PURCHASES OF NEW FARM TRACTORS AND MACHINERY IN RELATION TO THE NONFARM BUSINESS CYCLE, 1910-1956

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY

Lyle P. Fettig

1958

PURCHASES OF NEW FARM TRACTORS AND MACHINERY IN RELATION TO THE NONFARM BUSINESS CYCLE, 1910-1956

By

Lyle P. Fettig

A THESIS

Submitted to the College of Agriculture of
Michigan State University of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1958

ACKNOWLEDGMENTS

The author would like to express his sincere appreciation to all those who made the completion of this thesis possible.

Foremost among those to whom the author is grateful is Professor Dale E. Hathaway, his major professor. His guidance and encouragement throughout the development of this thesis was invaluable.

Professor Clifford Hildreth, now head of the Economics Department, and Professor Lester Manderscheid of the Agricultural Economics Department, made important contributions in working out the statistical aspects of the problem. Similarly, Professors Glenn L. Johnson and William Cromarty of the Agricultural Economics Department provided valuable insights into the analytical aspects of the problem.

Thanks are also due Professor L. L. Boger for supplying financial aid in the form of an assistantship, making graduate study possible at this time. The cooperation of the statistical pool in carrying out the statistical computations and departmental secretaries in typing earlier drafts is sincerely appreciated.

Typing of the final manuscript was done by my sister, Marilyn. The author is indebted to her for her patience in this task and aid in making the meeting of deadlines possible.

Finally the author wishes to acknowledge the support of fellow graduate students, both material and moral, in the completion of a graduate program.

The author bears full responsibility for the content of this thesis.

****

PURCHASES OF NEW FARM TRACTORS AND MACHINERY IN RELATION TO THE NONFARM BUSINESS CYCLE, 1910-1956

By

Lyle P. Fettig

AN ABSTRACT

Submitted to the College of Agriculture of
Michigan State University of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

Year 1958

Approved _____

ABSTRACT

Input flows into agriculture have been hypothesized as varying during different phases of the business cycle. This hypothesis has been investigated in this study for one of the groups of inputs from the nonfarm economy which flows into agriculture, farm tractors and machinery.

The primary purpose of the study was to determine if the relationships of factors associated with farm tractor and machinery purchases differed during different phases of the business cycle.

The years included in the study, 1910 through 1956, were classified individually as being either a contraction year or an expansion year. This classification was made on the basis of two criteria, (1) reference cycles for the general economy developed by the National Bureau of Economic Research, and (2) gross national product estimates. Using these criteria, there were fifteen contraction years and thirty-two expansion years during this period.

Synthetic variables were employed in the statistical models used in the analysis so that regression coefficients for variables during contractions could be compared with the regression coefficients for the corresponding variables during expansions. This method increased the computational efficiency and made it possible to use a common test in comparing regression coefficients. The single equation models were linear in the original variables and fitted using ordinary least squares techniques.

Twenty equations in all were included in the four groups of equations that were examined in the analysis. The variables included in these equations were either machinery expenditures by farmers or shipments to

dealers as the dependent variable, and independent variables consisting of: (1) net cash farm income, (2) capital gains and losses on livestock, crops, and real estate, (3) stocks of machinery on farms, (4) the price of machinery relative to prices received by farmers, (5) the price of labor relative to machinery prices, and (6) a calendar time variable, assumed to represent a measure of the state of technological advance. Variations in the form of the variables were made between equations and changes in the variables included were made between groups of equations.

The results indicated that different relationships between variables have existed during contractions and expansions in respect to net cash farm income, capital gains and losses and "technological trend" as represented by the time variable. Changes in the rate of machinery purchase appear to have been more closely related to changes in farm income during contractions, and changes in the rate of machinery purchase appeared to be more closely related to capital gains and the presence of new technology during expansions.

The relationship between the relative price of machinery and the rate of machinery purchase appeared to be about the same in contractions and expansions. Changes in the rate of machinery purchase in relation to the stocks of machinery on farms appeared to be overpowered by the development of new technology. Evidence was not found to support the hypothesis that the relative price of hired labor has been important in the machinery - labor substitution that has taken place on the farms of America during this period.

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

LIST OF TABLES

LIST OF TABLES - Continued

LIST OF FIGURES

CHAPTER I

INTRODUCTION

One of the more important gaps in the knowledge possessed by agricultural economists relating to the agricultural industry is a clear understanding of the nature of the aggregate supply function for agriculture. Papers submitted to the Joint Economic Committee[1] suggest there is general agreement that the agricultural industry is out of adjustment at the present time. Proposals for bringing the agricultural sector of the economy into adjustment are contingent upon assumptions concerning the nature of this aggregate supply function. Belief in a supply curve which is highly inelastic calls for programs involving stringent production controls and high price supports, while belief in an elastic supply function calls for reductions in price supports and relaxation of production controls.

The Problem

The task of this thesis is not to attempt to explain the aggregate supply function for agriculture. Much more must be known before this can be done. The subject matter of this thesis is closely related to the understanding of the aggregate supply function for agriculture, however.

A responsive aggregate supply curve for agriculture may be explained in part by increases in resources used in agricultural production as a result of increases in the demand for agricultural products. This

---

1. Policy for Commercial Agriculture, Its Relation to Economic Growth and Stability, Joint Economic Committee Print, November 22, 1957.

was suggested in a paper by Hathaway[2] relating agriculture to the business cycle. Measuring the changes in these inputs which are used in agriculture involves many difficulties, so that rather than attempting to work on all the inputs which go into agriculture, one of the major input categories, farm tractors and machinery, was examined. The findings of this study gives some indication as to the usefulness of looking at other inputs in a similar manner, and some of the problems involved if such investigations are to be made.

The problem, simply stated, is that of examining farm tractor and machinery investments over the business cycle to determine if the variables which are associated with these investments are related differently during different demand conditions. These demand conditions are considered to be changing with changing conditions of well-being in the general economy, i.e., the business cycle.

Literature Leading to the Study

The development of the conceptual framework used in this study was done by Johnson and appears in the paper "Supply Function - Some Facts and Notions."[3] Hypotheses are presented concerning resource employment in agriculture in relation to the general level of employment and business activity. The inputs used in agriculture have been classified into nine categories in Johnson's paper. The category "nonfarm produced durables"

---

2. Hathaway, Dale E., "Agriculture and the Business Cycle", in Policy for Commercial Agriculture, Ibid, Table 4, p. 58.

3. Johnson, Glenn L., "Supply Function - Some Facts and Notions" in Agricultural Adjustment Problems in a Growing Economy, edited by Heady, et. al., Iowa State College Press, 1958, ch. 5.

includes farm tractors and machinery. Table 1.0 presents hypotheses developed in Johnson's paper concerning nonfarm produced durables.[4]

TABLE 1.0 - HYPOTHESES CONCERNING EMPLOYMENT OF NONFARM PRODUCED DURABLES IN RELATION TO THE GENERAL LEVEL OF BUSINESS ACTIVITY

RECOVERY	PROSPERITY	RECESSION	DEPRESSION
Stable +	Expanding +	Stable +	Stab. or Contr.+

The hypotheses in Table 1.0 were framed in reference to the fixed asset concept developed by Johnson. An asset is considered fixed when its marginal value product is less than its acquisition cost and in turn, its salvage value is less than its marginal value product. In such a situation it doesn't pay to employ more of the input and the input will return more in its present use than through salvage.

The fixed asset concept was offered as an explanation of why inputs do not leave agriculture during periods of low earnings and why more inputs do not enter into agriculture on the outset of a betterment of the terms of trade between agriculture and the non-agricultural sectors of the economy. In Table 1.0 we see that employment of nonfarm produced durables is hypothesized as being stable or contracting in three of the four stages of the business cycle. Employment of nonfarm produced durables is hypothesized as expanding only during periods of prosperity. The plus (+) signs indicate the influence of technological advance upon the employment of nonfarm produced durables. There is a plus sign for each phase of the

4. Ibid, Table 5.1, p. 82.

business cycle, suggesting that employment of nonfarm produced durables is increased in all phases of the business cycle due to this cause. However, it does not suggest that the rate of increase from this cause will be the same in each phase of the business cycle, even though the effect is hypothesized to be positive. The interest in this study is in obtaining a more complete knowledge of the reasons for, or more correctly the factors associated with, variations in the rate of purchase of new tractors and machinery which become inputs in agriculture.

