}} + \beta_{01}^{\text{DEPM}} X_{01t}^{\text{PM}} + \beta_{01}^{\text{DETE}} X_t^{\text{TE}} + \beta_{01}^{\text{DEAE}} X_{01t}^{\text{AE}} \\
 &+ \beta_{01}^{\text{DETP}} X_t^{\text{TP}} + \epsilon_{01t}^{\text{DE}}
 \end{aligned}$$

$$\begin{aligned}
 \text{(VII.7)} \quad Y_{01t}^{\text{FR}} &= \beta_{01}^{\text{FR}} + \beta_{01}^{\text{FRPP}} Y_{01t}^{\text{PP}} + \beta_{01}^{\text{FRDE}} Y_{01t}^{\text{DE}} + \beta_{01}^{\text{FRWH}} X_{01t}^{\text{WH}} \\
 &+ \beta_{01}^{\text{FRTE}} X_t^{\text{TE}} + \epsilon_{01t}^{\text{FR}}
 \end{aligned}$$

$$\text{(VII.8)} \quad Y_{01t}^{\text{SU}} = Y_{01t}^{\text{DE}} + X_{01t}^{\text{GO}} + X_{01t}^{\text{NX}}.$$

In equations (VII.5) - (VII.8) the subscript 01 is the value of m for January.

The β 's are constant coefficients. The first two letters in the superscript of a β indicate which variable is on the left side of the equation, and the next two are identical with the superscript of the variable to which the coefficient belongs. The estimates of the β 's will be denoted by b 's with the same subscripts and superscripts.

Each ϵ has the same superscript as the left-hand variable. This superscript thus shows to which equation an ϵ belongs. The ϵ 's also have time-identifying subscripts identical with those of the X 's and the Y 's.

The following assumptions were made regarding the model (VII.5) - (VII.8). The figures ϵ_{01t}^{SU} ($t = 1952, 1953, \dots, 1966$) are values of 15 different but identically distributed random variables $\underline{\epsilon}_{01t}^{SU}$ ($t = 1952, 1953, \dots, 1966$).¹

Each of these random variables has an expected value, $E(\underline{\epsilon}_{01t}^{SU})$ equal to zero, and a finite variance, $\text{Var}(\underline{\epsilon}_{01t}^{SU})$. The random variables corresponding to various values of t are mutually uncorrelated. Formally, we may write

$$(VII.9) \quad E(\underline{\epsilon}_{01t}^{SU}) = 0 \quad (t = 1952, 1953, \dots, 1966)$$

$$(VII.10) \quad \text{Var}(\underline{\epsilon}_{01t}^{SU}) = \sigma^2 < \infty \quad (t = 1952, 1953, \dots, 1966)$$

$$(VII.11) \quad E(\epsilon_{01t}^{SU} \cdot \underline{\epsilon}_{01s}^{SU}) = 0 \quad (t = 1952, 1953, \dots, 1966; s = 1952, 1953, \dots, 1966; s \neq t).$$

Assumptions quite analogous to those mentioned so far for $\underline{\epsilon}_{01t}^{SU}$ were also made for $\underline{\epsilon}_{01t}^{DE}$ and $\underline{\epsilon}_{01t}^{FR}$. It was further assumed that

$$(VII.12) \quad E(\underline{\epsilon}_{01t}^{SU} \cdot \underline{\epsilon}_{01s}^{DE}) = 0 \quad E(\underline{\epsilon}_{01t}^{SU} \cdot \underline{\epsilon}_{01s}^{FR}) = 0$$

$$E(\underline{\epsilon}_{01t}^{DE} \cdot \underline{\epsilon}_{01s}^{FR}) = 0 \quad (t = 1952, 1953, \dots, 1966; s = 1952, 1953, \dots, 1966; s \neq t).$$

¹The underlining of $\underline{\epsilon}_{01t}^{SU}$ signifies that $\underline{\epsilon}_{01t}^{SU}$ is a random variable and not the value of a random variable. Underlining thus corresponds to boldface letters in printed text.

The use of certain estimation procedures (limited information maximum likelihood and full information maximum likelihood) requires that each ϵ is normally distributed. Also the standard procedures for constructing confidence limits and testing hypotheses regarding the β 's are based on this assumption. The assumption was therefore adapted in certain cases.

It was also assumed that there is no multicollinearity.

The statistical models for the other months can be written in a similar way. The statistical assumptions made for these models are equivalent to the assumptions explained for the January model.

Identification

The relations of the models of the present work are all overidentified according to the simple counting rule for determining the degree of identification.¹ In reality the situation with regard to identification may be different from what is suggested by this counting rule, but in our case there seems to be little reason for believing that any of the relations are underidentified.

¹Ibid., pp. 60-61

CHAPTER VIII

THE ESTIMATED STRUCTURES

Estimation Procedures

The estimation methods that were used in the present work are (1) ordinary (unrestricted) least squares (OLS), (2) two-stage least squares (2SLS), (3) limited information single equation maximum likelihood (LISE), (4) three-stage least squares based on the limited information single equation maximum likelihood estimates (L-3SLS), (5) three-stage least squares (3SLS), (6) full information maximum likelihood based on the two-stage least squares estimates (2-FIML), and (7) full information maximum likelihood (FIML).

The estimation methods and the abbreviations used for their names are also listed in a more detailed way in the beginning of Appendix A.

Only the methods OLS, 2SLS, LISE, and 3SLS were used in the analyses that were undertaken in 1965.

It was not decided definitely at the outset which variables and relations were to be included in the final structures. The models described in detail in the preceding chapter were regarded initially at the most com-

prehensive models that might potentially be used. It was anticipated, however, that several of the variables would prove to be statistically insignificant. These variables, it was planned, would be excluded from the final structures.

As a method of choosing between the several potential variables listed in the models of the preceeding chapter, it was planned to use simultaneous equation methods already from the outset. By this procedure, it was thought, the explanatory power of each potential variable would be tried out in the best possible way. It turned out, however, that simultaneous equation methods could not be applied with advantage to the models of the preceeding chapter. The reason for this was that the models contain too many predetermined variables. The number of observations was only 13. The number of predetermined variables or "instruments" was also 13 or more for all months. Since there is no multicollinearity, the rank of the matrix of predetermined variables is then equal to 13. In such a case, 2SLS and LISE yield estimates identical with the OLS estimates. 3SLS yields estimates that are the same as if the explanatory jointly dependent variables of each equation were misclassified as predetermined and the

Zellner-Aitken estimation procedure were applied.¹

In this situation it was decided to use OLS only and to experiment with slight alterations of the original models; models in which some of the variables were left out. On the basis of these experimentations a model to be estimated by simultaneous equations procedures was finally selected.

Criteria for Choosing between Submodels

Not all conceivable submodels obtainable by deleting variables in the original models were experimented with. The number of models to be tried had to be kept within a reasonable limit, and therefore only the models that were thought to be potentially the most successful ones were used. Thus an element of subjectivity was present during the experimentation, but this was unavailable in order to restrict the extent of the computations. A very large number of models were explored, however.

The results of this large number of experiments or estimations were not always easy to interpret. Some principles and criteria for choosing between various models therefore had to be introduced. Each model was eva-

¹See William Lewis Ruble, Improving the Computation of Simultaneous Stochastic Linear Equations Estimates, (Agricultural Economics Report Number 116 and Econometrics Special Report Number 1 (East Lansing: Dept. of Agricultural Economics, Michigan State University, October, 1968), pp. 105-106 and p. 308.

luated on the basis of its performance judged according to the following criteria: (1) The reasonableness of the signs of the estimated coefficients. This criterion was very important. Nevertheless, it was not always easy to apply, since in some cases the right sign was not determinable a priori. (2) The sizes of the estimated standard errors, correlation coefficients and other statistical measures. Generally the standard errors were large, but ceteris paribus, small standard errors were regarded to reflect a good model. (3) The magnitudes of the estimated coefficients. The writer had some preconceived ideas--right or wrong--about the actual magnitudes of the coefficients. Also, certain coefficients should theoretically fulfill certain equations. For instance, some of the coefficients in the supply equations for various months should theoretically add up to one. (4) The variability of results obtained by various estimation procedures. Models that yielded similar results according to all estimation procedures were generally regarded better than models that led to highly different results when different methods of estimation were applied.

The four criteria listed above were insufficient to arrive at an unanimous selection of the best model. A fifth guiding principle was the following: Even though a certain model did perform very well when applied to a

particular month, this model was not necessarily adapted if the corresponding models (possibly with minor necessary changes due to dissimilarities between months) did not perform well when applied to other months in which the market structure was believed to be similar. This means that if a certain variable had the right sign, a reasonable order of magnitude, and a small standard error in the estimated structure pertaining to a particular month, the variable might still be dropped from the equation if this variable generally had a wrong or varying sign or magnitude, or a large standard error, in the models for other months where this variable á priori was deemed equally important. In other words: it was sought to arrive at a reasonable degree of consistency between the results for various months. It was recognized that the various months may be different, but in cases where there was no conceivable reason for differences, broadly similar results were expected.

It should also be mentioned that, because of the central role played by the price of potatoes in this work, this variable was never dropped from the supply and demand relations of any months, regardless of the criteria described above.

The criteria or principles discussed so far give a clue to how the final models were selected. In spite of the application of these guidelines, there

remains an element of subjectivity, of course. Accordingly, the final estimated structures presented as results in this thesis can be regarded as solutions suggested by economic theory, econometric theory, information on markets, and the data. There is no claim, however, that it is impossible to discover more basic or in a certain sense better structures, applying the same tools. Both limitations of scope and inadequacy of data make the results of this thesis tentative, like the results of most other pieces of research.

Test of Significance

The present writer had fairly strong beliefs based on economic and biological reasoning that certain explanatory variables, such as particular production variables, ought to be retained in certain relations. Since the number of observations is rather small, some variables may not show statistical significance even though they might be significant in models estimated on the basis of larger samples. As mentioned earlier, the price of potatoes was retained in the supply and demand relations regardless of statistical significance. In dealing with a relation containing several explanatory variables there may be a number of relevant null-hypotheses to be tested. Since the explanatory variables are in general not orthogonal, a systematic testing of

null-hypotheses requires much more work than simply looking at the t values computed on the bases of the standard errors obtained when all the explanatory variables are included in the relation. When twelve months are dealt with and the model for each month consists of two or three relations, each containing several explanatory variables, the work involved is quite large. For some explanatory variables the possible direction of the effects upon the dependent variable is quite clear, while for other variables the matter may be more or less uncertain. Thus, in some cases a one-tailed test, and in other cases a two-tailed test may be appropriate. There are also variables for which the use of tails of unequal size may be fitting.

For the various reasons mentioned in the preceding paragraph, statistical significance was not considered as the only criterion for choosing between models. Neither was a statistical testing carried out quite systematically. Statistical measures were used as descriptive, and not uncritically as decisive devices.

In the following the word "significant" will be used sometimes as a shortcut way of describing results. In order to fix standards, let us agree that what is meant is statistical significance at the ten percent level, using a simple conditional two-tailed test.

Introductory Remarks

Since a very large number of models were tried, it goes without saying that a complete description of all results would be too space consuming. Only the model that was finally chosen for each month will be described in any detail in the following, but other models will be commented on in passing. Reasons will also be given why certain variables were excluded from the final models.

While the early experimentations were done with 13 observations, the final estimates are all based on 15 observations. A few variables were also slightly re-defined before the computations based upon 15 observations were run.¹ As explained earlier, the initial model consisted of four simultaneous equations. In the final models the farm-retail spread was dropped from the demand equation. It was then no more need for the farm-retail spread equation in the simultaneous equations system. The final simultaneous equations models therefore all consist of three relations, namely a supply relation, a demand relation, and an identity.

¹The estimation was originally based on 13 observations and was completed while the writer was in the United States. For personal reasons the writing of the thesis was not completed at that time, however. When the writer had returned to Norway and had stayed there for some time, observations for two more years had become available, and he decided to add these to his scanty sample.

The Supply Relations

The lagged price variable, X_{mt}^{PL} , and the lagged supply variable, X_{mt}^{SL} , both very seldom had an estimated coefficient that was significantly different from zero. They also had a wrong sign (plus) in more than one half of the cases they were tried. They were therefore dropped from the supply equations at an early stage, and they were not tried in the models that were formulated after the time series had been updated.

The lagged price variable that was used may not have been sophisticated enough.¹ Instead of a single price difference for the past season, maybe a weighted mean of price differences for several intervals of the past marketing season ought to be used. Furthermore, not only one marketing season, but two or more seasons may need to be taken into account. In order to be able to construct intelligently indexes of past price experience, it is necessary to know more about seasonal marketing patterns for the various crops. Future research may throw more light on this.

The trouble with the lagged supply variable may have been that the past time intervals for which supplies

¹This variable is described in Chapter V.

were added up have not been the right ones.¹ But the dependence between supplies in various months is probably very complicated. Expectations play a major role, but they are influenced by the fact that two or more crops are marketed simultaneously in any one month of the year. Since the production variables that were used are common for several months, and since prices in various months are more or less correlated, the dependence between months may to some degree show up in the coefficients of these variables, this being the reason for the lacking significance of X_{mt}^{SL} .

Initially the acreage variable, X_{mt}^{AE} , was included also in the supply relation since supply among other things might depend on the quantity of potatoes used on farms for seed, and this quantity again is related to planted acreage.² The acreage variable is very crude, however, and the relationships are complex. The inclusion of this variable seemed doubtful, and it was eventually dropped.

Also the time variable, X_t^{TE} , was among the variables that were not retained in the supply relations. Time was included originally because it was believed

¹This Variable is described in Chapter V.

²The construction of the acreage variable is explained in Chapter VI.

that the demand for potatoes for use on farms might have changed over time. This would then affect supply from farms. There were also other reasons for believing that supply might have changed over time. For most months the coefficient of the time variable was not significantly different from zero. This variable was also correlated with some of the production variables, and its inclusion in the supply relations seemed to distort some of the coefficients of the production variables.

In the supply relations that were finally adopted, the only explanatory variables that were retained are the price of potatoes, X_{mt}^{PP} , and various production variables. (For certain months a stock variable, X_t^{M1} , was substituted for Fall production.)

In the following the estimated supply relations for individual months will be discussed briefly. The results are listed in Table 1 of Appendix A. A common model was used for each of the months January, February, and March, and each of the three structures was estimated by seven different estimation procedures. The fit, as measured by the coefficient R^2 , was relatively good in most cases, but in a few cases it was very poor, even yielding a negative R^2 , which indicated that the residual sum of squares exceeded the total sum of squares. This, of course, is a very unattractive situation, indeed! It is probably right to have very little confi-

dence in the corresponding coefficient estimates.

The coefficient of the Fall production variable, X_t^{FL} , has a reasonable sign and magnitude and a small standard error throughout. The various estimates indicate that a one unit increase in Fall production less home use for food will on average lead to an increase in supply which amounts to something like 0.10-0.15 units during each of the three months, assuming price and the production variable for the Winter crop to be constant.

For April, May, and June stocks on March 1 was used as a supply shifter instead of the production variable based on the Fall crop. The sign of the corresponding coefficient is positive throughout, and the estimated standard error is quite small. The magnitudes of the estimated coefficients are also quite reasonable.

Turning to the coefficients, b_m^{SUPP} , of the price variable, X_{mt}^{PP} , we notice that the estimates generally have large standard errors, varying magnitudes, and even different signs. The estimates for March seem to be the most reasonable and consistent ones. They indicate that a one unit price change, assuming production to be constant, will on average lead to a change in supply in the same direction, the magnitude of this change being in the neighborhood of 600 units.

The coefficient, b_{01}^{SUPP} , of the price variable for January is negative, except when estimated by the method 2-FIML. The corresponding coefficient, b_{02}^{SUPP} , for February is sometimes negative, sometimes positive, depending on which estimation procedure is used. Since the standard errors are very large, no definite conclusions can be drawn. One conceivable interpretation of the results is that the true price coefficient for February is close to zero. True enough, the coefficients estimated by the method full information maximum likelihood are large, but the standard errors are large as well, and the possibility of specification errors together with the relatively poor fit may justify the conclusion that the two FIML-estimates are less reliable than the other estimates for February.

Turning to the coefficient, b_{03}^{SUPP} , for March, we notice that all estimates are positive, and that most of them are of the same magnitude. The standard error is in most cases about half the size of the coefficient estimate.

The three months considered together give the impression that the true price coefficient, β_m^{SUPP} , may be negative for January, close to zero for February, and positive for March. A positive supply elasticity for potatoes in March, if real, may be explained in the following way: In various other months there is a

tendency among potato growers to react to high prices by postponing sales, expecting to get even higher prices. March is the last major marketing month of the Winter crop, and it is also relatively late in the marketing season of the Fall crop. If prices are high in March, the growers of these crops therefore tend to sell out their potatoes to avoid competition from the Spring crops, especially from the important Late Spring crop. This tendency may still be dominating in April (see Table 2) before the marketing of the important Late Spring crop has started in full.

In order to investigate this hypothesis further, let us consider other months in which the supply elasticity, according to the results of the present work, may be supposed to be positive. According to Table 3, the estimated coefficient for July, b_{07}^{SUPP} , is positive, except when estimated by the method of ordinary least squares. The estimated standard error of the coefficient is relatively large for all estimation methods, but still we have reason to believe that the true coefficient β_{07}^{SUPP} , may be positive. A positive coefficient may be explained in the following way: If prices are high in July, growers of Late Spring potatoes try to sell out their potatoes to avoid later competition from the Late Summer crop and the new Fall crop. Also growers of

Early Summer potatoes may be very willing to sell because they know that the large Late Summer and Fall crops will be soon forthcoming.