Many valuable insights into demand factors of importance were obtained from Cromarty's recent investigation in this area.[5] In his study he used conventional time series analysis. The approach in this study was different because the purposes of the study were different. This will be discussed in more detail in Chapter II.

Wilcox and Cochrane[6] discussed the impact of business fluctuations on purchases of farm machinery and motor vehicles, pointing out the close association of these investments with changes in general business activity. They found that in "good times", investment in this area was increased and in "bad times", investment was restricted.

The other basic work involved, of which the present study is an outgrowth, is Hathaway's paper "Agriculture and the Business Cycle."[7] Implicit in this paper are the hypotheses that: (1) farm output is partially related to demand, and (2) part of the output increases which take place are a result of increased purchases of inputs from the nonfarm sector of

---

5. Cromarty, William A., The Demand for Farm Machinery and Tractors, Agricultural Experiment Station, East Lansing, Technical Bulletin (In Process).

6. Wilcox, W. W., and Cochrane, W. W., Economics of American Agriculture, Prentice-Hall, 1951, p. 458-9.

7. Hathaway, Dale E., op. cit., p. 51-76.

the economy. It would be desirable to consider all inputs used by agriculture in relation to the business cycle to test these hypotheses. Such an inquiry is beyond the scope of the present study.

Scope and Objectives of the Study

Expenditures which farmers in the United States have made on tractors and machinery over the period 1910 to 1956 are investigated in the study. This input category was chosen because available data provide some measure of the magnitude of input in individual years.

The primary objectives that are sought are: (1) the construction of a demand model for farm tractors and machinery that allows for, (2) determination of the differences in the relationships of variables in this demand model, during periods of general business contraction and periods of general business expansion. The second objective, although necessarily related to the success of accomplishing the first, is the primary objective of the study. In this light, the investigation might be considered as an attempt to develop a demand model for new farm tractors and machinery over the business cycle. However, it should be pointed out that primary emphasis is not on the development of a precise prediction equation, but rather upon possible differences in the relationships of variables with changes in general business activity.

The methodology, involving the theory used in the analysis, is discussed in Chapter II. Chapter III contains the analysis completed in the study along with its interpretation. Finally, in Chapter IV the findings of the study are summarized and evaluated.

CHAPTER II

METHODOLOGY

The present study deals with aggregates for the farm sector of the economy and as such lies in the realm of macroeconomics, which deals with mass economic behavior. The aggregates which are included in the analysis are considered to be derived from the many single units which constitute the whole. This approach to the development of the theory which is used in the analysis is called the analogy approach to the aggregate problem.[1]

Theory involved in the analysis of the macrovariables utilized in the study rests upon theory dealing with individual behaviors which are included in the composition of the aggregate. However, in dealing with the behavior of large groups of individuals, the "law of large numbers" tends to cancel out irregularities in the individual behaviors giving a resultant regularity in the aggregate behavior. The resulting aggregate is sufficiently stable to allow meaningful aggregative theories and measurement.[2] Apart from this, the objective of any study of this nature is to determine relevant and significant relationships and in this particular case the interest is in macroeconomic relationships.

Macroeconomics looks at economic affairs from an overall viewpoint, scanning the forest without looking at each of the trees individually. But, a forest is made up of individual trees, and it would follow that considerations pertinent to individual trees are important in molding the forest. It is here that microtheories aid in understanding the problem, in the development of a theoretical framework for the whole. This is the

---

1. Theil, H., Linear Aggregation of Economic Relations, North-Holland Publishing Company, Amsterdam, 1954, p. 6.

2. Ackley, Gardner, An Introduction to Macroeconomic Theory, preliminary edition for student use, Gardner Ackley, University of Michigan, Sept. 1957, Ch. I, p. 15.

approach of this study, in which demand for tractors and machinery by the farm sector of the economy is investigated.

The General Model Used in the Analysis

Variables associated with gross expenditures on tractors and machinery by farmers were examined. The selection of these variables, with the theory involved in their selection, is delayed to a later portion of the chapter. Before these variables are discussed, the development of a model which allows for differences in relations of the variables for years of contraction and years of expansion is discussed. This is done so that the hypothesis that employment of tractors and machinery differs during different phases of general business activity may be evaluated.

To test this hypothesis, it is necessary that the demand model used provide for comparison of the relationships of variables during different phases of the business cycle.[1] Business cycles were split into two major phases; expansion years and contraction years. The single equation model used was linear in the original variables since no particular justification for using curvilinear forms was apparent.

Since comparison of regression coefficients of corresponding variables for contraction and expansion years was the primary objective of the study, the model was constructed with this end in mind. "Splitting out" contraction years and expansion years and computing multiple correlations separately would raise serious problems in the comparison of regression coefficients by a common test. To avoid these problems, and to obtain greater efficiency in computation, synthetic variables were constructed so that both contraction years and expansion years could be treated as being from a single sample. Using this method, it was possible to compare regression

coefficients for corresponding variables in contraction years and expansion years for significant difference.

The single equation model used which incorporated this capability was linear in the original variables, of the form:

$$Y = a_{01} x_{01} + a_{02} x_{02} + b_{11} x_{11} + b_{12} x_{12} + \ldots\ldots b_{n1} x_{n1} + b_{n2} x_{n2} + u$$

where Y is gross expenditure on, or shipment of, tractors and machinery, a is the constant value, b is an estimated parameter, x is an independent variable, n is the number of independent variables, and u is the unexplained residual. The model includes independent variables $x_1 \ldots\ldots x_n$ which are divided into sub-variables, so that variables $x_{11\ldots12} \cdots\cdots x_{n1\ldots n2}$ are used.

Very simply stated, the model includes corresponding variables for contraction years and expansion years so that comparison of the regression coefficients of corresponding variables can be made. As an example, variable x_1 is income, and divided in this manner, x_{11} and x_{12} take the following values:

1. During contractions
   (a) x_{11} takes the value of x_1
   (b) x_{12} takes the value of zero
2. During expansions
   (a) x_{11} takes the value of zero
   (b) x_{12} takes the value of x_1

To obtain a double constant a value, 1's and zeros were used in a similar manner, where x_0 is considered to be 1.

The model, thus formulated, is based upon the assumption that the error term (u) is independent, i.e., that the unexplained residual has a similar distribution for expansion and contraction years. These residuals are examined in Chapter III to check the validity of this assumption. The equations are fitted using ordinary least square techniques.

Classification of Years

The use of this model requires that the years included in the study be classified individually as being either a contraction year or an expansion year. This classification was made with the use of the turning points of business activity developed by the National Bureau of Economic Research[3] and gross national product estimates. Since data pertaining to agriculture is reported on an annual basis, it was necessary to classify an entire year as being a year of contraction or a year of expansion though obviously turning points are not at the end of the year in all cases.

These turning points and gross national product figures are given in Table 2.0. The method of classification used was to observe the time in the year in which the turning point occurred, if at all, for the year being classified. Years in which turning points did not take place near the middle of the year were classified as follows: (1) if a peak in business activity occurred before mid-year, the year was classified as a contraction year, (2) if a trough occurred before mid-year, the year was classified as being an expansion year, (3) if a peak occurred after mid-year, the year was classified as being an expansion year, (4) if a trough occurred after mid-year, the year was classified as being a contraction year, (5) if neither peak nor trough occurred in the year being classified, it was classified as an expansion year if the last preceding turning point was a trough and as being a contraction year if the last preceding turning point was a peak.

---

3. For development of reference cycles for the general economy see burns, Arthur F., and Mitchell, Wesley C., Measuring Business Cycles, National Bureau of Economic Research, New York, 1947.