Table 3 shows that also for December the supply elasticity may be assumed to be positive, although the large estimated standard errors of the estimated coefficients of course make this assumption very uncertain. In December growers or storers of Fall potatoes may be expected to increase their supplied quantities in response of increased prices because they know that in the next months the Winter crop will also appear on the market.

If we assume on the basis of table 3 that the supply elasticity for November is negative, an assumption that is by no means certain, the negative elasticity may be explained in the following way: In November the bulk of the marketings come from the Fall crop, and the growers and storers of this crop know that no new crop is forthcoming in any considerable quantity the next month. If prices are high, the growers therefore expect them to remain high or increase, and accordingly they tend to decrease marketings in order to take advantage of the higher prices next month. A possible negative elasticity in October can be explained in a similar way. We will not comment on the corresponding results for other months because this will require too much space,

but it is possible to construct reasonable explanations for all the results that have been obtained. The fact that the results may not be the ones that one had expected a priori make them empirically interesting and calls for more research. If we consider all months together, it may be justified to draw the conclusion that current price does not seem to be the important determinant of supply.

Turning now to the coefficients of the remaining production variables (Fall production was discussed earlier), we notice that the estimates of the coefficient, β_m^{SUWR} , of Winter production less home use for food are negative for January, positive for March, and by most methods negative for February. The standard errors are so large that we are not justified to draw any definite conclusion as to the true signs. But the results seem to indicate that the sign of the true coefficient may be negative in January, positive in March, and slightly negative in February. How can such signs be explained? This question has been answered in Chapter V to which we refer.¹

¹It is interesting to notice also that other research workers have obtained various "unnormal" signs in connection with the smaller potato crops. These signs may also be explained along the lines suggested in the present work. See for example Simmons, op. cit., pp. 50-51.

The next production variable we will consider is the one based on the Early Spring crop. This production variable is included in the supply equations for April and May, and the signs of the corresponding coefficients are positive throughout. This results seems reasonable for this important crop. The standard errors are all large, so we can not rely too much on the numerical values of the estimates. If we assume that most of the Early Spring crop is marketed in April and May, we should expect the estimated coefficients for these months to add up to a number close to one. According to this criterion, the FIML estimates seem to be too small, while the other estimates seem to be too large. We should possibly expect the coefficient for May to be less than the coefficient for April since all of April is listed as a regular marketing period for the Early Spring crop.

By making additions of coefficients for various months, as described in the preceeding paragraph for the Early Spring crop, we can to a certain extent check our results for the various crops. We must remember, however, that these checks are not quite reliable. An increase, say, in the production of Early Spring potatoes will not only affect marketings of Early Spring potatoes, but it may also, via expectations, influence marketings of other crops.

In the models for May and June a production variable based on the Late Spring crop is included. The estimated coefficients, b_m^{SULP} , are positive without exception, but the estimated standard errors are relatively large. Since $b_{05}^{\text{SULP}} + b_{06}^{\text{SULP}}$ is considerably less than one regardless which estimation method is used, there is reason to believe that the size of Late Spring production influences marketings also of other crops. The crops in question may possibly be the Early Spring, Early Summer, and Fall crops. This is again an example of the complicated nature of the potato market.

The next production variable to be considered is the one based on the Early Summer crop. The estimated coefficient of this variable is always positive for July. The August estimates, except the FIML estimates, are negative. If the true coefficient for August is negative, this phenomenon may be explained in the following way: When, say the Early Summer crop is large and one might expect potato supply in August to increase for this reason, supply will decrease because producers of the large Late Summer and Fall crops tend to postpone marketings from August till later months. As a digression we will note that if this is true, yields of Late Summer and Fall potatoes will increase, and supply will therefore increase in some later period for this reason also. The standard errors of the estimated coefficients

are again relatively large, so it is difficult to draw conclusions as to the size of the coefficients. The discussion of signs must suffice.

A production variable based on the Late Summer crop is included in the models for July, August, September, and October. All estimates of the corresponding coefficients b_m^{SULU} are negative for August and September. The estimates for July and October are negative or positive, depending on which estimation method is used.

August and September are the typical marketing months for the Late Summer crop. Negative coefficients for these months may be due to the suppliers of Fall potatoes withholding some of their potatoes for some time in order to avoid competition from the Late Summer crop. Of course a similar tendency may also be present in July and October.

The Demand Relations

Several variables were included in the initial demand relations on an experimental basis. The demand relations that were finally adopted contain only a few explanatory variables. In the following some reasons for including and excluding the various variables will be given. Some numerical results will also be commented on.

As explained in Chapter VII, several demands are

treated together in the models, and accordingly there may be several reasons for including a certain explanatory variable in a model.

First, the variables that were not retained will be mentioned. Two alternative variables were used to try to explain, to some extent, the variation in demand due to variations in the activities of processing firms. Essentially, both variables can be regarded as indicators of the total quantity of potatoes used for processing purposes during each processing season.¹ It appeared that these variables might be related to demand in certain months, but the evidence was weak when judged in the framework of all months considered together. It was therefore finally decided to drop these variables. A time variable was retained, and this variable is to some extent a substitute for the processing variables.

The fact that the processing variables are very crude may explain the limited success in using them. Another circumstance that should be considered is mentioned in Chapter III where it is stated¹ that short haul rail movements to processors are not included in the shipments data. We have so far tacitly assumed that these shipments are roughly proportional to other ship-

¹The exact nature of these variables is explained in Chapter III under the heading Utilization Data.

ments. If they are not so, this may be another source of disturbance in the relationships between demand and the processing variables.

In the early runs certain variables were included in the demand equations that were expected to be highly correlated with the time variable. Among these variables that were included on an experimental basis were a population variable and an income variable. When it had been verified that the possible effects of these variables could hardly be distinguished from the effect of a time variable, it was decided not to include these variables in the final demand equations. The coefficient for the time variable therefore also includes the effect of population and income.

The farm-retail spread variable was a crucial variable in the demand relations since this variable was considered endogenous. The inclusion of this variable necessitated the inclusion of a separate farm-retail spread relation in the system. A pretty large number of least squares analyses were run with the farm-retail spread variable as a demand shifter. For certain months the inclusion of this explanatory variable in the demand relation seemed to be justified. When all months were considered together, the evidence was somewhat confusing, however. Both the sign of the estimated coefficient and the seeming importance of the variable

differed from month to month. As explained in Chapter VI the changing sign is perhaps as it should be. Since the farm-retail spread variable was generally not very successful judged by any criterion, it was decided in the present analysis to exclude it from the demand equations. It is clear, however, that more research is needed in connection with this variable, and that the last word with regard to its inclusion in demand relations of the present kind has not yet been said. One thing to be examined is whether the farm-retail spreads to some extent measure location effects. Transportation costs namely account for a substantial part of farm-retail spreads.

The next group of variables we will discuss consists of price indices for various foods. Most of these foods can be considered as substitutes for potatoes. Initially it was decided to work with two alternatives. The first alternative was to use the Consumer Price Index for food at home. The second alternative was to use three price indices, namely the Consumer Price Indices for (1) cereals and bakery products, (2) fruits and vegetables, and (3) meats, poultry, and fish. After some experimentation with various models that were estimated by the method of least squares, it was decided to drop the first alternative and work further with the second. Within this second alternative one, two, or

all three price indices were tried as demand shifters by the method of least squares. For certain months, certain price indices seemed to be very important. One was therefore tempted to use for each month the price index or price indices that seemed to produce the best fit. But this solution is not to be recommended as long as no relevant economic explanation can be given for the differences between months. There were some hypothetical explanations for the differences that were observed between months, but they were considered too weak by the present writer. It was therefore decided to try a new procedure. Accordingly the three indices were combined into a single price index. The combined index that was used is the arithmetic mean of the three original indices and is denoted by X_{mt}^{AV} . Of course one could have used a weighted mean; the reason for using equal weights is that no evidence is available as to what the proper weights should be.

There are some fundamental objections to the combination of the three indices into one index. Cereals and bakery products are usually considered as substitutes for potatoes, and the same is true for vegetables and possibly fruits. But what about meats, poultry and fish? Are not these foods complements to potatoes rather than substitutes? While the cross elasticities for substitutes are expected to be positive, the cross elasticities for complements are generally negative. Will not the combi-

nation of prices for substitutes and complements into a single price index obscure the whole matter? If meats, poultry, and fish really are complements to potatoes, this may be true. The preliminary analyses did not point strongly in favour of considering these foods as complements to potatoes, however. Let us take a closer look into the matter.

Meat, poultry, and fish can be regarded as substitutes for potatoes in one sense, and as complements to potatoes in another. In the context of a single meal, they are substitutes since, clearly, if much of the one food is consumed, less of the other will be used.

On the other hand, if we consider the number of hot meals as varying and assume that these foods are consumed mainly in connection with hot meals, potatoes will be complements to meats, poultry, and fish. More meat, etc. may imply more hot meals and thus more potatoes.

If, as seems plausible, we may assume that the number of hot meals are determined by habit and convention rather than by the prices of meats, poultry, and fish, potatoes and these foods can be considered mainly as substitutes. This conclusion is strengthened by the fact that meats, poultry, and fish are used in many situations where fresh or processed potatoes are not a natural or necessary complement to these foods. To treat meats, poultry, and fish together with cereals, bakery

products, vegetables, and fruits should therefore be an allowable procedure after all.

The estimated coefficients of the variable X_{mt}^{AV} are shown in Table 4. The coefficient is positive, as expected, for January through April and for September and December. This is not always the case for the other months.

On the basis of average prices and demand for the sampling period and the least squares estimates, the following elasticities of potato demand with regard to X_{mt}^{AV} have been computed: January 1.3, February 3.0, March 0.1, April 0.2, May -1.2, June -0.1, July 0.1, August 0.1, September 2.8, October 1.1, November -0.7, and December 2.0. Since it is difficult to find economic reasons for the large differences in the estimated elasticities, we must expect them to be subject to considerable errors. The average of the reported figures is 0.7. An elasticity of this magnitude may be regarded as reasonable. It should also be noted, however, that the coefficients may be biased downward because the food items that correspond to X_{mt}^{AV} make up a substantial part of the items in the Consumer Price Index that was used as deflator.¹

One of the possible reasons for the large variations in the estimated coefficients of the variable

¹See Foote, op. cit., p. 28.

X_{mt}^{AV} may be that the potatoes are partly demanded for storage. Prices of substitutes during the current month have little influence on this part of total demand. Since some of the price movements for substitutes are seasonal, there may be systematic effects that account for some of the strange elasticities.

The acreage variable X_{mt}^{AE} , mentioned earlier, was initially included in the demand relation for every month, since this variable could possibly be related to the demand for seed potatoes. As an alternative to A_{mt}^{AE} a variable, X_{mt}^{MS} , based on seed shipments from Maine was also tried, but with little success. In the final models, only the variable X_{mt}^{AE} was used, and it was not included for other months than March and April. The estimated coefficients are recorded in Table 4. A difficulty encountered in trying to construct an acreage variable of the present kind is that the time lags from seed shipments till planting are not known. Another problem with this variable is that it is not truly exogenous.

The time variable has been mentioned earlier. As is apparent from Table 4, the coefficient of this variable is generally clearly significant.

Finally, we turn to the variable of most interest, namely the price variable, Y_{mt}^{PP} . The estimated coefficients of this variable are shown in Table 4. If we use the least squares estimates and average

prices and demanded quantities for the sampling period, we get the following demand elasticities for potatoes with regard to own price: January -0.05, February -0.07, March -0.03, April -0.14, May -0.24, June -0.12, July -0.07, August 0.07, September -0.06, October 0.03, November 0.04, December 0.02. The low numerical values of the elasticities is consistent with the general belief that demand for potatoes is rather inelastic. The relatively high values for April, May, and June may partly be due to comparatively high prices for potatoes during these months. According to the figures above, demand elasticities tend to be positive during the first part of the marketing period of the Fall crop. A possible reason for this is that when prices for this important crop are high, demanders expect them to increase, and therefore they increase their demand. At this time of the year no new crop is forthcoming, except the relatively minor Winter crop whose marketing period begins mainly in January. Of course, the positive values for demand elasticities in this period may also be due to sampling errors, specification errors, etc., but the consistency with which they show up suggests that they reflect reality, although their numerical values are small.

If we consider the coefficients estimated by methods other than least squares, the same general picture of

demand elasticities emerges, even though there are exceptions. The signs of the coefficients are always the same, except for December, when the coefficients are close to zero. The numerical values of elasticities are often higher for the FIML estimates than for the OLS estimates.

The Farm-Retail Spread Relations

Since the farm-retail spreads were not included in the final demand relations, the farm-retail spread relations do not belong to the simultaneous relations systems. The estimated farm-retail relations are reported here only as an auxiliary matter.

Initially it was assumed that farm-retail spreads were a linear function of the following variables: (1) the price of potatoes, Y_{mt}^{PP} , (2) time, X_t^{TE} , (3) the wholesale price index, X_{mt}^{WH} , and (4) the quantity of potatoes demanded, Y_{mt}^{DE} . The coefficients in the corresponding equations for each month were estimated by the method of least squares in order to provide some information on the importance of the various variables.

The analyses showed that the quantity of potatoes demanded no doubt could be dropped from all equations. This variable had a coefficient with a negative sign in six months out of the twelve. Its coefficient was in almost no cases significant different from zero.

The regression analyses with the three remaining independent variables showed that the wholesale price index had a positive coefficient in all months. In only one month the coefficient was significantly different from zero, however. Because of the persistent positive sign, it was decided to keep this variable on economic grounds, in spite of the results of the statistical tests. The estimated coefficients are shown in Table 6.

The Reduced Form Relations

If the system of structural relations is solved so that each endogenous variable is expressed in terms of predetermined variables, coefficients, and disturbances, we get the reduced form relations. Coefficients of the reduced forms may be derived from coefficients of the structural relations or they may be estimated directly. If we want to predict values of the endogenous variables, the reduced forms are of particular interest. The reduced form relations are not always the best relations to use for prediction purposes. For lack of data at the time of prediction, and for other reasons, one may prefer other relations.

Since space is limited and price is the variable we are the most interested in predicting, only reduced form relations with price as dependent variable will be dealt with here. The method of least squares applied di-

rectly to the reduced form relations yield estimates that appear to be among the more reasonable ones. In order to save space, we will restrict ourselves to discuss estimates obtained by this method. These estimates are shown in Table 7.

The values of the coefficient of multiple determination are relatively high for most months. They range from 0.71 to 0.95. But it must be remembered that up to eight predetermined variables are present in each relation, and that several of the corresponding coefficients are not significantly different from zero. If the insignificant variables were dropped from each relation, R^2 would still be relatively high in most cases, however.

The coefficient of the time variable, X_t^{TE} , is significantly greater than zero for most months. For September and October the coefficient is negative, but the coefficient for October is not significantly different from zero, so the negative sign may be accidental. The in itself uninteresting time variable is not the only one that contributes to the explanation of price. Another important group of variables are the production variables. Before we discuss these variables, we must mention the question of which sign is to be expected for each coefficient.

If we accept the models whose estimated structures are shown in tables one to four as true, computations

will reveal that the reduced form coefficients can be obtained from the structural coefficients in the following way: (1) The true reduced form coefficient of a variable that is present in a demand relation is equal to its true coefficient in this relation divided by $q = \beta_m^{\text{SUPP}} - \beta_m^{\text{DEPP}}$. The true reduced form coefficients of X_{mt}^{GO} and X_{mt}^{NX} are obtained in a corresponding way by dividing their true structural coefficients, which are both equal to one, by q . (2) The true reduced form coefficient of a variable that is present in a supply relation is equal to minus its true coefficient in this relation divided by q .

From this we see that if β_m^{SUPP} is positive and β_m^{DEPP} is negative, the signs of the true reduced form coefficients will be the same as the signs of the true structural coefficients for variables that are present in a demand relation or an identity. For variables that are present in a supply relation, the relationship between signs in the structural relation and the reduced form relation will be the opposite.

Let us now turn to the production variables. If q is positive and the true coefficient of a production variable in the supply relation is positive, then we should expect the corresponding reduced form coefficient to be negative. Practically speaking, this means that when production increases, price will fall. This is the situation we are liable to call "normal", at least for

the major crops. As we have argued earlier in this chapter, the situation may be different due to the effects of expectations.

From Table 6 we see that the coefficient of the Fall production variable, X_t^{FL} , is negative and usually also significantly different from zero for all months when this variable is included in the system. The same may be said of the March 1 stocks variable, X_t^{M1} , which is included for the months when Fall production is excluded. Also the coefficients of the production variables, X_t^{LP} , for the important Late Spring crop and X_t^{EU} for the Early Summer crop have similar characteristics.

The coefficient of the net export variable, X_{mt}^{NX} , should under "normal" conditions be positive, but it is more often negative. We could try to explore, for each month, whether the negative sign can be traced back to q being negative or the difference in signs is due to sampling errors, but we shall not elaborate this. Net exports were never believed to be an important determinant of potato prices, but they were included in the models partly for aesthetic reasons, since data were available in any case. Since potatoes for seed and other purposes make up varying proportions of the potatoes that are exported and imported, the motives and forces directing foreign trade in potatoes may vary from month to month. Net exports are clearly not truly predetermined. A reliable conclusion

regarding the effects of foreign trade in potatoes on domestic prices can not be drawn until a separate analysis of this question has been undertaken.

The government diversion variable is similar to the net export variable from the point of view of model building, and it would have been quite logical to combine the two into a single variable. More interest is attached to government diversion than to net exports, however. From Table 6 we see that the coefficient of the government diversion variable is negative for five months. Taken at face value, this implies that government diversion has decreased potato prices for these months. Such a conclusion would be premature, however. Two of the negative coefficients can be safely disregarded, since diversions during these months have been quite negligible according to Table 10. The months in question are July and August. Only one of the remaining negative coefficients is significantly different from zero, and even this one may be due to accidental circumstances possibly connected with specification errors. We must also admit that even though the rules under which the potatoes are diverted are parameters that are wholly determined by the government, the diverted quantities are not quite predetermined. The negative signs might be real if, as is possible, diversion affects the expectations of the participants in the markets. If this is the case, the final

effects on prices may be rather unpredictable.

Another circumstance that may have distorted the coefficients of the diversion variables is that in some cases the potatoes that have been diverted are potatoes that would have been withheld anyway.¹

The reduced form coefficient of X_{mt}^{AV} , the price variable for substitutes for potatoes, has the "normal" positive sign for all months except May, June, and July. None of the negative coefficients are significantly different from zero, but all the positive ones, except one, are.

There is no doubt that it is possible to construct prediction equations for potato prices that are better and simpler to use in practice than the reduced form relations presented here. But the aim of the present work was not primarily to predict potato prices. More emphasis has been placed upon trying to explain interrelationships between factors that determine prices. Therefore the structural relations have been the focus rather than the reduced form relations.

Testing for Possible Serial Correlation in the Disturbance Terms

The Durbin-Watson statistic was computed and used to test the hypothesis that there is no serial correlation (positive or negative) among the disturbance terms

¹See Simmons, op. cit., p. 58.

of each structural relation. The Durbin-Watson statistic is given by the following formula:¹

$$d = \frac{\sum_{t=2}^n (\hat{\epsilon}_t - \hat{\epsilon}_{t-1})^2}{\sum_{t=1}^n \hat{\epsilon}_t^2}$$

Here $\hat{\epsilon}_t$ is the unexplained residual in the dependent variable for time period (year) number t , and n is the number of time periods or observations (years). Some economists have claimed that positive autocorrelation of disturbances may be expected to prevail almost universally. An investigation by Hildreth and Lu has cast some doubt on this claim.² Accordingly a two tailed test was used in the **present investigation**. This is appropriate when there is no prior knowledge of the sign of the serial correlation.

The test was performed at the 5 per cent probability level. For no equation or method of estimation was the hypothesis of serial independence rejected. In several cases the test was inconclusive, however. Such re-

¹See J. Durbin and G. S. Watson, "Testing for Serial Correlation in Least Squares Regression. II," Biometrika, XXXVIII (1951), pp. 159-78. Further details and tables of significance points are given in this article.

²See Clifford Hildreth and John Y. Lu, Demand Relations with Autocorrelated Disturbances. Technical Bulletin 276 (East Lansing: Dept. of Agricultural Economics, Agricultural Experiment Station, Michigan State University, November 1960), p. 40.

sults are very common according to Hildreth and Lu.¹

According to Durbin and Watson, the test used applies only to regression models in which the independent variables can be regarded as "fixed variables".² This requirement is not fulfilled for the structural relations of the present work. The results of the testing can therefore only be regarded as approximate.³ The fact that the hypothesis of serial independence in no case was rejected may be taken as a rough indication that while there may be serial correlation, this is at least not quite apparent. A further exploration of the possibility of serial correlation would be beyond the scope of the present work.

Most of the reduced form relations contain more than five variables, and for such cases no per cent points are available. By extrapolation it seems quite clear that the test would be inconclusive for all reduced form relations, however.

¹Ibid., p. 5.

²Durbin and Watson, op. cit., p. 159.

³See Joan Friedman and Richard J. Foote, Computational Methods for Handling Systems of Simultaneous Equations with Applications to Agriculture. Agriculture Handbook No. 94, Economic and Statistical Analysis Division, Economic Research Service, U. S. Dept. of Agriculture (Washington: U. S. Government Printing Office, November, 1962), p. 77.

CHAPTER IX

SOME IMPLICATIONS AND USES OF THE RESULTS AND SUGGESTIONS FOR FURTHER RESEARCH

Evaluation of the Results

The numerical results of the present work can not be characterized in general as very accurate and reliable. Some of the underlying data, notably the estimated monthly sales data, are doubtless subject to errors that may have influenced the results. Due to lack of data, there are also errors of model specification that may have created biases. But this does not mean that the results are without usefulness. The present work is very comprehensive in that each single month of the year has been analyzed separately. This creates possibilities for comparisons that have never been made before. The type of models that have been used have important aspects that represent a new approach to the problem. As a result, several magnitudes have been estimated that have never been estimated before.

Since the results are tentative, they should not be used extensively for policy purposes until they have been verified by new analyses with better data and pre-

ferably also with better models. Because so many months have been analyzed and so much work has been expended on constructing the necessary data, it has not been possible to go into as much detail as had been desirable for each particular month.

The principal value of the results of the present work is then that they provide temporary estimates of important coefficients, many of which were earlier unknown. The somewhat uncertain insights that has been gained through the present work may give some guidance in solving policy problems, but several of the results are too uncertain to be of direct practical value. Many of the results and insights that the present work has produced are of such a nature, however, that they ought to stimulate the formulation of new hypotheses and the conduct of further research.

No serious efforts have been made to evaluate the relative performance of the various estimation methods on the basis of the estimates obtained in the present work. Such an evaluation is very difficult as long as the true structures are unknown. Very briefly the impression of the present writer can be summarized as follows: The full information maximum likelihood methods in some cases yielded results that were obviously "wild". The method of ordinary least squares seldom yielded extreme results, while the remaining methods can be characterized as inter-

mediate between the two in this regard. If the author were to make a judgement as to the "best" estimator for this particular case, he would prefer the ordinary least squares estimator. The bias of this estimator is probably a less serious problem than the larger variances and the greater need for correct specification connected with the other estimators.

Comments on Elasticities Obtained in the
Present and Earlier Investigations

Both the supply elasticities and the demand elasticities that have been computed on the basis of the estimates of the present work have generally very low absolute values. It is generally agreed on the basis of various earlier investigations that demand for potatoes is rather inelastic, but most of these investigations have been based on periods longer than months, and most of the elasticities obtained tend to be higher in absolute value than the ones of the present work. How shall we interpret these differences? One reason for the low values of the present work is that these elasticities are measured at the farm level, while many of the earlier results refer to the retail level. The elasticities of the present work therefore indicate more realistically how limited the possibilities are for farmers to increase sales of potatoes by decreasing prices.

It could be that elasticities for months are

lower in absolute value than elasticities for longer periods, but theoretical considerations would rather suggest the opposite.¹ Since the different market levels alone are probably not sufficient to explain the differences in elasticities, we must conclude that the present analysis has produced demand elasticities that are generally lower than earlier estimates. Some of the data used in this work may be subject to errors, but the present work has its strength in that potatoes for all purposes have been dealt with on a monthly basis in very logical models. Which results are the more reliable ones is therefore an open question. Economic reasoning would indicate that the demand elasticities for potatoes are very close to zero.

In the following we will point out some reasons why elasticities obtained in earlier investigations may be too high.

Some of the elasticities obtained in, say, the work of Olman Hee can probably not be considered as genuine elasticities in the sense of the word prevalent in economic theory.² An elasticity is usually thought

¹When the time unit is short, price induced changes in demand that are connected with changes in storage or temporary changes in consumption are more important than when the time unit is long.

²See Hee, op. cit.

of as pertaining to a market of approximately constant size. The size of the market for, say, Early Spring potatoes varies with prices, however. When prices of these potatoes are low, other things being equal, they are shipped more widely throughout the United States than otherwise. This gives a high elasticity.

The high estimated cross elasticities in the work of Hee may be explained in a similar way. If competition between two types of potatoes is to be measured by elasticities of this kind, both goods have to be available all over the market at all times during the period of analysis. In the analyses referred to above the market is the United States, and it is doubtful that the seasonal categories of potatoes included in the analyses have been available all over the United States during all of the periods of analysis.

A second possible reason for upward biases in the absolute values of price elasticities estimated in earlier investigations may be errors in the predetermined variables. It is well known that in simple linear regression errors in the independent variable will, under rather unrestrictive conditions, bias the absolute value of the regression coefficient towards zero.¹ A similar

¹See Fox, op. cit., pp. 31-32.

bias may materialize in multiple regression.¹ Several of the earlier analyses have been undertaken according to the following pattern: The price received by farmers for a particular seasonal crop is regressed on production of the same crop, production or stocks of competing crops, and some other variables like disposable income.²

Now, it may be argued that in the context of demand analyses, the price and quantity that one has correlated according to the above described pattern do not properly match. Although some differentiation exists between potatoes from various seasonal crops, in several cases potatoes from various crops are indistinguishable from the point of view of the consumer. Consequently the grouping of potatoes according to seasonal groups becomes somewhat arbitrary when we consider the matter from the demand side. We may thus insist that prices received for a particular seasonal crop of potatoes should properly not be matched with production of the same crop, but rather with production of all potatoes which are considered by the consumers to be equivalent to the crop in question and which are available at the same time and

¹See J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, Inc., 1963), pp. 148-175 for an extension to more than two variables.

²See for example Simmons, op. cit., pp. 79-83.

at the same places. Judged from this point of view, production of the crop in question can be considered as being a substitute for the true production variable. Thus we may speak of errors in this independent variable.

These errors may cause a downward bias in the absolute value of the regression coefficient and a corresponding upward bias in the estimated price elasticity of demand.

A third possible source of bias in the earlier estimated price elasticities will also be mentioned. Let us consider analyses of the kind just dealt with. Fox has argued that the demand relation for several agricultural products can be estimated by regressing price on quantity and certain other variables.¹ Malinvaud makes the following statement pertinent to such situations:

"The regression of price on quantity constitutes a consistent estimator of the demand law if supply is inelastic . . . and if the errors affecting supply and demand are mutually independent."² Malinvaud supplies a proof of this statement for a relatively simple model, but the statement is probably valid for a wider class of models, including several models that have been employed to estimate demand elasticities for potatoes.

¹Fox, op. cit.

²E. Malinvaud, Statistical Methods of Econometrics, trans. A Silvey (2d rev. ed.; Amsterdam: North-Holland Publishing Company, 1970), p. 609.

Let us now examine whether the conditions in Malinvauds statement are likely to have been fulfilled in analyses where price of a particular seasonal crop of potatoes has been regressed on production of the same crop, production or stocks of competing crops, and various other variables.

According to this scheme, the supply schedule may be thought of as a vertical line at a distance from the origin equal to production. The shifts in this schedule are correlated with weather conditions.

The demand function in this system expresses production (which is assumed to be equal to consumption) as a function of price, production of competing crops, and some other variables. Shifts in this schedule may be due to shifts in the supply of potatoes or vegetables from crops that have not been included in the model. Such shifts may further be due to shifts in the timing and geographical extension of the marketing of the potato crops that have been included in the model. All these shifts may be correlated with the same weather conditions that cause shifts in supply. Thus the errors affecting supply and demand may not be mutually independent.

It is interesting to notice that the price flexibility of demand for potatoes in the Winter, as estimated by Zusman, was much higher than that found in earlier

studies for the total annual crop.¹ The estimated price flexibility in the spring, on the other hand, was generally lower than the annual price flexibility found in earlier studies. Zusman offers a couple of explanations for this, and these may be right as far as they go, but another explanation should also be considered. The price flexibility in the spring was estimated by a method of the kind that we have argued above may give biased results, while the price flexibility in the Winter was obtained by a method similar to the method used in the present work. The high price flexibility in the Winter implies a price elasticity of demand that lies well within the range of the elasticities estimated in the present work. Since Zusman works with retail prices, the agreement between Zusman's results and the general appearance of the results of the present work is even better than the raw figures suggest. Thus Zusman's results seem to support the hypothesis set forth in the present section, that price elasticities of demand for potatoes obtained in earlier investigations are generally too high.

On the basis of Zusman's results the present writer has also computed some supply elasticities. The average values of the variables for the sampling period

¹Zusman, op. cit., p. 602.

were used.¹ The elasticity of total per capita supply of late potatoes in September-February with regard to per capita production of late potatoes was 0.96. The elasticity of supply with regard to retail price was -0.03. The elasticities of supply with regard to farm price computed on the basis of the ordinary least squares estimates of the present work for the corresponding months have the following values: September 0.01, October -0.02, November -0.03, December 0.06, January -0.03, and February -0.02. Thus the supply elasticities of the two investigations are not dissimilar.

Another peculiarity of the price elasticities of supply and demand that have been estimated in the present work is that some of the supply elasticities are negative, while some of the demand elasticities are positive. The present writer is not going to defend the sign of any single elasticity. For this, the results are too uncertain. There is good reasons for believing that certain of the true elasticities have "unnormal" signs, however. Earlier writers have possibly been too reluctant to accept and publish results showing coefficients with unexpected signs. There are indications that they have occasionally obtained such results, however. The present writer's impression from experience

¹The figures were taken from Zusman, op. cit., p. 595 and p. 658.

gained through investigations is that the interrelationships operating in the potato market are extremely complicated and dynamic in nature. Negative elasticities of supply and positive elasticities of demand are by no means a strange phenomenon in this setting. For example, if suppliers and demanders expect prices to increase when they are high and to decrease when they are low, this could happen.

Some Implications of Low Elasticities of Supply and Demand, Some of Which Have Unexpected Signs

If both supply and demand elasticities are very close to zero as the results of the present analysis indicate, this phenomenon may explain why potato prices have fluctuated so violently in the past. In the usual cartesian coordinate system, with price measured vertically and quantity of potatoes horizontally, we can visualize a supply and a demand curve for potatoes as two very steep lines crossing each other. Because of the steepness of the lines, even a relatively small shift in one of the lines will cause a relatively large price change. Such shifts may be due to a change in one of the error terms, or to changes in the value of one or more of the other variables that determine supply and demand besides price of potatoes. Shifts of this kind can therefore be expected to occur quite often.

If elasticity of supply and elasticity of demand

both have the same sign, it is important to know the relative steepness of the supply line and the demand line. If the algebraic value of the slope of the supply line (in the diagram visualized earlier) is greater than the algebraic value of the slope of the demand line in such a situation, the equilibrium, if reached, will be unstable. If equilibrium is disturbed, the nature of the system will work to increase disequilibrium instead of reestablishing equilibrium. In such a case, almost anything may happen to prices. The unpredictability of the situation is increased by the fact that we do not know whether the supply and demand schedules are really linear. If they are not linear, there may be various equilibrium points at different prices.

Also if the "normal" signs of the supply and demand elasticities are reversed, i. e. if the supply elasticity is negative and the demand elasticity is positive, the equilibrium is unstable.

Turning to our empirical results, we see that the least squares estimates imply unstable equilibria for August, October, and November. The results are not statistically significant, so we shall not exaggerate the importance of the particular coefficients, but they do at least demonstrate the possibility that the potato market may be in such condition.

If "unnormal" signs of elasticities are a real-

ity, this has very important policy implications. It then becomes necessary to acquire a more detailed and thorough knowledge of market conditions. Without such knowledge, policy measures like certain kinds of diversion programs may accomplish the exact opposite of what was intended.

Some Suggestions for Further Research

In the opinion of the present writer, the models discussed and partly estimated in the present work have proved to represent in principle a very fruitful conceptual framework for attacking the problem of intraseasonal price analysis. The main difficulty encountered in trying to estimate the models is the lack of adequate data. The models that were estimated in the present work are therefore only rudiments of what was originally planned. Despite this, the results obtained have thrown new light on the potato market.

Fortunately, there are few basic hindrances to securing better data if all parties involved: growers, dealers, processors, statistical agencies, governments, research workers, and others combine in a strenuous effort to improve the data available and create new series. Among the data that have actually been employed in the present analysis, the estimated sales data are the ones that are most urgently in need of improvement.

Most of the basic data are already being collected, so the main problem still to be solved is to systematize a process by which the final data desired will be forthcoming. If this process is organized properly, and if electronic computers are used, the regular collection of high quality data of the desired kind can be undertaken with relatively small expense.

Several kinds of data, including production, sales, and shipments data, are available for smaller geographical units than the states used in the present investigation to construct monthly sales data. Counties might be the appropriate geographical units to use, at least for some states. The monthly sales data can then be computed with much greater accuracy.

Even a disaggregated analysis over time is possible, since shipments data are available also by weeks. The trouble with disaggregation over time is, of course, that we lack data for several other variables by weeks. There is no necessity for this to be an insurmountable problem in the future, however. Furthermore, for certain parts of the year, at least, it may be desirable to use very short time units if the potato price problem is to be dealt with adequately.

The following quotation illustrate that the use of weekly data might be considered. "Many experienced observers have set up a formula expressing the opinion

that 7,500 carlot shipments (by rail and truck) per week is the approximate maximum to return a parity price."¹

Another kind of disaggregation that may prove fruitful is a geographical disaggregation whereby the United States is divided into regions. In models where several regions were considered simultaneously, freight rates could also be taken into account. These often average from 40 to 80 per cent of farm price.²

In the present work most kinds of demands were treated as an aggregate because of data inadequacies. Especially troublesome was the lack of monthly data for processing and seed shipments. Very likely the pertinent data can be obtained in the future with relatively little effort. These data will permit a substantial disaggregation of the models. This disaggregation will probably yield much more reliable results, and, above all, estimates of the parameters of the more disaggregated structure will be much more useful for policy decisions.