TABLE 2.0 - CLASSIFICATION OF THE YEARS USED IN THE ANALYSIS

	(1)	(2)		(3)		(1)	(2)		(3)
Year	Classi-fication*	Turning Point Peak	Trough	GNP Bil.$	Year	Classi-fication*	Turning Point Peak	Trough	GNP Bil.$
1910	C	Jan	-	36.7	1934	E	-	-	65.0
1911	C	-	-	36.8	1935	E	-	-	72.5
1912	E	-	Jan	38.5	1936	E	-	-	82.7
1913	C	Jan	-	40.0	1937	E	May	-	90.8
1914	C	-	Dec	38.5	1938	C	-	June	85.2
1915	E	-	-	42.1	1939	E	-	-	91.1
1916	E	-	-	47.8	1940	E	-	-	100.6
1917	E	-	-	59.5	1941	E	-	-	125.8
1918	E	Aug	-	65.5	1942	E	-	-	159.1
1919	E	-	Apr	77.1	1943	E	-	-	192.5
1920	E	Jan	-	86.2	1944	E	-	-	211.4
1921	C	-	July	70.3	1945	C	Feb	Oct	213.6
1922	E	-	-	72.5	1946	C	-	-	209.2
1923	E	May	-	84.3	1947	E	-	-	232.2
1924	C	-	July	83.4	1948	E	Nov	-	257.3
1925	E	-	-	90.0	1949	C	-	Oct	257.3
1926	E	Oct	-	95.3	1950	E	-	-	285.1
1927	C	-	Nov	93.5	1951	E	-	-	328.2
1928	E	-	-	95.6	1952	E	-	-	345.4
1929	E	June	-	104.4	1953	E	July	-	363.2
1930	C	-	-	91.1	1954	C	-	Aug	361.2
1931	C	-	-	76.3	1955	E	-	-	391.7
1932	C	-	-	58.5	1956	E	-	-	414.7
1933	E	-	Mar	56.0					

*C denotes contraction, E denotes expansion.

Source: Col. 2, Mills, Frederick C., Introduction to Statistics, Henry Holt Company, New York, 1956, Table 12-3, p. 353. Col. 3, Handbook of Basic Economic Statistics, Economic Statistics Bureau of Washington, D.C., July 15, 1958, p. 224.

When classifying years in which the turning point occurred near mid-year, the change in gross national product was used as an additional criterion. For years with this characteristic, the classification was as follows: (1) if the gross national product for the year exceeded the gross national product for the preceding year, it was classified as being an expansion year, (2) if the gross national product estimate declined from the level of the preceding year, it was classified as being a contraction year.

Exceptions to this system of classification are the years 1920 and 1946. The turning point in 1920 occurred in January, which was a peak. This would cause the year to be classified as a contraction based upon the turning point criterion. Gross national product rose substantially over the 1919 level, so the year was classified as an expansion year. The year 1946 would be classified as an expansion using the turning point criterion, but was classified as a contraction because gross national product declined from the 1945 level.

Complete classification of the years 1910 to 1956 is given in Column 1 of Table 2.0. Using this system of classification, there are fifteen years of contraction and thirty-two years of expansion included in the forty-seven years covered by the study.

The Dependent Variable

The dependent variable which is to be explained by other independent variables in the single equation model must be such that it reflects the purchases of tractors and machinery for agricultural use. To obtain a measure of the physical purchases of farm tractors and machinery, gross expenditures on farm tractors and machinery were deflated by an index of

farm tractor and machinery prices. Deflation of the expenditure figures adjusts the estimates for price changes, thus giving a more accurate measure of physical purchases than would expenditure figures, not adjusted. While the components of this input mix (i.e., types of machines, etc.) have been changing rapidly over the period under study, this is a problem which we are not presently capable of handling and is regarded as being beyond the scope and purpose of this study. Rather, the primary concern was in what the relationships between independent variables and investment in farm tractors and machinery as a broad category have been, with an understanding that specific items included in the category as to kind and number (i.e., the mix) have changed from your to year. The gross capital expenditure figures are derived by marking up shipment figures to retail and making an adjustment for dealer inventory changes.[4] These mark-ups have been computed at relatively constant rates, while mark-ups by dealers most likely vary with the business cycle. This would tend to amplify errors in the shipment estimates.

Shipments to dealers was used as an alternative dependent variable in several of the fittings. With this variable, there is the problem of dealers' inventories; dealers do not necessarily sell all the tractors and machinery shipped to them in any given year. Dealers may, in some years, have to carry stocks above their planned inventory into the following year.

Each of these two variables have been used in the analysis to determine which was more capable of prediction within the limits of the formulations used. Values of tractor and machinery shipments have been deflated by the index of farm tractor and machinery prices as with the case of gross expenditure figures.

---

4. Major Statistical Series of the U.S. Department of Agriculture, Vol. 3, Gross and Net Farm Income, Agriculture Handbook, No.118, U.S D.A., Dec. 1957, p. 18.

The Underlying Investment Theory

The crucial problem involved in this study is the choice of explanatory, "independent" variables which are used in the model to explain why farmers purchase tractors and machinery. This problem is not unique in character from other studies in which explanation of phenomena are the goal. Variables which are chosen for this purpose must be the more important ones selected from among the many relevant ones. It is here that theory guides the investigator in determining what variables possess these characteristics. On this subject Koopmans has written:

> But "good" choices means relevant choices....The choices as to what variables to study....call (s) for a systematic argument to show that the best use has been made of available data in relation to the most important aspects of the phenomena studied.[5]

This clearly outlines the present task of the author, who, following Koopmans' advice, shall try to set down such "systematic argument" which displays the reasoning behind the choice of the variables which have been related to farmers' investments in tractors and machinery.

At the outset of this discussion, it should be pointed out that the author recognizes that "we have as yet no thoroughly satisfactory theory of investment,"[6] so that what follows is by no means presumed to be "the" theory of investment. This weakness does not prevent investigations of an empirical nature from being made; indeed, many times such investigations provide insights which lead to further clarification of the relevant theory, through rejection of invalid parts and indications as to needed additions. The primary concern in choosing variables for explanation of

---

5. Koopmans, T. C., "Measurement Without Theory", in Review of Economic Statistics, Vol. XXIX, No. 3, Aug. 1947, p. 164.

6. Ackley, op. cit., ch. XII , p. 28.

investment is with the selection of those which appear to be relevant and important, using as a guiding reference existing investment theory.

The present context in which investment is being explained deals with aggregate gross investment in tractors and machinery for the farm sector of the economy. The macrotheory involved in the study is derived from microtheory by the use of the analogy approach. Thus, the theory which is discussed deals with the theory of the firm, assuming that the aggregates used reflect the simple summed effects of the variables for individual firms which go into the make-up of the aggregative variables.

The decision to make investment on the part of individual farm managers involves many considerations such as the age of the operator, the number of children and the amount of responsibility which the manager bears, to list but a few. However, most of these tend to "cancel out" when investment is considered in the aggregate, so that many of the variables which are highly relevant to the decision of the individual manager are not particularly germane when aggregate investment is considered. Thus, only those variables which affect aggregate investment in a regular and systematic fashion need be included.

The discussion which has evolved to this point has been preliminary in character, leading up to the question of why capital investments are made by farmers. The investment theory used in the selection of variables is advanced in the discussion that follows.

One of the more useful concepts in explaining the nature of investment, the marginal efficiency of capital, was developed by Keynes.[7] As contrasted to the marginal value productivity of capital, which is the

---

7. Keynes, J. M., The General Theory of Employment, Interest and Money, Harcourt, Brace and Company, 1935, ch. 11.

addition to total revenue resulting from using more of a capital input, marginal efficiency of capital as defined by Keynes refers to the expected rate of return over cost over a period of time from using capital assets.[8] A closer comparison between these two concepts is deemed necessary so that confusion between them may be eliminated. When using the marginal value product, we are interested in comparing this (MVP) with the marginal factor cost (MFC). Considering one input, greatest profit can be obtained by using that level of input where MVP = MFC since additions of the input prior to this level add more to gross income than to total cost and additions after this level add more to cost than to return. Thus, in using the MVP concept, we must compare cost and return simultaneously. The marginal efficiency of capital (MEC) is the expected rate of return over cost. In this case, both costs and returns have been looked at to obtain the return over cost, so the same elements concerned in MVP = MFC have been involved. Thus, we see in total that both concepts are used in conjunction with costs and returns; these costs and returns being the expected values in each case. From this discussion, it can be seen that the two concepts are highly complementary, marginal efficiency of capital being considered the longer run of the two. The concept of the marginal efficiency of capital is the basic proposition of the theory used.