Another possible means of refining the analyses is to use more than one price in the supply relations. Clearly enough, suppliers of potatoes from the Winter

¹Francis P. Pusateri, What Factors Influence the Price of Potatoes? Kern County Potato Growers Association, Special Report (Bakersfield, California: September 15, 1958), p. 5. This report contains a useful summary of the factors determining price.

²See Simmons, op. cit., p. 2.

crop, say, respond to expected prices for this seasonal crop, rather than to an average price for all crops.

The situation is similar on the demand side. Potatoes for fresh use, processing, seed, etc. may have separate prices that ought to be included in a more detailed analysis.

Several potential supply and demand shifters have been mentioned in the course of the model discussions of the present work, but for lack of data, several of these have not been included in the models. The omission of relevant variables may create biases in the estimated coefficients. An important task in future investigations will therefore be to provide new data series so it can be tested whether the peculiar results of the present thesis are due to biases or they reflect important realities.

When more has been learned about the structures for individual months, it may also prove fruitful to combine the models for various months into a single model by the use of dummy variables. Another approach that may become feasible in the future is to deal with models to be estimated on the basis of time series made up of data for successive months. In such models the various dynamic interrelationships can be taken fully into account, but the formulation of such models is a very difficult task, since it requires very much a priori knowledge of seasonal movements, etc.

As far as prediction is concerned, the models of the present work were devised mainly with a view to predicting potato prices. As it turns out, however, the models may just as well be used to predict supplies and demands which in turn can be used to derive predicted shipments. Data showing predicted shipments can be of interest in various connections. Among the potential users of such data are railroad companies, transportation officials, and various policy makers. Predictions of this kind can be disaggregated in various ways.

Finally, it should be mentioned that shipments data and other data of a similar kind as the ones that have been used for potatoes are available also for other vegetables. Since the market structure for many vegetables is similar to the structure for potatoes, the models used in the present work may be adapted also to several other vegetables.

APPENDIX A
RESULTS OF ECONOMETRIC
ANALYSES

List of Abbreviations Used for Estimation Methods

OLS	ordinary (unrestricted) least squares
2SLS	two-stage least squares
LISE	limited information single equation maximum likelihood
L-3SLS	three-stage least squares where the LISE estimates are used instead of the 2SLS estimates on the second stage.
3SLS	three-stage least squares
2-FIML	full information maximum likelihood where the initial estimates are the 2SLS estimates instead of the LISE estimates
FIML	full information maximum likelihood

Definition of Variables¹

Variables Included in the Final Models

Y_{mt}^{PP}	= deflated average price in dollars per hundreweight received by farmers for potatoes in month m of year t
Y_{mt}^{SU}	= total domestic supply of potatoes in 1,000 hundreweights in month m of year t
Y_{mt}^{DE}	= total domestic demand for potatoes, excluding government diversion, in 1,000 hundreweights in month m of year t
Y_{mt}^{FR}	= deflated farm-retail spread for potatoes in dollars per hundreweight in month m of year t

¹Variables denoted by the symbol Y are endogenous, while variables denoted by X have been assumed to be exogenous.

- X_t^{FL} = total production of Fall potatoes in year t or $t-1$ minus the part of it used for household use on farms where grown, in 1,000 hundreweights¹
- X_t^{WR} = total production of Winter potatoes in year t minus the part of it used for household use on farms where grown, in 1,000 hundreweights
- X_t^{MI} = total stocks of potatoes in 1,000 hundreweights held by growers and local dealers in the Fall states on March 1 of year t
- X_t^{EP} = total production of Early Spring potatoes in year t minus the part of it used for household use on farms where grown, in 1,000 hundreweights
- X_t^{LP} = total production of Late Spring potatoes in year t minus the part of it used for household use on farms where grown, in 1,000 hundreweights
- X_t^{EU} = total production of Early Summer potatoes in year t minus the part of it used for household use on farms where grown, in 1,000 hundreweights
- X_t^{LU} = total production of Late Summer potatoes in year t minus the part of it used for household use on farms where grown, in 1,000 hundreweights
- X_{mt}^{AV} = arithmetic mean of deflated price indices for (1) cereals and bakery products, (2) meats, poultry, and fish, and (3) fruits and vegetables in month m of year t
- X_t^{TE} = time trend (1952 = 2, 1953 = 3, . . . , 1966 = 16)

¹When the variable X_t^{FL} is included in a model for one of the months January-June, production means production in year $t-1$. For August-December production refers to year t .

X_{mt}^{AE} = value of the acreage variable for potatoes for month m in year t, in 1,000 acres¹

X_{mt}^{WH} = deflated Index of Wholesale Prices for all commodities except farm products and foods for month m of year t

X_{mt}^{NX} = total net exports of potatoes in dollars per hundredweight in month m of year t

X_{mt}^{GO} = total quantity of potatoes in 1,000 hundredweights diverted to starch, flour, and livestock feed under government programs in month m of year t

Variables Excluded from the Final Models

X_{mt}^{PF} = deflated Consumer Price Index for total food at home in month m of year t

X_{mt}^{PB} = deflated Consumer Price Index for cereals and bakery products for month m of year t

X_{mt}^{PM} = deflated Consumer Price Index for meats, poultry, and fish for month m of year t

X_{mt}^{PV} = deflated Consumer Price Index for fruits and vegetables for month m of year t

X_t^{Yq} = deflated per capita disposable personal income in 1,000 dollars in quarter q of year t

X_t^{D1} = total stocks of potatoes in 1,000 hundredweights held by growers and local dealers in the Fall states on December 1 of year t

¹This variable was presumed to be correlated with demand for seed potatoes. It was constructed as the sum of the acreages planted of certain potato crops. For further details regarding this variable, see Chapter VI.

x_t^{J1} = total stocks of potatoes in 1,000 hundreweights held by growers and local dealers in the Fall states on January 1 of year t

x_t^{F1} = total stocks of potatoes in 1,000 hundreweights held by growers and local dealers in the Fall states on February 1 of year t

x_t^{TP} = computed total quantity of potatoes in 1,000 hundreweights processed, except for starch and flour, in year t^1

x_t^{CS} = computed quantity of potatoes in 1,000 hundreweights processed as chips and shoestrings in year t^1

x_{mt}^{PL} = value of the lagged price variable for potatoes for month m in the year t , in dollars per hundreweight²

x_{mt}^{SL} = value of the lagged supply variable for potatoes for month m in the year t , in 1,000 hundreweights³

¹For further details regarding this variable, see Chapter III.

²This variable was intended to reflect the price increase experienced in the preceeding year from month m until the end of the marketing season of the potatoes marketable in month m . A more detailed explanation of this variable is given in Chapter V.

³For further details regarding this variable, see Chapter V.

x_{mt}^{HP} = total human population figure used for month m
in the year t, in millions¹

x_{mt}^{MS} = certified seed shipments from Maine in month m
of year t as a percentage of shipments during the
crop year July-June²

¹The population figure for January 1 was used for each of the months January-March, the population figure for July 1 was used for the months April-September, and the population figure for January 1 the next year was used for October-December. For further details and sources of the data, see Chapter III.

²For further details regarding this variable, see Chapter VI and Appendix B, Table 13.

TABLE 1.--Estimated supply relations by months for the period 1952-66.
January-March^a

Month no. (m)	Esti- mation method	Constant term	Coefficients of			R ²	d
			y_{mt}^{PP}	x_t^{PL}	x_t^{WR}		
1	OLS	3770.3 (2840.6)	- 330.09 (379.09)	0.11497 (0.01114)	-0.37764 (0.28058)	0.93	1.88
1	2SLS	4032.0 (3225.7)	- 377.37 (468.80)	0.11429 (0.01184)	-0.38967 (0.28938)	0.93	1.92
1	LISE	8137.2 (4227.3)	-1119.00 (645.33)	0.10358 (0.01477)	-0.57828 (0.35171)	0.91	2.23
1	L-3SLS	3636.0 (3785.8)	- 338.61 (551.76)	0.11502 (0.01396)	-0.34452 (0.33720)	0.93	1.92
1	3SLS	3923.9 (3224.2)	- 366.79 (468.70)	0.11448 (0.01184)	-0.37705 (0.28907)	0.93	1.92
1	2-FIML	-16941.0 (24350.7)	7174.31 (11421.43)	0.15960 (0.05341)	-0.80399 (0.53378)	-2.27	1.41
1	FIML	19530.3 (11932.5)	-4299.07 (3275.74)	0.08329 (0.03913)	-0.94566 (0.53336)	0.20	2.07
2	OLS	3435.1 (3137.9)	- 161.75 (417.30)	0.09898 (0.01246)	-0.22666 (0.32010)	0.88	1.55

TABLE 1.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of			R^2	d
			y_{mt}^{PP}	x_t^{FL}	x_t^{WR}		
2	2SLS	2922.4 (3358.8)	- 66.25 (472.39)	0.10026 (0.01283)	-0.20266 (0.32557)	0.88	1.59
2	LISE	2472.7 (3386.3)	17.55 (477.05)	0.10138 (0.01292)	-0.18160 (0.32968)	0.88	1.62
2	L-3SLS	2225.6 (3221.6)	6.75 (466.97)	0.10210 (0.01288)	-0.14104 (0.28159)	0.88	1.59
2	3SLS	2218.5 (3199.8)	- 6.14 (464.06)	0.10212 (0.01280)	-0.14057 (0.27908)	0.88	1.59
2	2-FIML	-7320.8 (10002.5)	1881.67 (1699.74)	0.12562 (0.03072)	0.26653 (0.70975)	0.63	1.86
2	FIML	-7320.8 (10002.5)	1881.67 (1699.74)	0.12562 (0.03072)	0.26653 (0.70975)	0.63	1.86
3	OLS	-4186.8 (2659.5)	691.45 (324.43)	0.14461 (0.01097)	0.10481 (0.28674)	0.94	1.30
3	2SLS	-3772.9 (2789.7)	614.85 (358.96)	0.14362 (0.01118)	0.08582 (0.28992)	0.94	1.32

TABLE 1.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of			R ²	d
			Y_{mt}^{PP}	X_t^{FL}	X_t^{WR}		
3	LISE	-2582.1 (1925.1)	394.50 (301.60)	0.14076 (0.01162)	0.03118 (0.30073)	0.94	1.40
3	L-3SLS	-4609.6 (2709.8)	672.43 (364.98)	0.14470 (0.01154)	0.20769 (0.24275)	0.94	1.29
3	3SLS	-4608.2 (2636.4)	672.35 (353.35)	0.14467 (0.01115)	0.20877 (0.24069)	0.94	1.29
3	2-FIML	-5257.7 (2736.0)	666.74 (456.49)	0.14936 (0.01094)	0.18036 (0.19938)	0.94	1.34
3	FIML	-5257.7 (2736.0)	666.74 (456.49)	0.14936 (0.01094)	0.18036 (0.19938)	0.94	1.34

^aThe table shows the constant term and the coefficients of the variables listed in the boxhead when the supply relation for each month is written with Y_{mt}^{SU} to the left of the equality sign. The figures in parentheses under the coefficients are the respective standard errors. In the last two columns the coefficient of multiple determination, R², and the Durbin-Watson statistic, d, are given. The symbols and units used for each variable and the abbreviations employed for names of estimation methods are explained in the beginning of Appendix A.

TABLE 2.--Estimated supply relations by months for the period 1952-66.
April-June^a

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			y_{mt}^{PP}	y_t^{ML}	x_t^{EP}	x_t^{LP}		
4	OLS	- 7855.3 (3205.0)	214.20 (423.09)	0.40128 (0.04705)	0.73037 (0.64252)	. . .	0.93	2.59
4	2SLS	- 9116.2 (3458.7)	498.67 (500.91)	0.42015 (0.05088)	0.60526 (0.66504)	. . .	0.93	2.94
4	LISE	- 9780.3 (3571.0)	648.49 (521.82)	0.43010 (0.05254)	0.53938 (0.68345)	. . .	0.92	3.08
4	L-3SLS	- 8539.1 (3533.2)	439.14 (508.04)	0.41090 (0.05079)	0.62982 (0.63662)	. . .	0.93	2.88
4	3SLS	- 8460.0 (3440.3)	432.70 (493.95)	0.40990 (0.04921)	0.62841 (0.61062)	. . .	0.93	2.87
4	2-FIML	-11494.1 (4415.2)	1023.70 (741.27)	0.45747 (0.06337)	0.35172 (0.75236)	. . .	0.90	3.27
4	FIML	-11494.1 (4415.2)	1023.70 (741.27)	0.45747 (0.06337)	0.35172 (0.75236)	. . .	0.90	3.27
5	OLS	467.4 (4359.8)	-858.75 (412.80)	0.25120 (0.03751)	0.65740 (0.57288)	0.07098 (0.15025)	0.92	1.52

TABLE 2.---Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			y_{mt}^{PP}	x_t^{M1}	x_t^{EP}	x_t^{LP}		
5	2SLS	219.4 (4541.7)	-824.41 (448.67)	0.25286 (0.03847)	0.64876 (0.57478)	0.07536 (0.15197)	0.92	1.50
5	LISE	- 323.7 .	-749.22 .	0.25650 .	0.62983 .	0.08498 .	0.92	1.45
5	L-3SLS	- 338.8 (4233.6)	-837.74 (441.02)	0.24308 (0.03640)	0.59684 (0.48878)	0.13552 (0.12827)	0.92	1.50
5	3SLS	- 335.0 (4212.4)	-838.67 (439.41)	0.24286 (0.03623)	0.59661 (0.48504)	0.13604 (0.12727)	0.92	1.50
5	2-FIML	-10678.4 (8752.3)	517.09 (1059.16)	0.31491 (0.06621)	0.28074 (0.80820)	0.31251 (0.23743)	0.84	1.06
5	FIML ^b	.	.	.	.	.	.	.
6	OLS	12273.0 (356.4)	-609.22 (252.46)	0.04921 (0.02309)	.	0.13332 (0.11444)	0.75	3.05
6	2SLS	11291.3 (4030.8)	-519.32 (304.92)	0.05263 (0.02410)	.	0.12369 (0.12369)	0.74	3.12
6	LISE	10975.7 (4054.6)	-490.43 (306.95)	0.05373 (0.02421)	.	0.16520 (0.12435)	0.74	3.14

TABLE 2.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			y_{mt}^{PP}	x_t^{M1}	x_t^{EP}	x_t^{LP}		
6	L-3SLS	10415.4 (3214.4)	-463.50 (276.13)	0.06363 (0.02340)	. . .	0.16161 (0.07450)	0.73	3.02
6	3SLS	10378.2 (3192.7)	-461.26 (274.68)	0.06392 (0.02328)	. . .	0.16225 (0.07368)	0.73	3.02
6	2-FIML	1981.9 (6126.4)	220.26 (608.96)	0.10489 (0.04120)	. . .	0.34892 (0.14792)	0.47	2.35
6	FIML	1981.9 (6126.4)	220.26 (608.96)	0.10489 (0.04120)	. . .	0.34892 (0.14792)	0.47	2.35

^aThe table shows the constant term and the coefficients of the variables listed in the boxhead when the supply relation for each month is written with y_{mt}^{SU} to the left of the equality sign. The figures in parentheses under the coefficients are the respective standard errors. In the last two columns the coefficient of multiple determination, R², and the Durbin-Watson statistic, d, are given. The symbols and units used for each variable and the abbreviations employed for names of estimation methods are explained in the beginning of Appendix A.

^bNo results. The print line count from a user run card was exceeded during the run on the computer.

TABLE 3.--Estimated supply relations by months for the period 1952-66.
July-December^a

Month no. (m)	Esti- mation method	Constant term	Coefficients of					R ²	d
			Y _{mt} ^{PP}	X _t ^{FL}	X _t ^{ML}	X _t ^{EU}	X _t ^{LU}		
7	OLS	5536.0 (4579.4)	-63.528 (231.39)	. . .	0.06617 (0.04326)	0.18271 (0.22932)	0.06965 (0.12760)	0.63	1.99
7	2SLS	3153.4 (5147.3)	234.34 (307.32)	. . .	0.07833 (0.04727)	0.21984 (0.24860)	0.08612 (0.13813)	0.57	1.94
7	LISE	2524.3 (5389.5)	312.99 (327.35)	. . .	0.08154 (0.04932)	0.22964 (0.25909)	0.09047 (0.14392)	0.53	1.95
7	L-3SLS	8418.7 (3456.5)	132.17 (311.70)	. . .	0.05243 (0.03111)	0.27353 (0.15616)	-0.04757 (0.08299)	0.56	2.08
7	3SLS	8220.9 (3405.1)	137.63 (299.72)	. . .	0.05358 (0.03067)	0.27232 (0.15441)	-0.04331 (0.08258)	0.56	2.08
7	2-FIML	8008.0 (2887.0)	425.73 (439.63)	. . .	0.05664 (0.02694)	0.36727 (0.15567)	-0.10047 (0.08407)	0.36	2.00
7	FIML	8008.0 (2887.0)	425.72 (439.63)	. . .	0.05664 (0.02694)	0.35727 (0.15567)	-0.10047 (0.08407)	0.36	2.00
8	OLS	11860.2 (3283.3)	242.05 (307.66)	0.05070 (0.01211)	. . .	-0.22353 (0.19973)	-0.09107 (0.08459)	0.79	2.38

TABLE 3.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of					R ²	d
			PP y _{mt}	FL x _t	M1 x _t	EU x _t	LU x _t		
3	2SLS	12437.3 (3623.3)	126.20 (429.51)	0.05164 (0.01243)	. . .	-0.26153 (0.22356)	-0.09344 (0.03540)	0.79	2.39
8	LISE	16988.4 (5990.1)	-787.43 (851.95)	0.05900 (0.01857)	. . .	-0.56125 (0.37561)	-0.11214 (0.12404)	0.56	2.14
8	L-3SLS	12503.3 (4169.8)	- 43.385 (556.38)	0.05977 (0.01492)	. . .	-0.41955 (0.25433)	-0.07299 (0.09779)	0.77	2.32
8	3SLS	12003.5 (3036.1)	339.65 (393.66)	0.04097 (0.01076)	. . .	-0.07015 (0.18592)	-0.10257 (0.07133)	0.78	2.33
8	2-FIML	14347.6 (4021.5)	-711.08 (865.67)	0.06117 (0.01818)	. . .	0.50865 (0.35618)	-0.06270 (0.08953)	0.57	2.29
8	FIML	14347.6 (4021.5)	-711.08 (865.67)	0.06117 (0.01818)	. . .	0.50865 (0.35618)	-0.06270 (0.08953)	0.57	2.29
9	OLS	12487.8 (4243.6)	70.00 (459.13)	0.03906 (0.00974)	. . .	. . .	-0.04093 (0.09639)	0.65	1.67
9	2SLS	12377.4 (4307.5)	89.36 (477.02)	0.03924 (0.00981)	. . .	. . .	-0.03952 (0.09685)	0.65	1.69
9	LISE	12154.5 (4311.2)	128.44 (477.56)	0.03961 (0.00982)	. . .	. . .	-0.03669 (0.09692)	0.65	1.73

TABLE 3.---Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of					R ²	d
			Y _{mt} ^{PP}	X _t ^{FL}	X _t ^{ML}	X _t ^{EU}	X _t ^{LU}		
9	L-3SLS	14014.9 (3581.4)	- 19.51 (460.56)	0.03505 (0.00922)			-0.06249 (0.08039)	0.65	1.59
9	3SLS	14096.8 (3510.0)	-	0.03469 (0.00915)			-0.06282 (0.07876)	0.65	1.58
9	2-FIML	9898.2 (5286.1)	858.22 (747.27)	0.04083 (0.01394)			-0.01343 (0.09640)	0.54	2.22
9	FIML	9898.2 (5286.1)	858.22 (747.27)	0.04083 (0.01394)			-0.01343 (0.09640)	0.54	2.22
10	OLS	9664.0 (6434.3)	- 226.00 (712.00)	0.03903 (0.01465)			0.13791 (0.14997)	0.47	2.05
10	2SLS	8587.2 (6843.0)	- 26.20 (828.98)	0.04065 (0.01510)			0.15306 (0.15385)	0.47	2.06
10	LISE	-26144.0 (38865.6)	6418.25 (6619.48)	0.09297 (0.06711)			0.64184 (0.65315)	-3.71	1.52
10	L-3SLS	7191.7 (17001.8)	- 0.14 (2372.19)	0.03613 (0.04261)			0.22287 (0.37714)	0.45	2.03
10	3SLS	8260.7 (5987.8)	- 28.79 (804.59)	0.03868 (0.01451)			0.17509 (0.13335)	0.47	2.06

TABLE 3.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of					R ²	d
			Y _{mt} ^{PP}	X _t ^{FL}	X _t ^{ML}	X _t ^{EU}	X _t ^{LU}		
10	2-FIML	66908.9 (106439.4)	-10645.51 (19219.26)	-0.04663 (0.16895)	. . .	. . .	-0.68178 (1.58558)	-9.81	1.41
10	FIML ^b	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
11	OLS	3034.7 (2662.2)	- 348.29 (535.50)	0.09238 (0.01226)	. . .	. . .	. . .	0.85	1.63
11	2SLS	3860.3 (2890.0)	- 601.83 (631.58)	0.09024 (0.01267)	. . .	. . .	. . .	0.85	1.72
11	LISE	14920.5 (9645.9)	-3936.70 (2638.99)	0.06218 (0.03331)	. . .	. . .	. . .	0.31	1.86
11	L-3SLS	3650.6 (6169.9)	- 581.13 (1359.78)	0.09123 (0.02701)	. . .	. . .	. . .	0.85	1.75
11	3SLS	3860.7 (2889.4)	- 601.87 (631.56)	0.09024 (0.01267)	. . .	. . .	. . .	0.85	1.73
11	2-FIML	12288.3 (6569.7)	-3491.63 (2148.87)	0.07156 (0.02072)	. . .	. . .	. . .	0.43	1.98
11	FIML	12288.3 (6569.7)	-3491.63 (2148.87)	0.07156 (0.02072)	. . .	. . .	. . .	0.43	1.98

TABLE 3.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of					R ²	d
			y_{mt}^{PP}	x_t^{FL}	x_t^{M1}	x_t^{EU}	x_t^{LU}		
12	OLS	-962.10 (2650.9)	578.65 (519.38)	0.10528 (0.01274)				0.85	1.42
12	2SLS	- 940.42 (2699.0)	571.31 (546.97)	0.10523 (0.01279)				0.85	1.42
12	LISE	- 850.35 (2699.7)	540.82 (547.19)	0.10503 (0.01279)				0.85	1.43
12	L-3SLS	- 1300.8 (2691.2)	593.82 (546.93)	0.10707 (0.01274)				0.85	1.44
12	3SLS	- 1292.4 (2691.1)	593.29 (546.82)	0.10703 (0.01274)				0.85	1.44
12	2-FIML	-11524.8 (12202.3)	3927.20 (3935.80)	0.13156 (0.03743)				0.34	1.48

(w) method no. vector group	method no. vector group	form constant	coefficients of					χ^2_{red}	g
			χ^2_{LB}	χ^2_{ST}	χ^2_{SJ}	χ^2_{EH}	χ^2_{TH}		
TS	5-6181	(5500.2) -1120.8	(348.80) -100.1	(348.80) -100.1	(348.80) -100.1	(348.80) -100.1	(348.80) -100.1	0.02	1.12
TS	3272	(5637.7) -7355.7	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	0.02	1.12
TS	1-3272	(5637.7) -7355.7	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	0.02	1.12
TS	1122	(5637.7) -7355.7	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	0.02	1.12
TS	3272	(5637.7) -7355.7	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	0.02	1.12
TS	012	(5637.7) -7355.7	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	(360.80) -100.1	0.02	1.12

TABLE 3.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R^2	d
			y_{mt}^{PP}	x_t^{FL}	x_t^{ML}	x_t^{EU}	x_t^{LU}	
12	FIML	-11524.8 (12202.3)	3927.20 (3935.80)	0.13156 (0.03743)				0.34 1.48

^aThe table shows the constant term and the coefficients of the variables y_{mt}^{SU} to listed in the boxhead when the supply relation for each month is written with y_{mt}^{SU} to the left of the equality sign. The figures in parentheses under the coefficients are the respective standard errors. In the last two columns the coefficient of multiple determination, R^2 , and the Durbin-Watson statistic, d , are given. The symbols and units used for each variable and the abbreviations employed for names of estimation methods are explained in the beginning of Appendix A.

^bNo results. A singular matrix was encountered during the iteration process on the computer.

TABLE 4.--Estimated demand relations by month for the period 1952-66.
January-December

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			PP Y _{mt}	AV X _{mt}	T ^E X _t	AE X _{mt}		
1	OLS	-10402.5 (12961.7)	- 491.41 (312.04)	256.64 (132.09)	609.05 (54.38)		0.93	2.30
1	2SLS	-12146.8 (13450.5)	- 598.88 (374.90)	276.57 (138.15)	606.80 (54.85)	. . .	0.92	2.29
1	LISE	-16127.2 (14246.6)	- 844.13 (409.04)	322.05 (146.60)	601.69 (57.62)	. . .	0.92	2.27
1	L-3SLS	-14156.7 (13977.3)	- 629.03 (392.54)	297.41 (143.51)	606.80 (57.62)	. . .	0.92	2.30
1	3SLS	-12847.0 (13437.2)	- 609.51 (374.78)	283.84 (138.01)	606.73 (54.85)	. . .	0.92	2.29
1	2-FIML	26585.4 (40438.2)	-5787.50 (9501.44)	9.34 (261.89)	414.58 (217.44)	. . .	-1.77	1.51
1	FIML	2658.1 (22409.1)	2237.41 (2499.56)	60.35 (225.20)	715.37 (144.37)	. . .	0.36	2.09
2	OLS	-37495.2 (15410.2)	- 630.78 (327.62)	526.72 (157.38)	453.15 (61.16)	. . .	0.88	2.03

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R^2	d
			y_{mt}^{PP}	x_{mt}^{AV}	x_t^{TE}	x_{mt}^{AE}		
2	2SLS	-37802.3 (15520.0)	- 656.14 (360.10)	530.40 (158.91)	452.33 (61.37)	. . .	0.88	2.01
2	LISE	-37903.9 (15523.4)	- 664.54 (360.22)	531.62 (158.94)	452.06 (61.38)	. . .	0.88	2.01
2	L-3SLS	-28468.7 (13480.3)	- 571.44 (354.39)	433.03 (137.56)	473.19 (60.31)	. . .	0.87	2.04
2	3SLS	-28337.9 (13440.4)	- 570.21 (354.22)	431.66 (137.14)	473.53 (60.28)	. . .	0.87	2.04
2	2-FIML	-44032.0 (19927.7)	-1184.58 (1012.40)	605.74 (216.50)	430.44 (102.99)	. . .	0.85	1.74
2	FIML	-44032.0 (19927.7)	-1184.58 (1012.40)	605.74 (216.50)	430.44 (102.99)	. . .	0.85	1.74
3	OLS	- 7751.9) (16221.2)	- 295.41 (392.97)	25.85 (178.30)	862.08 (74.80)	13.895 (5.508)	0.93	2.45
3	2SLS	-12457.1 (16939.4)	- 569.22 (398.89)	74.69 (185.92)	858.07 (77.06)	14.231 (5.675)	0.93	2.39

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R^2	d
			y_{mt}^{PP}	x_{mt}^{AV}	x_t^{TE}	x_{mt}^{AE}		
3	LISE	-15973.3 (18003.1)	- 773.84 (436.22)	111.19 (197.47)	855.07 (81.44)	14.482 (5.998)	0.92	2.35
3	L-3SLS	-21394.5 (14478.4)	- 646.52 (405.19)	251.57 (159.42)	811.56 (77.78)	8.291 (4.834)	0.92	2.07
3	3SLS	-20763.9 (14049.6)	- 641.03 (384.98)	239.16 (154.68)	814.68 (73.97)	8.706 (4.695)	0.92	2.09
3	2-FIML	-33773.7 (15978.5)	-1010.87 (674.28)	444.53 (224.30)	801.63 (100.21)	3.906 (6.846)	0.88	1.98
3	FIML	-33773.7 (15978.5)	-1010.87 (674.28)	444.53 (224.30)	801.63 (100.21)	3.906 (6.846)	0.88	1.98
4	OLS	- 4291.9 (19294.8)	-1059.81 (368.35)	39.45 (206.14)	948.02 (89.33)	8.979 (6.555)	0.93	1.95
4	2SLS	- 6101.1 (19612.4)	-1167.84 (411.72)	59.98 (209.85)	946.37 (89.75)	8.992 (6.583)	0.93	1.86
4	LISE	- 7159.0 (19748.1)	-1231.00 (415.99)	71.98 (211.31)	945.40 (90.33)	9.000 (6.626)	0.93	1.81

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			PP y _{mt}	AV x _{mt}	TE x _t	AE x _{mt}		
4	L-3SLS	-13191.7 (18318.4)	-1238.44 (409.39)	156.62 (195.83)	927.03 (89.46)	7.318 (6.175)	0.93	1.79
4	3SLS	-14018.5 (17891.4)	-1247.15 (405.73)	168.09 (191.22)	923.89 (88.69)	7.116 (6.036)	0.93	1.78
4	2-FIML	-18222.8 (22576.6)	-1565.44 (503.91)	207.24 (252.40)	940.97 (98.05)	7.756 (7.384)	0.91	1.60
4	FIML	-18222.8 (22576.6)	-1565.44 (503.91)	207.24 (252.40)	940.97 (98.05)	7.756 (7.384)	0.91	1.60
5	OLS	35241.4 (12484.4)	-1553.38 (246.21)	-194.16 (123.29)	518.49 (53.57)	. . .	0.94	1.96
5	2SLS	34760.3 (12534.7)	-1610.81 (260.49)	-187.81 (123.93)	517.98 (53.71)	. . .	0.94	2.00
5	LISE	34575.8 . . .	-1632.83 . . .	-185.52 . . .	517.79 . . .	. . .	0.94	2.02
5	L-3SLS	26124.5 (10607.0)	-1656.93 (259.15)	-101.42 (104.85)	518.39 (52.71)	. . .	0.94	1.62

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			y ^{PP} x _{mt}	x ^{AV} x _{mt}	x ^{TE} x _t	x ^{AE} x _{mt}		
5	3SLS	26016.7 (10534.2)	1657.59 (258.53)	-100.33 (104.13)	518.25 (52.57)	. . .	0.94	1.61
5	2-FIML	28866.6 (12895.9)	-1645.50 (348.71)	-131.02 (126.41)	543.19 (59.26)	. . .	0.94	1.73
5	FIML ^b							
6	OLS	18813.1 (15993.6)	- 725.15 (191.07)	- 20.33 (156.61)	111.21 (51.63)	. . .	0.68	2.76
6	2SLS	19283.7 (16148.9)	- 705.64 (211.43)	- 25.42 (158.45)	111.15 (51.66)	. . .	0.68	2.79
6	LISE	19399.6 (16153.3)	- 700.83 (211.51)	- 26.68 (158.50)	111.13 (51.67)	. . .	0.68	2.80
6	L-3SLS	16616.8 (8436.9)	- 707.12 (202.55)	- 1.86 (83.45)	140.21 (47.48)	. . .	0.67	2.76
6	3SLS	16613.1 (8350.7)	- 706.85 (202.43)	- 1.89 (82.61)	140.94 (47.41)	. . .	0.67	2.76

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			y_{mt}^{PP}	x_{mt}^{AV}	x_t^{TE}	x_{mt}^{AE}		
6	2-FIML	12870.0 (12310.8)	698.37 (305.07)	30.37 (124.45)	187.84 (63.28)	. . .	0.61	2.45
6	FIML	12870.0 (12310.8)	698.37 (305.07)	30.37 (124.45)	187.84 (63.28)	. . .	0.61	2.45
7	OLS	10863.9 (17469.6)	- 358.23 (189.38)	13.37 (171.86)	189.98 (48.36)	. . .	0.67	2.30
7	2SLS	16276.6 (18649.6)	- 222.17 (235.43)	- 42.94 (184.35)	190.20 (49.48)	. . .	0.66	2.12
7	LISE	19002.1 (19249.4)	- 153.66 (245.97)	- 71.29 (190.36)	190.32 (50.86)	. . .	0.64	2.05
7	L-3SLS	21471.5 (11262.0)	- 196.85 (220.67)	- 92.75 (112.20)	172.21 (46.77)	. . .	0.64	2.13
7	3SLS	21747.1 (11337.2)	- 194.58 (215.52)	- 95.55 (112.87)	172.78 (45.75)	. . .	0.64	2.13
7	2-FIML	18652.3 (8155.1)	- 107.54 (256.30)	- 70.20 (80.98)	203.61 (47.95)	. . .	0.62	1.97

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R^2	d
			y_{mt}^{PP}	x_{mt}^{AV}	x_t^{TE}	x_{mt}^{AE}		
7	FIML	18652.3 (8155.1)	- 107.54 (256.30)	- 70.20 (80.98)	203.61 (47.95)	. . .	0.62	1.97
8	OLS	10451.5 (15728.5)	499.31 (345.37)	16.27 (161.06)	291.34 (52.59)	. . .	0.75	2.16
8	2SLS	13473.6 (17890.1)	618.94 (479.82)	16.74 (185.94)	296.90 (55.07)	. . .	0.74	2.15
8	LISE	93130.3 (104733.7)	3772.16 (3837.86)	- 886.97 (1129.74)	443.48 (234.12)	. . .	-1.33	2.22
8	L-3SLS	56314.1 (43125.7)	1506.87 (1283.85)	- 467.02 (445.83)	367.50 (155.34)	. . .	0.48	1.91
8	3SLS	105.4 (15071.4)	316.35 (437.11)	125.38 (156.03)	262.80 (52.34)	. . .	0.73	2.17
8	2-FIML	135679.3 (254095.5)	5704.10 (10313.84)	-1360.42 (2781.36)	559.83 (591.99)	. . .	-4.52	2.23
8	FIML	135679.3 (254095.5)	5704.10 (10313.84)	-1360.42 (2781.36)	559.83 (591.99)	. . .	-4.52	2.23