Assuming rationality, more of the capital asset should be employed, so long as the expected percentage return, discounted for uncertainty, exceeds the rate of interest. This follows because if the marginal efficiency of capital exceeds the rate of interest, invested capital leaves a return over the rate of interest. Conversely, if the marginal efficiency of capital is below the rate of interest, not enough return would be

---

8. Ibid, p. 140-41.

made to pay the rate of interest. Interest charges must be covered whether the capital is borrowed or owned, since with owned capital there is the alternative of loaning the money to others (to banks, through purchase of securities, etc.) and collecting the rate of interest. Ability to obtain loans is another issue discussed below.

Expectations relating to the future play a very important role in investment decisions (to invest or not to invest). Prospective yields from capital investments are nothing more nor less than the expectations which investors hold. These expectations are conditioned by what has happened in the recent past and what is happening in the present, particularly in shorter lengths of run. Longer run expectations are highly unstable with much emphasis placed on the things which are known at the present time and not much weight attached to uncertain matters. Expectations in reference to decisions on purchasing machinery would probably be concerned with some intermediate length of run depending upon the use intended for the machine, the expected durability of the machine, and other such factors.

The ability to obtain loans with which to make investment is another consideration which must be made along with the marginal efficiency of capital. It is not sufficient that the marginal efficiency of capital be attractive to investment; in addition the farmer must be able to provide funds or obtain credit to make the investment.

While the rate of interest must be covered by the return on the investment for investment to be profitable, "since the rate of interest is relatively 'sticky', fluctuations in the inducement to invest depend primarily upon changes in the marginal efficiency of capital",[9] and not

---

9. Dillard, Dudley, The Economics of J. M. Keynes, Prentice-Hall, Inc., New York 1948, p. 142.

on the rate of interest.[10] In relation to tractor and machinery purchases, Cromarty also reached this conclusion and states "interest rates, judging from their stability, have not been effective in varying equipment sales."[11]

Arguments along this line dismiss the importance of the interest rate in determining investment. Furthermore, if one does allow that the interest rate should be included as a determining variable, the relevant rate of interest to use as a determinant is unascertainable. Using the mortgage rate of interest would assume that this is the relevant rate, but farm tractors and machinery are financed by and large from non-mortgage type loans. A report in a recent Federal Reserve Bulletin giving the findings of the Agricultural Loan Survey made in 1956 by the Federal Reserve System gave the following:

> Among loans to finance intermediate-term investments, the difference in rates was most pronounced for the smaller classes where loans to buy farm machinery and consumer durable goods were concentrated.[12]

This statement provides a strong indication of the difficulty involved in obtaining a relevant rate of interest for use as a determinant of investment. Probably the most suitable published series in this regard would be the series on interest rates for intermediate credit to farmers. However, since the rate of interest is relatively "sticky" and the marginal

---

10. See also in this regard Shackle, G.L.S., Uncertainty in Economics, Cambridge University Press, 1955, p. 128-44.

11. Cromarty, op. cit.

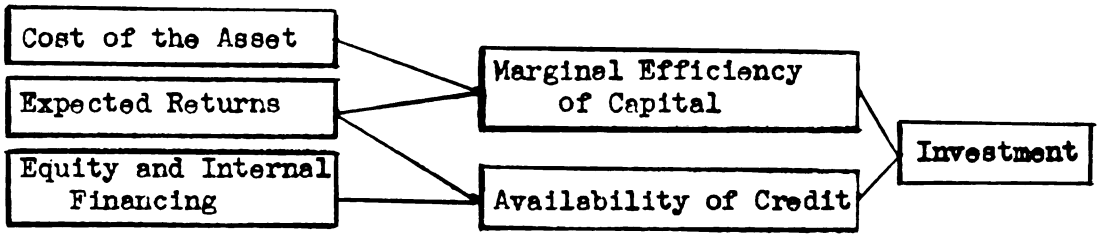
12. Morelle, Wilellyn, "Interest Rates on Farm Loans", Farm Loans at Commercial Banks, Board of Governors of the Federal Reserve System, Washington, D. C., 1957, p. 49.

efficiency of capital fluctuates to a great degree with changes in business activity, changes in the marginal efficiency of capital are considered to be the dominating factor of these two variables. It is more reasonable to expect changes in investment because of (say) a change in the marginal efficiency of capital from 0% to 10% or 15% than to expect a change in the interest rate from 6% to 7% to have much effect. Because of these considerations, rates of interest were not used as variables in the analysis.

The factors which would appear to be important in the determination of investment are summarized schematically in the Figure 2.0. The variables used in the analysis of investment in tractors and machinery need necessarily be related to these factors. The selection of independent variables is discussed in the following section.

Figure 2.0

Factors Considered to be Important in the Determination of Investment



The Independent Variables

The selection of variables that are related to changes in farmers' investment in tractors and machinery was made with the assistance of the theory which was presented in the preceding section. In making these choices, it is very difficult to be certain exactly what a particular variable measures, so that in essence intuitive reasoning many times pro-

vides the only link between a variable and a factor which the theory said was important. Exploration of alternative variables must be made to find those which give the "best fit" and are logically consistent. Statistical measures of association and tests of significance then provide some indication of the (apparent) relevance of the variables used. The reasoning underlying the use of particular variables is discussed in each of the following cases.

Farm income. Farm income was used as a variable that is associated with farmers' investment in tractors and machinery. Farm income constitutes a crucial element in farm capital outlays[13] and should provide a measure of the marginal efficiency of capital in agriculture. This seems to be fairly plausible in that lower incomes appear to be consistent with lower marginal efficiency of capital, given the cost of the asset, and higher incomes represent higher marginal efficiency of capital.

The marginal efficiency of capital was defined as being the expected rate of returns over costs. Assuming that farmers' expectations of the future are largely conditioned by outcomes of the present, net farm income, or the excess of gross farm income over costs, appears to be quite closely related to the marginal efficiency of capital in agriculture. It is not argued that expectations of return over cost for the coming year are based completely on the outcome of the present year, but rather that this aspect probably has an important influence on the expectations which are formed. Apart from this, farm income provides a stock of funds which may be used for machinery purchases.

Net income was used to represent that part of farm income which is available for investment purposes. Further, because farmers cannot invest

---

13. Monthly Review, Federal Reserve Bank of San Francisco, July 1956, p. 82.

"realized nonmoney" income, a net-cash-income concept was considered most fitting. Net cash farm income was obtained by subtracting current operating expenses (excluding hired labor), taxes on farm property, and interest on farm mortgage debt from the total of cash receipts from marketings and government payments. To put this income in terms of "real" net cash income, the estimates have been deflated by the index of prices paid by farmers.

Farm income, along with providing some measure of the marginal efficiency of capital in agriculture, is probably important from the standpoint of farmers' ability to obtain loans with which to invest. Ackley has written in connection with this point:

> We can still relate total investment to current (or recent) profits if we assume that the amount of outside capital which a firm can attract depends upon the amount of internal financing that its owners can supply (or that increases in the ratio of external to internal financing involve appreciable increases in the cost of outside capital.)[14]

This idea is closely related to the danger of "illiquidity" when too much credit is taken so that the rate of interest that must be paid is pushed upward.[15] Higher incomes provide savings which can be used for investment, thus reducing the ratio of external to internal financing.

Capital gains and losses. Capital gains and losses which come about as a result of changes in the prices of assets in which farmers have an equity, may be another variable important in the determination of farmers' investments in tractors and machinery. The potential importance of capital

---

14. Ackley, op. cit., ch. XII, p. 27.

15. Kalecki, M., "The Principle of Increasing Risk", Economica, New Series Vol. IV, 1937, p. 442.

gains in agricultural capital formation has been stressed by Johnson.[16] Such gains may expand the credit base for farmers as they occur and thus make credit more available for machinery purchases.

Capital gains and losses have been computed for real estate, livestock, and crops, and the total of these used in the analysis. Computation of these gains and losses is given in Appendix II.

The stock of machinery. The stock of machinery on farms was included as a variable in the analysis with the thought that the need for additional (new) machinery has been conditioned in part by the amount of existing stocks. Farmers can continue to use machinery until it wears out. To obtain an approximation of the stock of machinery on farms, expenditures in constant dollar terms were weighted linearly for the eight previous years and totaled. This was done because examination of Figure 3.0 in Chapter III, machinery expenditures charted over time, indicated a cycle of highs and lows about eight years in duration. Cromarty also considered a replacement time of eight years as being a valid approximation of the length of time which elapses between the time a farmer purchases a particular piece of machinery and the time when he re-enters the market to make an additional purchase. As he points out, this is only a rough approximation because the life of a piece of machinery may be extended if supplies are restricted or if farm purchasing power falls to a low level.[17]

This still appears to be a better approximation of machinery stocks on farms than a depreciated book value, such as the value of machinery on farms after depreciation. Such depreciation is done for income tax and

---

16. Johnson, G. L., "Sources of Expanded Agricultural Production" in Policy for Commercial Agriculture, Its Relation to Economic Growth and Stability, op. cit., p. 141-2.

17. Cromarty, op. cit.

accounting purposes and is not considered as being a good indicator of the "sets" of machinery actually on farms. The use of weighted sums of previous years purchases, while being a rough approximation admittedly, appears to be more useful for this purpose. The weighting has been done linearly, giving the expenditure of the most recent year a weight of eight times its value and giving the expenditure of the eight years previous a weight of one times its value.

The "real" price of machinery. In order to obtain a measure of the real price of machinery, the price of machinery relative to the prices received by farmers was included. Changes in expenditures for tractors and machinery should come about when this relative price changes as farmers compare the prices they receive with the price they must pay for the machinery. The rate that was used was obtained by dividing the retail index of farm tractor and machinery prices by the index of prices received by farmers.

The "real" price of labor. The price of labor relative to the price of machinery was used in the analysis to obtain the effect of the substitution of capital, in the form of machinery, for labor, when labor becomes more expensive relative to machinery prices. Considering labor and machinery as substitutes to some degree in production, one would expect machinery to be substituted for labor as the ratio of farm labor prices to machinery prices increases. Since the salvage value of farm machinery outside agriculture is very low, we would not expect machinery once purchased to be replaced by hired labor until the marginal value product of the machinery drops to the point where it equals its salvage value. In this respect, we would not expect hired labor to substitute for machinery as the ratio of farm labor prices to machinery prices decreases, unless additional inputs are being used to expand production.

The optimum combination of machinery and labor is reached when the ratio of the marginal physical product from machinery use to the price of machinery is equal to the ratio of the marginal physical product from labor use to the price of labor. This may be written in equation form as follows:

$$\frac{\text{MPP Machinery}}{\text{P Machinery}} = \frac{\text{MPP Labor}}{\text{P Labor}}$$

This condition defines the least cost combination for producing a given output and also the highest output from a given outlay.[18] When the price ratio between labor and machinery prices change, the optimum combination of machinery and labor changes. While we cannot expect the optimum to be obtained in a world of uncertainty, the tendency should be in that direction, it appears. This variable was obtained by dividing the index of farm wage rates by the index of tractor and machinery prices.

This variable, of course, only considers hired labor. Family labor has constituted a very important portion of the agricultural labor force in the United States. When has machinery replaced family labor? It is impossible to place a price applicable to family labor such as that for hired labor because of its fixed nature. Hence, we must look to other sources for measurement. Employment opportunities in the nonfarm economy are pointed out by Schultz[19] as being important in the movement of labor, both family and hired, from agriculture to jobs in urban communities. Machinery may be used, in turn, to replace labor which has left agriculture as a result of improved job opportunities. On the importance of

---

18. Bradford, L. A. and Johnson, G. L., Farm Management Analysis, Wiley and Sons, Inc., New York, 1953, p. 127-130.

19. Schultz, Theodore W., Agriculture In An Unstable Economy, McGraw-Hill, New York, 1945, p. 130.

employment opportunities as affecting the rate of machinery investment, Wilcox and Cochrane have written:

> There is considerable evidence that mechanization in recent years primarily replaced labor that had already left the rural community for nonfarm jobs, rather than that machinery took jobs away from local workers.[20]

At first, inclusion of an employment variable, based on the percent of the labor force employed, was considered for use in the analysis because of these speculations. However, because of the close association by definition between the classification, based upon business cycles, and the percent of the labor force employed, it was decided that inclusion of such a variable would not be useful. (See Appendix II, Table 8, for an employment series.)

Time as a variable. In addition to the preceding variables, a time variable (1910=1) was used in the analysis of machinery purchases. Time used as a variable has been referred to as a "catchall factor" that allows for the factors which change over time for which data are non-available.[21] Writing on technological change and its relation to forecasting in this connection, Siegel has said in regard to the use of calendar time as a variable:

> In such a case, time serves two purposes; it is a conglomerate variable representing all the omitted pertinent factors of production, and it is a parameter reflecting the continuous change in the structure of the productive process.[22]

---

20. Wilcox, W W., and Cochrane, W W., op. cit., p. 83-4.

21. Thomsen, F. L. and Foote, R. J., Agriculture Prices, McGraw-Hill, New York, 1952, p. 287.

22. Siegel, Irving H., "Technological Change And Long-Run Forecasting", The Journal of Business of The University of Chicago, Volume 26, July, 1953, p. 152.

The second purpose which Siegel points out was the primary purpose for including the time variable. Probably the thing which best typifies agriculture in the United States since the turn of the century has been the improvements which have been made in the production process. Development of new technology must have had a great impact on the purchase of new machinery. Therefore, the reasoning behind the inclusion of a time variable was to capture some of the influence of "technological trend" with the passage of time. The magnitude of the coefficient for this variable should give some indication of the rate of adoption of technology in contractions as compared to expansions.

The Use of Lagged Variables

"Time lags are used whenever the effect of a given independent variable takes place in a later time interval ...."[23] Some of the independent variables utilized in this study were considered as (possibly) being in this classification, and because of this, certain variables were lagged. Considering farm income, for example, the use of a lag seems very appropriate.

> .....while income is, to a great extent, determined in the fall as crops are harvested, machinery purchases reach a fairly high peak in the spring months as farm operations get underway. For this reason, income of the previous year may have more effect on current machinery purchases than does current income.[24]

From this same line of reasoning, it would also appear to be more appropriate to use lagged capital gains rather than current capital gains. When a "lagged" variable is referred to, it means the estimate of the

---

23. Thomsen, F. L. and Foote, R. J., op. cit., p. 286.

24. Cromarty, op. cit.

variable for the previous year is related to the dependent variable for the current year. Similarly "current" variables are estimates of the variable for the same year as the dependent variable.

There must exist a logical basis for using a lagged variable rather than a current variable if one is to be used in an analysis. Variables used based on logical grounds can then be scrutinized on statistical grounds for appropriateness. This was the approach used in regards to the possibilities of lagged relationships. No attempt has been made to employ distributed lags, which was considered to be beyond the scope of this investigation.[25]

Prediction Versus Different Relationships Between the Variables

The construction of a demand model for farm machinery and tractors suggest that a great deal of attention should be given to the development of a precise prediction equation. While this is a noteworthy objective in itself, the efforts of this study are directed more toward obtaining indications as to possible differences in the relationships of variables considered relevant in aggregate investment decisions during upswings and downswings of the general business economy. In this way the study separates from studies which have investigated machinery investment in the conventional time series method.[26]

---

25. For the most recent discussion on the methodological aspects of using distributed lags, see Nerlove, Marc, Distributed Lags and Demand Analysis for Agricultural and Other Commodities, Agriculture Handbook No. 141, AMS, USDA, June 1958.

26. As an example, see Cromarty, William A., The Demand for Farm Machinery and Tractors, Agricultural Experiment Station, East Lansing, Tech. Bul. (In Process).

This accounts in part for the lack of attempt to refine the analysis by using simultaneous equations, distributed lags, et cetera, simply because the purpose was not to construct an accurate predictive model. Such a model if sought, would be difficult to construct, largely because of limitations as to accuracy and availability of data. In this connection, Miss Burk has made the admonishment".....I always feel called upon to warn against reliance on overly refined methods applied to rough data."[27] The data used in this study would be classified as being in this "rough" category and it was felt that the maximum return, in terms of time and effort, would be obtained by using the methods that were employed. These methods provide some indication of the differences of the relationships of corresponding variables for contraction years and expansion years. The statistical test of significance for difference between corresponding variables is given in Appendix I.