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			y _{mt} ^{PP}	x _{mt} ^{AV}	x _t ^{TE}	x _{mt} ^{AE}		
9	OLS	- 33304.1 (20196.0)	- 551.74 (532.07)	502.38 (211.65)	241.37 (55.72)	. . .	0.77	1.99
9	2SLS	- 34647.2 (20831.6)	- 604.41 (568.24)	517.10 (213.91)	238.70 (56.65)	. . .	0.77	1.96
9	LISE	- 36626.8 (20895.4)	- 682.04 (570.46)	538.80 (219.60)	234.77 (56.80)	. . .	0.77	1.92
9	L-3SLS	- 10455.2 (17341.8)	- 141.05 (511.22)	263.37 (181.51)	258.87 (52.47)	. . .	0.75	1.89
9	3SLS	- 9389.1 (16966.8)	- 123.40 (504.80)	252.32 (177.50)	258.81 (51.94)	. . .	0.75	1.89
9	2-FIML	-481856.8 (2316510.3)	-17633.45 (86394.92)	5395.20 (25206.53)	-491.83 (3539.63)	. . .	-20.48	1.96
9	FIML	-481856.8 (2316510.3)	-17633.45 (86394.92)	5395.20 (25206.53)	-491.83 (3539.63)	. . .	-20.48	1.96
10	OLS	- 4240.2 (15321.8)	342.11 (406.72)	205.25 (160.78)	298.01 (42.99)	. . .	0.85	2.03

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			Y _{mt} ^{PP}	X _{mt} ^{AV}	X _t ^{TE}	X _{mt} ^{AE}		
10	2SLS	11947.9 (19087.8)	1023.35 (575.38)	27.40 (202.13)	324.50 (50.07)	. . .	0.81	2.46
10	LISE	16532.7 (20663.8)	1216.29 (633.03)	- 22.97 (219.11)	332.00 (53.62)	. . .	0.78	2.52
10	L-3SLS	15114.7 (16890.8)	1080.07 (549.43)	- 5.40 (178.20)	321.84 (49.29)	. . .	0.80	2.49
10	3SLS	19047.8 (16658.9)	1165.36 (530.37)	- 46.93 (175.94)	324.59 (47.24)	. . .	0.79	2.52
10	2-FIML	- 2364.1 (18206.0)	793.22 (718.20)	177.31 (186.16)	313.35 (48.84)	. . .	0.82	2.25
10	FIML ^c	. . .	. . .	. . .	. . .	. . .	. .	. .
11	OLS	22747.2 (13049.7)	377.14 (368.24)	- 118.32 (138.56)	663.94 (41.57)	. . .	0.96	2.27
11	2SLS	23378.1 (15260.8)	404.26 (501.14)	125.34 (164.16)	665.16 (44.33)	. . .	0.96	2.33

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			Y _{mt} ^{PP}	X _{mt} ^{AV}	X _t ^{TE}	X _{mt} ^{AE}		
11	LISE	284570.7 (916882.2)	11630.24 (39211.78)	-3031.80 (10194.81)	1172.85 (1808.11)	. . .	-2.08	2.44
11	L-3SLS	156917.7 (90936.0)	4145.47 (3496.49)	-1579.87 (959.11)	978.27 (309.70)	. . .	0.52	2.41
11	3SLS	30921.7 (14989.6)	617.01 (494.56)	- 207.59 (161.16)	683.50 (43.76)	. . .	0.96	3.32
11	2-FIML	67561.3 (28109.7)	4071.84 (2190.26)	- 661.16 (301.92)	882.03 (131.27)	. . .	0.57	2.53
11	FIML	67561.3 (28109.7)	4071.84 (2190.26)	- 661.16 (301.92)	882.03 (131.27)	. . .	0.57	2.53
12	OLS	-23677.2 (17727.0)	192.82 (420.51)	355.81 (185.43)	675.54 (53.53)	. . .	0.94	1.53
12	2SLS	-25423.7 (18202.3)	119.14 (454.05)	375.01 (190.89)	674.23 (53.69)	. . .	0.94	1.53
12	LISE	-26537.8 (18254.1)	72.13 (455.77)	387.26 (191.44)	673.39 (53.82)	. . .	0.94	1.54

TABLE 4.--Continued

Month no. (m)	Esti- mation method	Constant term	Coefficients of				R ²	d
			Y_{mt}^{PP}	X_{mt}^{AV}	X_t^{TE}	X_{mt}^{AE}		
12	L-3SLS	-39003.4 (16509.0)	- 94.36 (438.44)	518.69 (172.80)	654.02 (52.42)	. . .	0.94	1.64
12	3SLS	-38679.8 (16546.7)	- 89.29 (438.13)	515.27 (173.21)	654.43 (52.36)	. . .	0.94	1.64
12	2-FIML	-40058.2 (32082.9)	- 133.08 (917.26)	528.51 (326.93)	671.49 (61.47)	. . .	0.94	1.66
12	FIML	-40058.2 (32082.9)	- 133.08 (917.26)	528.51 (326.93)	671.49 (61.47)	. . .	0.94	1.66

^aThe table shows the constant term and the coefficients of the variables listed in the boxhead when the demand relation for each month is written with Y_{mt}^{DE} to the left of the equality sign. The figures in parentheses under the coefficients are the respective standard errors. In the last two columns the coefficient of multiple determination, R^2 , and the Durbin-Watson statistic, d , are given. The symbols and units used for each variable and the abbreviations employed for names of estimation methods are explained in the beginning of Appendix A.

^bNo results. The print line count from a user rund card was exceeded during the run on the computer.

^cNo results. A singular matrix was encountered during the iteration process on the computer.

TABLE 5.--Farm-retail spread relations by months for the period 1952-66 estimated by the method of ordinary least squares^a

Month no. (m)	Constant term	Regression coefficients of			R ²	d
		y _{PP} _{mt}	x _{TE} _t	x _{WH} _{mt}		
1	0.136	0.137 (0.057)	0.084 (0.013)	0.027 (0.019)	0.83	2.28
2	-0.510	0.077 (0.092)	0.100 (0.022)	0.034 (0.034)	0.71	2.46
3	1.035	0.022 (0.083)	0.088 (0.022)	0.020 (0.035)	0.66	3.07
4	-2.923	0.043 (0.077)	0.098 (0.023)	0.061 (0.036)	0.63	2.10
5	-3.434	0.293 (0.173)	0.105 (0.046)	0.062 (0.073)	0.41	2.91
6	0.116	0.089 (0.143)	0.126 (0.048)	0.033 (0.080)	0.45	1.93
7	-0.488	0.497 (0.114)	0.168 (0.040)	0.027 (0.067)	0.78	2.06
8	-5.652	0.371 (0.212)	0.182 (0.048)	0.079 (0.075)	0.63	2.00
9	-4.700	0.424 (0.117)	0.147 (0.021)	0.067 (0.030)	0.87	2.55
10	0.677	0.137 (0.067)	0.109 (0.011)	0.020 (0.017)	0.94	2.39
11	0.808	0.262 (0.045)	0.109 (0.008)	0.016 (0.012)	0.97	2.06
12	3.022	0.122 (0.084)	0.070 (0.016)	0.000 (0.024)	0.78	1.91

^aThe table shows the constant term and the regression coefficients of the variables listed in the boxhead when y_{PP} is the dependent variable of each regression equation. The figures in parentheses under the coefficients are the respective standard errors. In the last two columns the coefficient of multiple determination, R^2 , and the Durbin-Watson statistic, d , are given. The symbols and units used for each variable are explained in the beginning of Appendix A.

TABLE 6.--Reduced form relations corresponding to y_{mt}^{PP} by months for the period 1952-66 estimated directly by the method of least squares^a

Month no. (m)	Constant term	Regression coefficients of			x_t^{M1}
		x_t^{TE}	x_t^{AE}	x_t^{FL}	
1	-12.98	3460 (1130)		-0.6523 (0.1933)	
2	-10.85	3876 (900)		-0.7656 (0.1654)	
3	-10.05	4148 (1061)	- 5.91 (32.08)	-0.7909 (0.1778)	
4	- 1.39	2667 (1139)	-23.00 (34.17)		-1.349 (0.453)
5	27.29	3445 (735)			-1.924 (0.394)
6	32.11	3561 (895)			-1.766 (0.428)
7	42.62	4548 (1433)			-1.009 (0.658)
8	-27.65	1916 (1372)		-0.3278 (0.2135)	
9	-24.79	- 995 (499)		-0.1392 (0.0559)	
10	-18.46	- 284 (787)		-0.1381 (0.1037)	
11	-21.47	1040 (741)		-0.2712 (0.1166)	
12	-19.98	2109 (484)		-0.4133 (0.0776)	

TABLE 6.--Continued

Month no (m)	Regression coefficients of				
	x_t^{WR}	x_t^{EP}	x_t^{LP}	x_t^{EU}	x_{LU}
1	0.8121 (1.8015)	. . .	. . .	. . .	. . .
2	-0.1552 (1.3299)	. . .	. . .	. . .	. . .
3	-0.4445 (1.6812)	. . .	. . .	. . .	. . .
4		0.0449 (3.7225)			
5		-0.1735 (2.5998)	-3.350 (1.037)		
6			-3.935 (1.089)		
7				-9.109 (3.208)	2.021 (1.513)
8				-2.523 (2.029)	1.321 (1.053)
9					0.255 (0.304)
10					0.109 (0.565)
11					
12					

TABLE 6.--Continued

Month no (m)	Regression coefficients of			R^2	d
	X_{mt}^{NX}	X_{mt}^{GO}	X_{mt}^{AV}		
1	4.492 (9.328)	0.622 (1.286)	2254 (976)	0.77	2.64
2	- 0.451 (6.204)	1.436 (1.368)	2222 (787)	0.85	2.54
3	- 2.197 (6.259)	1.748 (2.391)	2260 (818)	0.86	2.90
4	12.709 (10.677)	- 3.083 (3.451)	971 (1075)	0.83	2.31
5	35.378 (14.590)	0.199 (2.193)	- 973 (692)	0.90	2.11
6	12.334 (13.914)	4.565 (4.783)	-1395 (1506)	0.84	2.77
7	5.977 (25.740)	-133.462 (87.359)	-3368 (2921)	0.75	2.02
8	-25.859 (23.925)	- 33.001 (21.885)	3272 (1474)	0.71	2.01
9	-33.956 (7.085)	- 4.762 (1.621)	3009 (450)	0.95	1.93
10	-15.139 (6.517)	- 0.962 (0.877)	2318 (781)	0.80	2.63
11	- 4.973 (7.020)	0.193 (1.049)	2744 (754)	0.77	2.23
12	- 8.825 (3.596)	0.806 (0.721)	2720 (624)	0.91	2.81

^aThe table shows the constant term and the regression coefficients of the variables listed in the boxhead when Y_{mt}^{pp} is the dependent variable of each regression equation. The figures in parentheses under the coefficients are the respective standard errors. In the last two columns the coefficient of multiple determination, R^2 , and the Durbin-Watson statistic, d, are given. The symbols and units used for each variable are explained in the beginning of Appendix A, but note that the decimal point of each regression coefficient (not the constant term) has been moved four places to the right.

APPENDIX A

RESULTS OF ECONOMETRIC
ANALYSES

TABLES 7.--Potatoes for all purposes except diversion:
 Estimated sales from farms by months, united states:
 1951-66^a

Year	1,000 hundredweights					
	Jan.	Feb.	Mar.	Apr.	Mai	June
1951	21,625	18,598	23,729	20,376	15,345	14,306
1952	14,870	15,990	15,656	9,535	8,962	14,854
1953	17,143	14,952	17,410	14,079	12,906	16,456
1954	17,144	15,121	17,482	14,596	14,696	14,830
1955	16,572	14,523	17,649	15,652	14,281	17,900
1956	17,168	15,753	18,084	14,745	13,991	13,176
1957	17,242	15,927	18,294	16,106	17,455	16,594
1958	18,443	16,392	18,711	14,614	16,834	16,142
1959	20,376	17,986	20,008	19,192	16,091	15,395
1960	20,801	18,702	23,965	17,865	17,708	17,375
1961	20,737	19,763	23,351	20,402	19,919	17,860
1962	20,195	18,402	22,973	20,324	20,243	16,935
1963	22,409	20,645	23,464	23,154	20,135	17,124
1964	23,758	20,283	24,177	22,153	18,675	16,835
1965	21,347	17,570	23,947	19,746	15,742	15,290
1966	24,521	23,993	29,675	27,374	20,433	18,609

TABLES 7.--Continued

Year	1,000 hundredweights					
	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951	12,429	13,821	15,315	16,914	14,640	12,335
1952	11,018	14,816	16,996	18,848	13,118	13,761
1953	13,104	14,878	18,142	18,631	14,605	13,537
1954	12,369	14,617	16,459	17,284	14,330	14,124
1955	11,023	13,753	17,124	17,740	15,507	14,472
1956	12,116	16,757	16,352	18,405	15,712	14,151
1957	13,287	15,611	15,843	18,761	15,592	14,962
1958	14,351	14,397	18,182	19,794	15,940	17,450
1959	13,028	14,871	18,199	19,257	18,371	19,582
1960	13,242	16,259	18,506	19,766	18,757	18,893
1961	15,361	15,601	17,647	18,735	18,511	17,300
1962	14,450	17,125	18,058	20,943	19,216	18,424
1963	14,626	17,108	18,734	20,895	20,310	20,175
1964	13,402	16,748	18,103	21,345	20,580	20,559
1965	14,083	17,891	20,558	20,865	22,329	22,553
1966	14,695	18,375	20,964	21,051	21,879	22,794

^aData used and methods of computation are described in Chapters III and IV and in Appendix C.

TABLE 8.--Deflated average price received by farmers for potatoes: United States, by months, 1950-66^a

Year	Dollars per hundredweight					
	Jan.	Feb.	Mar.	Apr.	May	June
1950	2.46	2.41	2.36	2.52	2.23	1.98
1951	1.57	1.67	1.72	1.80	2.04	2.48
1952	3.52	3.60	3.78	4.10	4.05	4.60
1953	3.38	2.83	2.50	2.03	1.86	1.50
1954	1.20	1.14	0.90	1.23	2.21	2.53
1955	2.00	2.12	2.14	3.75	3.47	2.14
1956	1.79	2.01	2.42	2.90	3.63	4.64
1957	1.63	1.49	1.37	1.23	1.36	1.34
1958	1.82	2.23	3.21	3.01	2.10	1.64
1959	1.20	1.09	1.03	1.27	2.30	3.51
1960	2.19	2.16	2.63	3.08	2.81	2.22
1961	1.83	1.67	1.63	1.74	1.63	1.60
1962	1.12	1.16	1.27	1.31	1.68	2.12
1963	1.49	1.52	1.48	1.39	1.54	1.47
1964	1.41	1.51	1.76	2.08	2.85	3.72
1965	3.75	4.01	4.10	4.52	4.46	4.44
1966	1.86	1.94	2.12	2.33	2.26	1.65

TABLE 8.--Continued

Year	Dollars per hundredweight					
	July	Aug.	Sept.	Oct.	Nov.	Dec.
1950	2.16	2.15	1.83	1.43	1.41	1.40
1951	2.31	1.92	2.20	2.37	3.02	3.29
1952	4.45	4.72	3.83	3.57	3.67	3.30
1953	1.46	1.49	1.72	1.44	1.40	1.23
1954	2.67	2.42	2.10	1.67	1.95	1.92
1955	1.62	1.39	1.30	1.20	1.42	1.42
1956	5.44	2.61	1.76	1.43	1.59	1.54
1957	1.61	1.76	1.71	1.57	1.75	1.62
1958	1.54	1.31	1.22	1.01	1.14	1.15
1959	2.65	1.75	1.59	1.61	1.80	1.92
1960	2.41	2.17	1.93	1.73	1.94	1.88
1961	1.60	1.47	1.34	1.23	1.20	1.12
1962	2.04	1.82	1.59	1.39	1.42	1.40
1963	1.81	2.09	1.58	1.32	1.31	1.31
1964	3.27	2.54	2.10	2.19	2.66	3.39
1965	4.27	2.25	1.72	1.67	1.78	1.77
1966	1.57	2.03	1.85	1.67	1.81	1.82

^aAll prices were deflated by the Consumer Price Index. For sources and further description, see Chapter III.

TABLE 9.---Total potato production: United States, by seasonal groups, 1951-66^a

Year	1,000 hundredweights					
	Winter	Early Spring	Late Spring	Early Summer	Late Summer	Fall
1951	3,330	2,555	20,499	12,237	31,394	125,761
1952	2,761	3,134	22,355	9,908	31,829	141,108
1953	3,991	3,831	27,706	11,928	32,945	151,278
1954	3,723	3,829	22,087	11,167	32,646	146,095
1955	5,175	3,800	23,992	14,001	31,396	148,332
1956	5,260	4,022	21,840	11,622	35,067	167,981
1957	6,790	4,408	27,084	11,348	33,108	159,784
1958	4,971	4,703	23,761	14,007	35,378	184,167
1959	4,005	3,140	22,124	13,807	34,761	167,435
1960	3,264	3,489	25,995	14,937	34,348	175,071
1961	4,967	4,645	26,920	15,908	36,491	204,235
1962	4,160	3,422	21,150	12,939	28,264	194,875
1963	3,866	5,152	22,809	12,954	28,182	198,195
1964	3,691	4,186	19,725	11,716	27,267	174,491
1965	3,659	4,940	24,224	11,959	29,578	216,809
1966	5,084	4,924	25,937	13,740	29,430	227,787

^aSources are given in Chapter III.

TABLE 10.--Total quantities of potatoes diverted under government programs: United States, by months, 1952-66^a

Year	1,000 hundredweights											
	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952	.	.	.	.	.	.	.	.	.	.	.	.
1953	.	.	.	.	.	.	.	.	.	.	.	.
1954	.	.	.	1,333	1,167	689	.	.	.	.	.	.
1955	.	.	71	524	.	.	.	.	326	1,488	1,187	1,799
1956	1,553	1,253	1,392	909	310	38	.	.	.	1,187	1,972	2,262
1957	2,127	1,944	2,456	2,615	2,159	1,810	130	330	759	1,611	2,188	2,162
1958	2,320	1,606	1,077	.	.	.	.	.	1,244	4,594	3,100	2,439
1959	3,048	3,409	3,003	2,261	284	77	.	.	.	.	.	.
1960	.	.	.	.	.	.	.	.	.	.	.	.
1961	.	.	802	1,243	1,289	.	.	.	350	3,737	3,852	4,340
1962	5,558	3,807	2,912	2,167	2,025	475	43	.	.	.	.	.
1963	1,408	1,062	1,110	1,292	1,258	.	.	.	.	.	725	784
1964	1,593	1,000	799	692	.	.	.	.	.	.	.	.
1965	.	.	.	.	.	.	.	.	.	.	.	.
1966	.	.	.	.	.	.	.	.	.	.	.	.

^aAll categories of potatoes (specification A and culls), and all forms of diversion (livestock feed, starch, and flour) are included. The data were computed from weekly data. For further information, and for source of primary data, see Chapter III.

TABLE 11.--Total quantities of potatoes diverted under government programs: By states and by marketing years, crops of 1953-63^a

State	1,000 hundredweights										
	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Calif.	.	.	80	230	202	708	.	.	800	321	744
Colo.	.	.	539	976	697	1,707	.	.	34	699	.
Idaho	534	.	1,633	2,402	3,929	159	.	.	8,565	.	1,923
Maine	2,850	1,221	7,086	12,563	3,459	7,518	.	3,334	8,526	3,750	.
Minn.	.	.	.	11	113	2,016	.	.	1,991	.	.
Mont.	.	.	.	.	18	.	.	.	196	.	36
N. J.	.	.	.	.	.	.	.	.	81	.	.
N. Y.	.	.	.	.	.	.	.	.	28	.	.
N. Dak.	.	.	.	175	326	5,228	.	.	2,882	.	.
Oreg.	.	.	625	1,573	1,391	2,750	.	.	2,438	840	1,611
Pa.	.	.	167	.	.	.	.	.	33	.	.
R. I.	.	.	.	.	.	.	.	.	13	9	.
Utah	.	.	13	.	.	.	.	.	8	9	25
Wash.	.	.	33	740	1,968	3,370	.	.	3,760	607	1,350

^aThe figures in the body of the table refer to the marketing period of the crops of the calendar years shown in the boxhead. Only potatoes from the Late Summer and Fall crops were diverted during the period covered. There were no diversion programs affecting crops of 1951, 1952, 1959, and 1964-66. All categories of potatoes (specification A and culls), and all forms of diversion (livestock feed, starch, and flour) are included. The data were computed from weekly data. For further information, and for source of primary data, see Chapter III.

TABLE 12.--Net exports of potatoes: United States totals, by months, 1951-66^a

Year	1,000 hundredweights											
	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951	-412	-508	-10	-223	-291	100	134	311	425	448	151	-73
1952	83	166	440	160	-41	434	157	289	311	296	-193	-554
1953	-226	-100	-62	-14	271	475	251	237	535	380	-262	-189
1954	-281	-141	-6	39	86	353	187	317	422	745	260	-65
1955	-4	57	186	236	336	529	243	204	450	660	11	-209
1956	-124	-198	-221	268	-2	286	352	8	282	327	-109	-301
1957	119	34	129	12	286	432	241	194	275	220	-218	-383
1958	-398	-349	-354	-339	122	339	199	216	296	371	18	38
1959	191	-32	-75	42	217	460	244	331	231	325	-61	35
1960	106	96	231	384	549	960	479	115	72	19	16	-161
1961	-65	-5	15	88	320	699	643	104	26	28	-17	-181
1962	-59	47	21	157	300	430	272	71	30	243	-96	-198
1963	-84	609	606	40	334	618	487	32	28	54	-140	-54
1964	-81	-18	-49	-280	-46	315	284	1	-19	-149	-507	-675
1965	-333	-263	-281	-421	76	422	281	34	27	-2	-100	-249
1966	-58	41	127	48	624	952	534	71	7	-57	-260	-704

^aComputed from export data (potatoes, white, fresh) and import data (potatoes, white, certified seed plus potatoes, white, other). For sources of primary data, see Chapter III.

TABLE 13.--Maine certified seed shipments by months, 1952-66^a

Year	1,000 hundredweights						
	Jan.	Feb.	Mar.	Apr.	May- June	July- Nov.	Dec.
1952	. .	1,765	2,882	1,586	. .	295	253
1953	415	1,700	2,579	1,816	107	118	110
1954	344	1,830	3,185	1,356	165	54	71
1955	290	1,130	3,309	2,019	384	298	94
1956	241	1,627	2,242	1,588	327	302	92
1957	189	1,308	2,792	1,663	260	295	66
1958	249	1,092	3,100	1,809	323	45	60
1959	214	1,450	2,660	1,856	450	65	38
1960	297	1,143	2,556	2,653	309	49	28
1961	185	1,140	3,478	2,141	639	20	17
1962	236	1,243	2,513	2,491	662	351	41
1963	246	1,278	2,627	3,110	705	62	24
1964	232	917	2,987	2,172	460	22	14
1965	265	1,052	2,199	2,079	190	23	17
1966	256	781	3,647	1,385	395	22	20

^aSource: Letter from John F. Boyle, Local Representative, Federal State Market News Service. Consumer and Marketing Service, U. S. Dept. of Agriculture, Presque Isle, Maine, November 24, 1967.

TABLE 14.--Imports of white certified seed Potatoes: United States total
(mainly from Canada), by months, 1952-66a

Year	1,000 hundredweights											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1952	217	43 ^b	23	66	130 ^b	38 ^b	.	.	1 ^b	24	173	408
1953	200	80	96	115	30	6	.	.	.	3 ^b	123	183
1954	220	121	72	68	163	36 ^b	2 ^b	.	.	1 ^b	102	235
1955	135	114	63	68	16	1 ^b	.	.	.	26	139	309
1956	123	106	176	269	133	68	.	1 ^b	.	1 ^b	311	456
1957	74	79	78	107	41	5	1	.	.	2	321	407
1958	365 ^b	175	131	127	42	9	.	.	.	10	193	150
1959	40	138	121	80	48	6 ^b	.	.	1 ^b	.	191	136
1960	86	38	24	50	18	1	.	.	.	.	3	238
1961	125	33	60	64	90	11	.	1 ^b	.	.	29	206
1962	108	11	21	71	71	.	.	.	.	.	97	226
1963	48 ^c	30	33	84	57	12	.	.	.	.	160	99
1964	140 ^c	22	25	139	163	51	2	.	.	13	236	476
1965	198	142	128	194	53	11	2	.	.	15	137	254
1966	93	80	51	94	35	6	2	24	.	15	54	.

^aCompiled from the same sources as the total imports data. These sources are given in Chapter III.

^bIncludes imports within and above quota.

^cIncludes imports within and above quota.

TABLE 15.--Potato processing in Idaho plus Idaho potatoes processed in Malheur county, Oregon. By months. Food only^a

Year	1,000 hundredweights							
	Jan.	Feb.	Mar.	Apr.	May-June	July-Oct.	Nov.	Des.
1957	748 ^b	749 ^b	913 ^b	886 ^b	715 ^b	977 ^b	465 ^b	515 ^b
1958	706 ^b	896 ^b	1,084 ^b	1,024 ^b	953 ^b	1,457	979	1,031
1959	1,183	1,178	1,395	1,183	1,264	1,904	1,287	1,415
1960	1,537	1,488	1,642	1,418	1,801	3,427	2,124	2,349
1961	1,868	2,146	2,472	2,053	1,379	3,616	2,092	1,532
1962	1,694	2,323	2,600	2,139	2,245	3,786	2,170	1,865
1963	2,031	2,138	2,328	1,917	1,419	4,221	2,329	2,320
1964	2,475	2,458	2,529	2,430	1,681	5,402	2,507	2,231
1965	2,981	2,651	2,702	1,126	1,473	8,672	3,332	3,292
1966	3,542	3,399	3,805	3,251	4,349	7,281	3,823	3,687

^aThe table was compiled on the basis of data received in letters from Clarence E. White, Agricultural Statistician In Charge, Statistical Reporting Service, U. S. Dept. of Agriculture, Boise, Idaho, July 20, 1965 and November 15, 1967. The data do not include potatoes used in the processing of starch, flour, and alcohol.

TABLE 16.--Potato processing in Maine by months, 1961-66^a

Year	1,000 hundredweights											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1961	37	53	58	57	41	127	3	• •	30	46	16	20
1962	52	34	350	63	227	481	62	119	320	320	115	265
1963	246	281	294	320	401	182	122	25	519	239	631	221
1964	330	363	334	479	232	169	36	127	549	722	488	629
1965	506	599	618	573	170	22	• •	177	938	940	594	891
1966	835	638	946	743	205	356	25	267	971	713	833	623

^aThe table was compiled on the basis of data received in letters from Cedric Porter, Supervising Inspector, Dept. of Agriculture, State of Maine, Caribou, Maine October 13, 1965 and November 14, 1967. The information was provided through the courtesy of M. U. Van Kirk, Lokal Federal Supervisor, Consumer and Marketing Service, U. S. Dept. of Agriculture.

The data are based on experiences covering inspection of potato deliveries to five of the six frozen french fried potato processors in Maine. Due to an overlap of report times the listing may contain some inaccuracies from month to month.

TABLE 17.--Frozen french fried potatoes, end-of-month cold storage holdings:
United States totals, 1956-66^a

Year	1,000 hundredweights											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1956	203	267	332	396	430	379	275	214	190	242	334	420
1957	483	577	682	799	814	721	573	442	419	512	543	517
1958	527	633	691	771	820	663	480	343	326	442	589	682
1959	793	908	971	1,064	1,044	869	681	503	457	509	594	706
1960	814	968	1,075	1,076	1,063	882	597	509	540	740	1,013	1,250
1961	1,579	1,835	2,057	2,247	2,105	1,890	1,437	1,245	1,224	1,529	1,779	1,829
1962	1,904	2,208	2,553	2,649	2,477	2,142	1,660	1,302	1,242	1,652	1,988	2,243
1963	2,355	2,695	3,047	3,206	2,688	2,309	1,629	1,222	1,217	1,602	1,887	2,211
1964	2,509	2,894	3,087	3,458	3,169	2,468	1,553	1,127	1,228	1,532	1,939	2,237
1965	2,798	3,270	3,531	3,150	2,540	1,784	1,057	1,060	1,504	2,231	2,683	3,142
1966	3,758	4,135	4,637	4,694	4,459	3,582	2,666	2,273	2,442	3,004	3,550	4,098

^aThe table was compiled from data in U. S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, Summary of Regional Cold Storage Holdings, 1966 (Washington: U. S. Government Printing Office, April, 1967), p. 17 and from the corresponding publications for the years 1956-65.

APPENDIX C

FURTHER DETAILS REGARDING THE
ESTIMATION OF MONTHLY
SALES DATA FOR POTATOES

Abbreviations

In this appendix, the following abbreviations are used:

RS = rail shipments RSD = rail shipments data
TS = truck shipments TSD = truck shipments data
TU = truck unloads TUD = truck unloads data

Standard abbreviations are used for states.

Truck Conversion Factors

The truck conversion factors used were taken directly from the annual publications and are reproduced below.

From January 1950 through December 1959, the following representative factors were used by the U. S. Dept. of Agriculture to convert truck and boat shipments to rail carlot equivalents.

Potatoes

All size & type pkgs. in pounds	
Gulf & Atlantic States--Texas (Rio Grande Valley only) thru Del.	30,000
Mont., Wyo., Nebr., Colo., N. Mex., & West--Year around	36,000
All other States:	
October thru May	40,000 ¹
June thru September	36,000 ¹

From January 1960 through December 1965 the following factors have been in effect:

¹U. S. Dept. of Agriculture, Consumer and Marketing Service, Fruit and Vegetable Division, Market News Branch, Fresh Fruit and Vegetable Shipments by Commodities, States, Months, Calendar Year, 1959 (Washington: April, 1960), pp. 2-3.

Potatoes

All size & type pkgs.--in pounds

MAINE	50,000 ¹
ALL OTHER STATES	43,000 ¹

From January 1966, the truck conversion factors are as follows:

Potatoes

All size & type pkgs.--pounds

Fla. & Long Island	50,000
Maine	55,000 ²
All other States	48,000 ²

Rail Conversion Factors

As described in Chapter III, rail conversion factors were derived from railroad statistics for eight regions. The region borders do not always follow state borders, but each state was classified as belonging to a single region on the basis of two maps: one showing production areas within states³ and the other showing the region borders.⁴ Only for a few states (Pa., Ohio, N. Y., Wyo., Texas, Mo.) was there some doubt about the classification. West Va. did not have any RS. Miss. was placed

¹Fresh Fruit and Vegetable Shipments . . . Calendar year, 1960, p. 3.

²Fresh Fruit and Vegetable Shipments . . . Calendar year, 1966, p. 3.

³Kehr, Akeley, and Houghland, op. cit., p. 10.

⁴Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Summary Tables of the Sixty-Second Annual Report on the Statistics of Railways in the United States for the Year Ended December 31, 1948 (Washington: U. S. Government Printing Office, 1950), p. 2.

in a wrong region because it was treated together with La., but it had practically no RS.

The various states were classified as follows:

New England Region: Conn., Maine, Mass., N. H., R. I., and Vt.

Great Lakes Region: Mich., and N.Y.

Central Eastern Region: Del., Ill., Ind., Md., N. J., Ohio, and Pa.

Pocahontas Region: Va.

Southern Region: Ala., Fla., Ga., Ky., N. C., S. C., and Tenn.

Northwestern Region: Iowa, Minn., Mont., N. Dak., S. Dak., Wash., and Wis.

Central Western Region: Ariz., Calif., Colo., Idaho, Kans., Mo., Nebr., Nev., N. Mex., Oreg., Utah, and Wyo.

Southern Region: Ark., La., Miss., Okla., and Texas.

When the time series were updated in 1967, the question regarding rail conversion factors had to be taken up to renewed consideration.

No quarterly publications from which rail conversion factors can be derived, have been published since 1963.¹ It seemed inappropriate to extrapolate the data used earlier any longer, and a new approach therefore had to be devised. One possibility was to use yearly railroad data and derive yearly rail

¹Letter from M. Paolo, Director, Bureau of Accounts, Interstate Commerce Commission, Washington, November 16, 1967.

conversion factors from these.¹ Another possibility was to use the earlier mentioned truck conversion factors established from January 1, 1966 by the U. S. Dept. of Agriculture. The latter approach was followed for the calendar years 1965 and 1966 for the crop years 1965/66 and 1966/67. Since the truck conversion factors are based on the best judgement of the officials of the U. S. Dept. of Agriculture, as well as on the available railroad statistics, it should be safe to use this method. The use of common conversion factors for rail and truck also provided some computational convenience. Since neither of the two alternative sets of rail conversion factors vary between months, the choice between them is actually not a very important one. For the earlier years, the rail conversion factors used previously were retained.

Disregarded Data

When calendar year was not used, certain rather time consuming precautions had to be taken in order to keep the number of cities represented in the unloads data constant for any year. Calendar year was therefore

¹Such data were available for 1964 and 1965 for the U. S. as a whole, Eastern District, Pacahontas Region, Southern Region, and Western District, See Interstate Commerce Commission, Bureau of Accounts, Freight Commodity Statistics of Class I Railroads in the United States, Calendar Year 1965 (Washington: U. S. Government Printing Office, 1967), pp. 1-17.

chosen as often as it seemed satisfactory. In a few cases when calendar year was used, a very small number of carloads, reported as shipped in the first months of the calendar year, were disregarded. Such shipments belonged to the crop of the preceding year and were therefore not allowed to affect the monthly distribution of the current year's crop. TUD were treated the same way when they were used. In many cases the present writer had a suspicion that the movements in question were reshipments from other states. The problem is not important and is mentioned here only for completeness.

Even though TU and TS generally had a similar seasonal pattern during the usual marketing period, a few cars of TU were often reported as having occurred long before the beginning or long after the end of the usual marketing season for the state in question. Such TU were disregarded. In many cases they had probably been wrongly classified. The following principle was applied: Unloads occurring as much as one or more months before the beginning, or two or more months after the end of the usual marketing period for a state as listed in Agriculture Handbook No. 127¹ were disregarded. Again, the problem is a minor one and is mentioned for completeness.

Data on TS were disregarded when they were re-

¹Royston, Frost, and Gallaway, op. cit.

placed by data on TUD for reasons mentioned in Chapter IV.

Further Description of the Unloads Data and
Their Treatment

In all cases when they could be obtained, TUD were used instead of TSD when the latter were unavailable or inappropriate. Individual city reports could not be obtained for all cities, and in some cases the available reports did not contain TUD for potatoes. The city reports used for each calendar year are listed below. When calendar year was not used, data for some cities were disregarded for one part of the year in order to keep the number of cities constant for the whole year.