Criteria for Evaluation of Regression Coefficients

In reviewing the results from the use of alternative equations in the single equation formulations, the interest was in, first of all, the consistency of the signs of the estimated parameters with expected signs from the guiding theory. These expected signs are given in Table 2.1. Reasons for these expected signs, when the variables are considered separately, are fairly obvious and discussion of their derivation is considered unnecessary. However, inconsistencies in signs which appear in the analysis may sometimes be explained in terms of other factors.

---

27. Burk, Marguerite, "Studies of the Consumption of Food and Their Uses," Journal of Farm Economics, Vol. 38, 1956, p. 1741.

Interpretations of this general nature are made when they are considered appropriate.

TABLE 2.1 - EXPECTED SIGNS OF ESTIMATED PARAMETERS

Variable	Sign
Farm Income	+
Capital Gains	+
Machinery Stocks	-
Relative Price of Machinery	-
Relative Price of Labor	+
Time	+

Equations that do not fulfill the criteria of economic theory, i.e., the expected signs of the regression coefficients, must be regarded with suspicion. In some cases these discrepancies can be explained by the margin of error in the data used. Wrong signs at levels not significantly different from zero can be tolerated as not contradicting economic theory. Such results, though undesirable, appear in many cases to be inevitable. In other cases, discrepancies may be explained by some other factor exerting an influence on the association. From this, we see the necessity of examining results on both statistical and economic grounds.

CHAPTER III

THE RESULTS OF THE ANALYSIS

The purpose of the study, as previously indicated, was to determine if the relationships between variables associated with farm tractor and machinery purchases have been different during different phases of the business cycle. Several equations were fitted to obtain indications of the relationships of variables during contractions as compared to the relationships of corresponding variables during expansions in general business activity. Since primary interest was in relationships of variables rather than in accurate prediction in putting together formulations, it was not expected that "the" prediction equation would be achieved. Undoubtedly, it was not. However, this is a matter of purpose; some "feel" toward the relations of the variables included, thus the relationships involved, was obtained from the consistencies produced by these fittings. This was the focal point of interest in the examination of the results of the fitted equations.

The Results Presented

The equations that were fitted are divided into four groups on the basis of major differences in the variables included in the equations. Between equations within these groups, there were changes of a lesser nature in the form of the variables included. The results of each group are presented in tabular form and discussed from the standpoint of relationships indicated by the results. Overall results and interpretations are discussed after the results of all four groups have been presented.

Group I. The first group of equations contains one basic equation and five variations. One variable in the basic equation was changed in each of these variations. The variables included in each of these equations, along with the coefficient of multiple determination (R^2) for each equation, are given in Table 3.0.

TABLE 3.0 - VARIABLES INCLUDED AND THE COEFFICIENT OF MULTIPLE DETERMINATION, EACH EQUATION, GROUP I

Equation	R^2	Dependent Variable	Independent Variables
1	.809	Machinery Expenditures	Current year's income, current year's capital gain, stocks of machinery, the relative price of machinery and the relative price of labor.
2	.705	Machinery Shipments	Same as equation 1.
3	.849	Machinery Expenditures	Same as equation 1, except that previous year's income is used in place of current year's income.
4	.830	Machinery Expenditures	Same as equation 1, except that current year's capital gains are deflated by the index of prices of farm tractors and machinery.
5	.810	Machinery Expenditures	Same as equation 1, except that previous year's capital gain is used in place of current year's capital gain.
6	.724	Machinery Expenditures	Same as equation 1, except that stocks of machinery are dropped.

In addition to the variables given in Table 3.0, the constant term (a value) was also fitted as a "double" variable in the first two equations. Splitting of the a value resulted in values very close to each other

(-4148 for contractions and -4368 for expansions in equation one; -1285 for contractions and -1246 for expansions in equation two and nonsignificant from zero in each case), so in the remainder of the equations, the constant term was fitted as a single value in the usual manner.

The results from using each variable in Group I are given in Tables 3.1 to 3.5. These regression coefficients were examined for consistency with economic theory, significant difference from zero, and significant difference between corresponding regression coefficients. In reading these tables, it should be remembered from Chapter II that odd numbered variables are for contractions and even numbered variables are for expansions. The test statistics used are for two purposes: (1) the (t_b) test statistic is used to test the regression coefficient for significant difference from zero in the conventional manner, and (2) the ($t_{b_i\ b_j}$) test statistic is used to test corresponding regression coefficients for significant difference. The (t_b) test statistic is obtained by dividing the regression coefficient by its standard error (s_b). The derivation of the ($t_{b_i\ b_j}$) test statistic is given in Appendix I.

In Table 3.1, we see that the use of farm income as an independent variable in Group I resulted in coefficients consistent in sign with economic theory. These coefficients were significantly different from zero as evidenced by the (t_b) test statistic. The regression coefficients of the farm income variable for contractions were always larger than the corresponding coefficients for expansions. This was true in all cases, whether the current year's income or the previous year's income was used, and suggests that changes in farm income are more closely associated with machinery purchases in contractions than in expansions.

There is a definite indication that income changes are more closely related to machinery purchases in contractions than in expansion, and the ($t_{b_i b_j}$) test statistic indicates that the difference is statistically significant.

TABLE 3.1 - RESULTS FROM USING FARM INCOME AS AN INDEPENDENT VARIABLE, GROUP I

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	Test statistics $t_{b_i b_j}$
1	Current Year's Income	x_{11}	.1620	.0540	3.00	1.55
		x_{12}	.0696	.0253	2.75	
2	Current Year's Income	x_{11}	.1153	.0439	2.63	1.99
		x_{12}	.0188	.0206	.91	
3	Previous Year's Income	x_{11}	.1528	.0457	3.34	.83
		x_{12}	.1094	.0256	4.27	
4	Current Year's Income	x_{11}	.1763	.0562	3.14	1.33
		x_{12}	.0938	.0263	3.56	
5	Current Year's Income	x_{11}	.1160	.0822	1.41	.82
		x_{12}	.0462	.0222	2.08	
6	Current Year's Income	x_{11}	.2222	.0575	3.86	2.37
		x_{12}	.0684	.0304	2.25	

Table 3.2 gives the results from using capital gains as an independent variable in Group I. First of all, in checking these results, it should be noticed that the use of the current year's capital gain always resulted in regression coefficients, both in expansions and in contractions, which have negative signs. This is inconsistent with the theory developed in Chapter II. However, when the capital gain for the previous year was used, the regression coefficients for both expansions and con-

tractions take the correct sign. Thus, we have an indication that the capital gain from the previous year is the more correct variable to use.

TABLE 3.2 - RESULTS FROM USING CAPITAL GAINS AND LOSSES AS AN INDEPENDENT VARIABLE, GROUP I

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Current Year's	x_{21}	-.0208*	.0121	1.73	1.26
	Capital Gain	x_{22}	-.0041*	.0056	.73	
2	Current Year's	x_{21}	-.0095*	.0098	.97	.79
	Capital Gain	x_{22}	-.0009*	.0046	.20	
3	Current Year's	x_{21}	-.0067*	.0092	.73	.34
	Capital Gain	x_{22}	-.0032*	.0045	.72	
4	Current Year's	x_{21}	-.0224*	.0135	1.66	.45
	Capital Gain Deflated	x_{22}	-.0154*	.0074	2.09	
5	Previous Year's	x_{21}	.0006	.0208	.03	.39
	Capital Gain	x_{22}	.0090	.0056	1.60	
6	Current Year's	x_{21}	-.0321*	.0133	2.41	2.11
	Capital Gain	x_{22}	-.0007*	.0304	.11	

*Inconsistent with expectations

When the previous year's capital gain was used in equation five, the regression coefficient for expansions was larger than for contractions, indicating that capital gains and losses were more closely associated with purchases of tractors and machinery in expansions than during contractions. The regression coefficient for expansions had some significance from zero while the regression coefficient for contractions did not. However, there was not a significant difference between the regression coefficient for expansions as compared to the corresponding coefficient for contractions.

The results from using stocks of machinery as an independent variable in Group I are given in Table 3.3. Examination of these results reveals that the regression coefficients for both contractions and expansions have positive signs.

TABLE 3.3 - RESULTS FROM USING STOCKS OF MACHINERY AS AN INDEPENDENT VARIABLE, GROUP I

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test Statistics t_b	t_{bibj}
1	Stocks as Defined	x_{31}	.0169	.0079	2.15	.03
		x_{32}	.0172	.0048	3.61	
2	Stocks as Defined	x_{31}	.0093	.0064	1.45	.74
		x_{32}	.0148	.0039	3.82	
3	Stocks as Defined	x_{31}	.0137	.0071	1.92	.64
		x_{32}	.0187	.0038	4.87	
4	Stocks as Defined	x_{31}	.0162	.0073	2.22	.38
		x_{32}	.0192	.0041	4.74	
5	Stocks as Defined	x_{31}	.0209	.0113	1.84	.18
		x_{32}	.0187	.0043	4.38	

The theory in Chapter II suggested the coefficients for the stocks variable would be negative, particularly during contractions of general business activity. After farmers had acquired machinery stocks, their needs for additional machinery would be reduced until they must replace that which exists. However, this relation appears to be overpowered by the trend in new technology that has occurred in agriculture. Wilcox and Cochrane apparently anticipated this result when they wrote:

> ...unless important technological advance keeps reoccurring a heavy volume of investment must decline after a few years.[1]

1. Wilcox, W. W., and Cochrane, W. W., op. cit., p. 459.

The positive sign on the stocks of machinery coefficients appear to attest to the importance of technological trend. Interpreted in this manner, this result is consistent with theory. All of the regression coefficients were significantly different from zero, tending to be a little larger in expansions than in contractions. However, the difference between regression coefficients for expansions and contractions was not statistically significant.

Table 3.4 gives the results from using the relative price of machinery as an independent variable in Group I. The signs of the regression coefficients are as expected, with the exception of equations five and six. Equation five has coefficients not significantly different from zero and equation six has coefficients which do have some significance from zero. Equation six doesn't include the stocks variable, giving some indication of the importance of the inclusion of a variable reflecting trend, as stocks apparently do.

In general, the first four equations have coefficients for the relative price of machinery which are larger in contractions than in expansions. This suggests that farmers pay closer attention to machinery prices compared to prices they receive during contractions than during expansions. This difference was not statistically significant, however.

TABLE 3.4 - RESULTS FROM USING THE RELATIVE PRICE OF MACHINERY AS AN INDEPENDENT VARIABLE, GROUP I

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test Statistics t_b	t_{bibj}
1	Relative Price of Machinery as Defined	x_{41}	-227.34	206.61	1.10	.82
		x_{42}	- 10.47	163.81	.06	
2	Relative Price of Machinery as Defined	x_{41}	-113.23	168.11	.67	.12
		x_{42}	-138.31	133.28	1.04	
3	Relative Price of Machinery as Defined	x_{41}	-205.96	147.39	1.40	1.06
		x_{42}	- 71.06	115.04	.62	
4	Relative Price of Machinery as Defined	x_{41}	-203.11	167.55	1.21	.41
		x_{42}	-145.70	125.99	1.16	
5	Relative Price of Machinery as Defined	x_{41}	3.95*	172.04	.02	.08
		x_{42}	- 7.79	136.21	.06	
6	Relative Price of Machinery as Defined	x_{41}	98.12*	187.68	.52	.62
		x_{42}	205.21*	139.30	1.47	

*Inconsistent with expectations

The results from using the price of labor relative to the price of machinery in Group I are given in Table 3.5. The regression coefficients for this variable had these characteristics in general: (1) the coefficient for contractions was always a large negative, and (2) the coefficient for expansions was either a smaller negative, or positive.

A negative regression coefficient for the price of labor relative to the price of machinery is inconsistent with the theory developed in Chapter II. The negative coefficients in contractions were significantly

different from zero; while in expansions, in two cases negative coefficients, and in one case a positive coefficient, were significantly different from zero. There was a significant difference between the regression coefficient for contractions as compared to the regression coefficient for expansions. Possible interpretations of this result are delayed until the discussion of overall results in the latter part of this chapter.

TABLE 3.5 - RESULTS FROM USING THE RELATIVE PRICE OF LABOR AS AN INDEPENDENT VARIABLE, GROUP I

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Relative Price of Labor as Defined	x_{51}	-392.09*	205.95	1.90	1.57
		x_{52}	14.01	156.60	.09	
2	Relative Price of Labor as Defined	x_{51}	-330.40*	167.57	1.97	1.49
		x_{52}	- 16.74*	127.41	.13	
3	Relative Price of Labor as Defined	x_{51}	-352.51*	176.97	1.99	.42
		x_{52}	-266.88*	141.54	1.89	
4	Relative Price of Labor as Defined	x_{51}	-432.05*	194.15	2.23	1.25
		x_{52}	-153.57*	140.48	1.09	
5	Relative Price of Labor as Defined	x_{51}	-318.30*	229.23	1.39	1.26
		x_{52}	- 9.24*	126.71	.07	
6	Relative Price of Labor as Defined	x_{51}	-217.54*	235.06	.92	2.21
		x_{52}	356.77	129.53	2.75	

*Inconsistent with expectations

Group II. This group differs from Group I in that instead of including the relative price of machinery as one variable, the index of machinery prices and the index of prices received by farmers were included as separate variables. The variables included in the equations of this group along with the coefficient of multiple determination (R^2) for each equation are given in Table 3.6.

TABLE 3.6 - VARIABLES INCLUDED AND THE COEFFICIENT OF MULTIPLE DETERMINATION, EACH EQUATION, GROUP II

Equation	R^2	Dependent variable	Independent variables
1	.830	Machinery Expenditures	Previous year's income, previous year's capital gain deflated, index of machinery prices, index of prices received.
2	.843	Machinery Expenditures	Same as equation 1, plus the time variable.

Table 3.7 gives the results of the equations used in Group II. Before examining these results, it should be pointed out that using the indexes of machinery prices and prices received involves high intercorrelation between the two indexes as well as inter-correlation between each of the indexes and farm income. Using the relative price of machinery did not present this problem. Thus, the results from this group are believed to be highly distorted because of the inconsistent signs for several of the regression coefficients compared with the results in Group I.

The signs for coefficients of prices received and of machinery prices were inconsistent in all cases. Results such as these raise serious

questions as to the usefulness of formulations including the two price indexes separately. It is interesting to note the difference in the coefficients of the time variable, however, which suggests a difference in the influence of the passage of time, or rather variables which change over time, in contractions as compared to expansions. This variable was examined in greater detail in Group IV.

TABLE 3.7 - RESULTS FROM GROUP II

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Previous Year's Income	x_{11}	.0790	.1294	.61	.08
		x_{12}	.0892	.0224	3.97	
2	Previous Year's Income	x_{11}	.0886	.0407	2.18	.14
		x_{12}	.0943	.0292	3.23	
1	Previous Year's Capital Gain Deflated	x_{21}	.0174	.0127	1.36	1.06
		x_{22}	.0022	.0074	.30	
2	Previous Year's Capital Gain Deflated	x_{21}	.0202	.0123	1.64	1.40
		x_{22}	.0004	.0072	.06	
1	Current Prices Received	x_{71}	-1.335*	2.053	.65	.34
		x_{72}	- .550*	1.067	.52	
2	Current Prices Received	x_{71}	-1.868*	.200	.93	.61
		x_{72}	- .441*	1.489	.30	
1	Current Price of Machinery	x_{81}	4.801*	2.359	2.04	.49
		x_{82}	3.534*	1.115	3.17	
2	Current Price of Machinery	x_{81}	7.543*	2.586	2.92	1.34
		x_{82}	3.409*	2.082	1.64	
2	Time (1910=1)	x_{61}	-9.712	4.355	2.23	1.88
		x_{62}	.731	4.428	.17	

*Inconsistent with expectations

Group III. Because of the results obtained in Group II, it was decided that efforts along the lines of Group I would be more fruitful than continuance of Group II. In Group III, the equations included both income of the previous year and income of the present year as variables. This was done to obtain a (possible) better measure of the influence of expectations on tractor and machinery purchases. The equations are different from the equations in Group I in this respect. Also, stocks of machinery was not included as a variable in the formulations of this group. There are five equations in the group. The variables included in each equation, along with the coefficient of multiple determination (R^2) are given in Table 3.8.