In the following, the cities for which city reports were used are listed. An X under a year indicates that the city report for that year was available and that it contains TUD for potatoes by states and months:

	1950	1951	1952	1953	1954	1955	1956	1957
Atlanta	X	X	X	X	X	X	X	X
Baltimore	X	X	X	X	X	X	X	X
Birmingham							X	X
Boston	X	X	X		X	X	X	X
Chicago	X	X	X	X	X	X	X	X
Cincinnati					X	X	X	X
Cleveland			X		X	X	X	X
Dallas			X	X	X	X	X	X
Fort Worth				X	X	X	X	X
Denver		X	X	X	X	X	X	X
Detroit		X	X	X	X	X	X	X
Jackson						X	X	X
Kansas City				X	X	X	X	X
Los Angeles	X	X	X	X	X	X	X	X
Louisville							X	X
Minneapolis-S. Paul							X	X
New Orleans	X	X	X	X	X	X	X	X
New York City	X	X	X	X	X	X	X	X

	1950	1951	1952	1953	1954	1955	1956	1957
Oakland	X	X	X	X	X	X	X	X
Philadelphia	X	X	X	X	X	X	X	X
Pittsburg			X	X	X	X	X	X
Portland	X	X	X				X	X
St. Louis	X	X	X	X	X	X	X	X
San Francisco	X	X	X	X	X	X	X	X
Seattle		X	X	X	X	X	X	X
Washington	X	X	X	X	X	X	X	X

For 1958-59, unload totals for 39 cities were used. The corresponding data for 1960-66 covered 41 cities. Seattle and Tacoma were the two cities added.

Since the number of cities covered by the data was much larger for 1958 than for 1957, an adjustment had to be made for states where calendar year was not used. Individual city unload summaries were not available for the additional cities for the year 1958.¹ Data for these cities could therefore not be subtracted. Instead the data for 1957-58 were adjusted so that the ratio between unloads before January 1 and total unloads after January 1 was the same this year as it was in average for the preceding and the succeeding year.

A corresponding method of adjustment was also used in a few cases when TSD were used for one part of a year and TUD for the other.

In cases when TUD for 1959/60 were used, data for Seattle and Tacoma were subtracted from the TUD for 1960 if

¹Saylor, letter, October 6, 1965.

they were available.¹ Subtractions should have been made, but data were not available for the following states: Conn., Ind., Iowa, Mass., Nebr., Nev., N. J., N. Mex., N. Y., N. C., Ohio, Pa., R. I., S. D., Utah, Vt., and Wis. It is likely that shipments to Seattle and Tacoma from most of these states were zero or very small, however.

Description of the Data and Their Treatment
for Individual States

Space does not allow a complete description of the availability of various categories of data for individual states. Some deficiencies in the available data for certain states are mentioned below, however. Corrections for such deficiencies are also described if any corrections were made.

The main rule followed was to use all available RSD and TSD. TUD were used instead of TSD when the latter were unavailable or inadequate. In general only the cases when the TSD were considered inadequate for some reason are mentioned below. When a state is not mentioned at all this indicates that the available data (RSD together with TSD or with TUD, or any one of the three alone) were used.

¹Monthly TU data for Seattle and Tacoma by state of origin for certain states were obtained from the U. S. Dept. of Agriculture, Agricultural Marketing Service, Fruit and Vegetable division, Market News Branch, Fresh Fruit and Vegetable Unloads in Western Cities by Commodities, States, and Months, Calendar Year 1960 (Washington: March, 1961) p. 124.

Alabama: For 1954 and 1955 TSD were not available for the period after June 8 and June 11, respectively. Inspection of the data seemed to reveal similar incompleteness for 1952-53. Since in addition no TSD were available for 1951, TUD rather than TSD were used for the whole period 1951-55.

Arizona: Ariz. TS are interstate only, but the available data were used.

California: Two kinds of truck movements are shown in the shipments tables for Calif. "Passings" represent interstate movement, while "unloads" represent receipts of Calif. production at Los Angeles, Oakland, and San Francisco markets. The two were added in the present analysis. Calif. truck passings for 1959 were incomplete for October, November, and December because one station, Truckee was not reported. To adjust for this, average data for Truckee for the corresponding months in 1961-63 were added to the Calif. data.¹

Since the preliminary TSD for 1967 gave the impression of being incomplete, TUD were used instead of TSD for the year 1966/67.

Connecticut: The TSD for 1951/52 and 1956/57 were disregarded. Comparison with TUD seemed to indicate that they had been reported only for a shorter period.

¹Data for Truckee were obtained from Saylor, letter, August 13, 1965.

Delaware: TUD were used instead of TSD for 1952-55 and 1957-58. TS seemed to have been reported for only part of the season. More TU than TS were reported for all years.

Florida: The TSD for Fla. represent interstate movement and shipments from the peninsula area to West Fla. These data were used.

Georgia: Production estimates were discontinued for this state in 1965.¹ The figure showing quantity sold from farms in 1965 was therefore used also for 1966, since this was about the best that could be done.

Illinois: Very few data were available. The available data on sales, shipments, and unloads were added together with corresponding data for N. J. and W. Va. In all these three states only Late Summer potatoes are grown.

Kentucky: The monthly data for Tenn. were used for 1951-55 since no movements data were available for Ky. In both states only Early Summer potatoes are grown.

Louisiana: All available data for Miss. were added to the La. data.

Maine: All the available data for N. H. and Vt. except the TUD for Vt. for 1957/58 were added to the Maine data.

Maryland: Only TUD were used. All shipments data for 1951-55 pertained to Eastern shore only. This seemed to be the case for shipments data also for later years. TU

¹See Potatoes and Sweetpotatoes: Estimates By States and Seasonal Groups--Crops of 1965 and 1966, pp. 4-5.

In several of the later years were spread over a longer season, more in accordance with the listing of the usual marketing period in Agriculture Handbook No. 127. Massachusetts: The TSD for 1951/52 were disregarded since they seemed to have been collected only during part of the season. TUD for Boston, nearby were available for 1950/51 and 1951/52 but they were not included in the TUD for Mass. Data on boat shipments plus TU were used for 1953/54-1954/55.

Michigan: The TSD for the first half of 1961/62 were disregarded and TUD were used for the whole year.

Minnesota: TUD were used instead of TSD for 1953/54, 1962/63, and 1964/65 since TS were reported for only part of the year.

Mississippi: Very few data were available. All the available data were added to the data for La. In both states only Late Spring potatoes are grown.

Missouri: TUD for St. Louis, nearby were not added to the Mo. data since these TU might also have been shipped from Ill.

Montana: The usual adjustment of TU for 1957/58 was not undertaken, since the ratio of TU in the first part of 1958 to TU in the last part of 1957 was smaller than the average of the corresponding ratios for 1956/57 and 1958/59.

New Hampshire: Very few data were available. All

available data were added to the corresponding data for Maine. In both states only Fall potatoes are grown.

New Jersey: All available data for Ill. and W. Va. were added to the corresponding data for this state.

New Mexico: Since very few data were available for 1950/51-1955/56 and for 1957/58, monthly averages of shipments and unloads data for all other years were added to the available monthly data for each of these years.

New York: The shipments data for N. Y. are reported separately for N. Y., Long Island and for N. Y., Upstate. Since the data were not complete, it was decided to disregard the distinction. When data expressed in carlots had been compiled for each part of the state, the data were therefore added together for the whole state.

Since no TSD were available for 1950/51-51/52, TUD for N. Y. as a whole were used for those years. For the remaining years, both RSD and TSD were available for N. Y., Long Island, but very few shipments data were obtainable for N. Y., Upstate. It was therefore decided to supplement the data for N. Y., Upstate with TUD. For the years 1952/53-57/58 a special problem was involved in the use of

these data, however.

The difficulty was that the reporting practice with regard to N. Y. was different for different cities and years during this period and it was not always quite clear whether "N. Y." meant N. Y., Upstate or N. Y., total.

The available data for the various cities were therefore divided into four groups labeled (1) N. Y., (2) N. Y. Long Island and N. Y. Upstate, (3) N. Y., Upstate, and (4) N. Y., Unspecified. The latter two kinds of data were added together and used to represent TUD for N. Y., Upstate in the cases when the corresponding TSD were not available or were disregarded. Since the data for both parts of N. Y. were later added together, it is clear that by this procedure some TU from Long Island were counted twice. Since the data were used only as weights, this error need not be particularly serious, however. The reason for following this procedure was that it was felt more satisfactory to count some Long Island unloads twice than to disregard all unspecified TUD. It is also likely that the unspecified data really were data for N. Y., Upstate in several cases.

A few available TSD for N. Y., Upstate for January through April 1955 were disregarded. The data labeled N. Y. Unspecified were disregarded for the last part of 1957 since there was no comparable data available

for the first part in 1958. Also the TUD used for N. Y., Upstate in 1963/64 had the handicap that they might include some TU from Long Island.

The TUD used to represent TU from N. Y., Upstate for the years 1962/63 and 1964/65 had to be adjusted. The reason for this was that unloads from Long Islands seemed to be included in the TUD for 1963-64 while they were not included in the data used for 1958-62 and 1965. The lacking TUD for N. Y., Upstate for January-June 1963 and July-December 1964 were constructed as an average of the figures for the corresponding months in 1960/61 and 1961/62.

When the time series were updated in 1967, the data for N. Y., Upstate for the period 1962/63-66/67 were treated in a different way. Comparable TUD data for all of N. Y. were then available for the whole period beginning in 1963. These data were used to represent N. Y., Upstate TU for the years 1963/64-66/67.¹

TUD for N. Y., Upstate were used for the first half of 1962/63, and TUD for N. Y. as a whole were used for the second half. The latter data were adjusted so that the ratio between the totals for the two parts of the year was the same for 1962/63 as it was in average for the years 1961/62 and 63/64.

¹Again, this means that some N. Y., Long Island unloads were counted twice.

Geographically, N. Y., Upstate belongs to the Great Lakes Region, while N. Y., Long Island belongs to the New England Region. Because the data were added together, all of the state was treated as belonging to the Great Lakes Region, however.

The official truck conversation factors established from January 1, 1966 were different for the two parts of N. Y. The conversion factor for Long Island was used for the whole state, however.

The TSD for N. Y., Long Island for July and August, 1964 were recorded in one single figure. This figure was split by distributing it on the two months proportionally to the corresponding TUD used for N. Y., Upstate.

North Carolina: For the years 1957-66, TSD were available only for June and July. Since this might be due to closing of the shipping point offices during the rest of the season, the TSD were supplemented with all available TUD for the remaining months of the season.

North Dakota: TUD were used instead of TSD for the years 1953/54, 1962/63 and 1964/65, since the TSD seemed to be very incomplete.

Ohio: TSD were available only for 1957, and these data were disregarded. The usual adjustment of the TUD for 1957/58 was not undertaken for the same reason as was mentioned for Mont.

Oklahoma: Since very few data were available for the years 1956-66, the data were supplemented by adding to these the available data for Ark. In both states only Late Spring potatoes are grown.

Oregon: TUD were used instead of TSD for 1956/57 and 1964/65. TSD were used for the first half and TUD for the second half of 1957/58. These data were therefore adjusted in the way described earlier.

Pennsylvania: TUD were used instead of TSD for 1957.

Rhode Island: The movement data for Mass. were used as distributive weights for R. I. sales in 1952/53 and 1954/55 since no movement data for R. I. were available.

South Dakota: The TUD for 1957/58 were disregarded. They would have had to be adjusted for varying number of cities, but this was little to bother with, since so very few data were available.

Texas: TUD were used instead of TSD for all years. . The TSD cover only Lower Valley (Rio Grande Valley). The pattern of these TS was very different from that of the TU, which seemed to have originated from all over the state.

Utah: The usual adjustment of the TUD for 1957/58 was not undertaken for the same reason as was mentioned for Mont.

Vermont: Very few data were available. All available

data, except the TUD for 1957/58, were added to the corresponding data for Maine and N. H. In all three states only Fall potatoes are grown. Because they were very small, the TU for 1957/58 were disregarded. They would have had to be adjusted in any case.

Washington: Since no TSD were available for 1952, the TSD for 1952/53 were disregarded, and TUD were used instead.

West Virginia: The very few data that were available were combined with the corresponding data for N. J. and Ill.

Wyoming: The TUD for 1957/58 were disregarded. The recorded TU for this year were so small that there was no reason to keep the data and adjust them.

TABLE 18.--Potatoes for all purposes except diversion: Calculated shipments as percentage of sales from farms, by months and by states or by groups of states, years beginning 1951-56a

State or groups of states	Year beginning	Percentage shipments are of sales												Percentage production is of U. S. production (1958-62 average) ^b				
		Year beginning																
		1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962		1963	1964	1965	1966
Ala.	Jan.	66	45	58	61	43	92	70	82	95	105	108	98	97	86	90	91	1.0
Ariz.	Jan.	86	92	79	77	81	87	87	94	101	102	102	101	104	101	104	95	0.3
Ark.	Jan.	11	11	4	18	5	12	6	0	4	8	3	1	6	10	12	23	0.1
Calif.	Aug.	84	78	78	75	84	69	68	78	76	69	71	69	73	75	67	62	11.2
Colo.	July	93	88	89	87	88	95	84	89	89	84	83	90	82	87	82	84	4.7
Conn.	July	8	6	5	7	3	5	16	9	12	15	18	16	16	14	11	10	0.5
Del.	Jan.	24	33	23	24	29	47	29	38	74	71	43	35	35	34	42	34	0.8
Fla.	Nov.	91	93	92	94	90	89	88	86	84	91	88	93	88	88	88	86	1.9
Ga.	Jan.	51	19	36	30	23	25	14	13	26	35	18	38	17	32	18	24	0.1
Idaho	July	77	77	67	71	69	65	68	53	45	38	41	38	34	26	30	23	17.7
Ind.	July	9	4	3	7	6	12	12	28	55	41	41	52	45	43	54	49	0.6
Iowa	July	7	23	8	8	4	2	5	10	11	18	10	11	4	10	12	18	0.2
Kans.	Jan.	15	47	2	48	23	73	39	17	10	32	42	29	13	17	22	7	0.1
Ky.	Jan.	7	8	4	6	7	7	5	8	5	8	4	5	3	4	6	6	0.3
La. and Miss.	Jan.	14	26	49	29	13	6	24	4	17	24	28	28	28	20	26	21	0.2
Maine, N. H. and Vt.	Aug.	83	76	73	71	80	78	79	77	72	77	76	71	60	61	53	52	13.9
Md.	Jan.	26	15	19	16	25	19	18	30	21	27	23	15	13	11	14	18	0.2
Mass	July	18	5	2	5	7	8	10	17	14	20	17	16	11	13	11	11	0.5

TABLE 18.--Continued

State or group of states	Year beginning	Percentage shipments are of sales													Percentage production is of U. S. production (1958-62 average) ^b			
		Year beginning																
		1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963		1964	1965	1966
Mich.	July	30	32	33	30	36	30	32	27	26	31	29	29	28	31	27	33	3.0
Minn.	July	68	64	58	87	66	65	68	60	68	69	65	42	46	45	41	50	4.7
Mo.	Jan.	22	42	8	28	23	9	18	16	21	37	33	31	29	28	24	20	0.2
Mont.	Aug.	39	40	28	34	41	43	44	42	46	45	60	45	57	46	45	67	0.5
Nebr.	July	52	48	36	38	35	25	18	27	32	23	25	21	31	27	29	43	0.9
Nev.	July	46	42	21	28	33	14	30	28	30	25	39	26	30	36	19	10	0.1
N.J., Ill., and W.Va.	May	18	19	85	80	84	72	78	68	68	71	59	56	58	56	59	57	2.0
N. Mex.	June	43	69	55	42	38	4	7	4	3	8	18	9	6	15	20	15	0.2
N. Y.	July	36	59	59	57	65	63	64	65	65	69	66	64	84	92	94	87	7.7
N. C.	Jan.	72	78	70	74	80	77	53	60	47	51	47	36	48	26	57	49	1.2
N. Dak.	Aug.	86	91	86	92	88	82	84	80	80	74	81	61	57	54	52	57	5.3
Ohio	June	1	1	1	6	6	13	25	22	23	25	22	22	25	24	22	25	1.0
Okla.	Jan.	21	26	19	8	16	21	25	14	15	27	9	4	18	26	34	40	0.1
Oreg.	July	67	70	58	59	55	67	89	56	56	47	61	59	57	46	52	57	3.4
Pa.	July	21	14	18	23	16	20	13	19	17	17	20	18	14	13	15	11	2.9
R. I.	July	4	6	2	15	5	10	13	28	27	16	25	26	33	36	31	17	0.5
S. C.	Jan.	78	55	73	87	62	64	88	106	78	68	96	62	94	47	49	59	0.2
S. Dak.	July	50	33	30	36	23	24	16	23	26	24	91	14	21	11	29	34	0.2
Tenn.	Jan.	8	5	4	4	5	12	12	12	12	20	19	9	13	11	18	18	0.3
Texas	Jan.	46	46	42	42	31	41	30	28	41	48	51	53	49	48	46	44	0.9
Utah	Aug.	27	20	19	28	22	24	24	22	24	26	23	28	27	13	31	22	0.6

TABLE 18.--Continued

State or group of states	Year beginning	Percentage shipments are of sales														Percentage production is of U. S. production (1958-62 average) ^b		
		1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964		1965	1966
Va.	Jan.	53	76	85	92	77	92	82	78	82	85	81	73	70	59	65	76	1.5
Wash.	June	68	70	75	75	65	74	87	70	66	58	64	65	61	60	38	32	1.2
Wisc.	July	44	32	31	32	31	30	34	51	43	35	34	32	37	31	36	36	0.6
Wyo.	July	60	54	40	45	34	32	35	23	19	6	8	10	17	4	18	46	0.2

^aShipments include rail and truck. Truck unloads were used when truck shipments were not available. Data used and methods of computation are further described in Chapter III and IV and in Appendix C.

^bCompiled from Kehr, Akeley, and Houghland, op. cit., p. 10.

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