TABLE 3.8 - VARIABLES INCLUDED AND THE COEFFICIENT OF MULTIPLE DETERMINATION, EACH EQUATION, GROUP III

Equation	R^2	Dependent variable	Independent variables
1	.741	Machinery Expenditures	Current year's income, previous year's income, previous year's capital gains deflated by the price of machinery, the relative price of machinery, and the relative price of labor.
2	.643	Machinery Shipments	Same as equation 1.
3	.745	Machinery Expenditures	Same as equation 1, except that previous year's capital gains were not deflated by price of machinery.
4	.657	Machinery Shipments	Same as equation 3.
5	.648	Machinery Shipments	Same as equation 3, only the relative price of labor was dropped.

The results from using farm income in Group III are given in Table 3.9. It should be pointed out that the two incomes, the previous year's and the current year's, are highly inter-correlated, thus perhaps distorting the results of either looked upon separately. With this word of caution, we see the regression coefficient for the current year's income was positive in all contractions and negative in all expansions. The regression coefficient for the previous year's income was always consistent in sign in both expansions and contractions. The possible reason for this result is discussed in the general interpretations after all four groups are presented.

Here again, as in Group I, the indications are that income changes in contractions are more important than in expansions in farmers' decisions to purchase machinery. However, the pattern is not as clear in the case of the previous year's income in this group as in Group I, and this is possibly a result of the inter-correlation that exists with the current year's income. The coefficients in general were significantly different from zero, but were not significantly different in expansions and contractions.

TABLE 3.9 - RESULTS FROM USING FARM INCOME AS AN INDEPENDENT VARIABLE, GROUP III

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Current Year's Income	x_{11}	.0395	.1191	.33	.44
		x_{12}	-.0154*	.0406	.38	
2	Current Year's Income	x_{11}	.0953	.0915	1.04	1.52
		x_{12}	-.0515*	.0312	1.65	
3	Current Year's Income	x_{11}	.0712	.1153	.62	.69
		x_{12}	-.0127*	.0403	.32	
4	Current Year's Income	x_{11}	.1052	.0876	1.20	1.67
		x_{12}	-.0489	.0306	1.60	
5	Current Year's Income	x_{11}	.0387	.0793	.49	1.06
		x_{12}	-.0504*	.0305	1.65	
1	Previous Year's Income	x_{11}	.1810	.1007	1.80	.35
		x_{12}	.1410	.0556	2.54	
2	Previous Year's Income	x_{11}	.0524	.0774	.68	.76
		x_{12}	.1189	.0427	2.78	
3	Previous Year's Income	x_{11}	.1594	.1010	1.58	.36
		x_{12}	.1188	.0541	2.20	
4	Previous Year's Income	x_{11}	.0441	.0767	.57	.69
		x_{12}	.1034	.0411	2.51	
5	Previous Year's Income	x_{11}	.0372	.0775	.48	.99
		x_{12}	.1203	.0304	3.96	

*Inconsistent with expectations

Table 3.10 gives the results from using capital gains as an independent variable in Group III. Use of the previous year's capital gain deflated by the index of tractor and machinery prices in equations one and two resulted in inconsistent signs for the regression coefficients for both expansions and contractions. When capital gains were not

deflated in the other three equations, the sign in expansions was consistent, while the sign in contractions was inconsistent.

TABLE 3.10 - RESULTS FROM USING CAPITAL GAINS AND LOSSES AS AN INDEPENDENT VARIABLE, GROUP III

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Previous Year's Capital Gain	x_{21}	-.0118*	.0181	.65	.28
	Deflated	x_{22}	-.0063*	.0093	.68	
2	Previous Year's Capital Gain	x_{21}	-.0081*	.0139	.58	.52
	Deflated	x_{22}	-.0003*	.0071	.04	
3	Previous Year's Capital Gain	x_{21}	-.0175*	.0156	1.12	.12
		x_{22}	.0029	.0069	.42	
4	Previous Year's Capital Gain	x_{21}	-.0095*	.0119	.80	1.17
		x_{22}	.0056	.0053	1.07	
5	Previous Year's Capital Gain	x_{21}	-.0020*	.0110	.19	.58
		x_{22}	.0050	.0052	.96	

*Inconsistent with expectations

The three equations using non-deflated capital gains did not give statistically significant regression coefficients and there was not a significant difference between the regression coefficient of capital gains for contractions and expansions.

The results from using the price of machinery relative to prices received by farmers in Group III are given in Table 3.11. The striking feature of this table is that in all cases the regression coefficient has an inconsistent sign.

TABLE 3.11 - RESULTS FROM USING THE RELATIVE PRICE OF MACHINERY AS AN INDEPENDENT VARIABLE, GROUP III

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Relative Price of Machinery as Defined	x_{41}	49.33*	205.03	.24	.42
		x_{42}	120.97*	164.83	.73	
2	Relative Price of Machinery as Defined	x_{41}	47.99*	157.59	.30	.26
		x_{42}	81.96*	126.69	.65	
3	Relative Price of Machinery as Defined	x_{41}	62.87*	187.53	.34	.88
		x_{42}	205.97*	145.70	1.41	
4	Relative Price of Machinery as Defined	x_{41}	59.49*	142.51	.42	.58
		x_{42}	131.54*	110.72	1.19	
5	Relative Price of Machinery as Defined	x_{41}	38.97*	137.27	.28	.90
		x_{42}	150.13*	107.81	1.39	

*Inconsistent with expectations

The inconsistent sign is very difficult to explain. However, in Group I, the relative price of machinery had the correct sign, excepting when the stocks variable was dropped from the formulation. This indicates the need for a variable which reflects trend. Such a variable was used in Group IV. It appears to be unavailing to discuss a variable which displays such an inconsistent sign, but if we recognize the variable as such, having in mind a possible remedy, it is rather interesting to note certain consistencies. The regression coefficient was always larger in expansions. This indicates the factor used to correct this inconsistency has a "larger job to do" in expansions than in contractions. The (t_{bibj}) test statistic

indicates there was not a significant difference between regression coefficients for expansions and contractions.

The results from using the price of labor relative to the price of machinery in Group III are given in Table 3.12. In this group of equations, the coefficient for contractions was always a large negative, inconsistent with theory. The sign of the coefficient for expansions was always consistent with theory, but the coefficient was not significantly different from zero in each case.

TABLE 3.12 - RESULTS FROM USING THE RELATIVE PRICE OF LABOR AS AN INDEPENDENT VARIABLE, GROUP III

Equation	Form of variable	Regression coefficient	Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Relative Price of Labor as Defined	x_{51} -359.22*	268.29	1.34	1.39
		x_{52} 47.00	164.76	.29	
2	Relative Price of Labor as Defined	x_{51} -305.80*	206.21	1.48	1.50
		x_{52} 31.40	126.63	.25	
3	Relative Price of Labor as Defined	x_{51} -370.70*	250.87	1.48	1.69
		x_{52} 102.75	156.40	.66	
4	Relative Price of Labor as Defined	x_{51} -301.94*	190.64	1.58	1.72
		x_{52} 64.40	118.86	.54	

*Inconsistent with expectations

Results here, using the relative price of labor, correspond closely with the results in Group I. The test statistic for difference between regression coefficients indicates there was a significant difference between the regression coefficients for expansions and contractions.

Group IV. This group continues along the lines of Group III, differing from Group III in that a time variable (1910=1) was added to the variables included in the formulations. Also, because of the intercorrelation between succeeding years' incomes, three equations were used which included only one of the two incomes, current or previous year's. There were seven equations included in Group IV. The variables used, along with the coefficient of multiple determination (R^2), for each equation are given in Table 3.13.

TABLE 3.13 - VARIABLES INCLUDED AND THE COEFFICIENT OF MULTIPLE DETERMINATION, EACH EQUATION, GROUP IV

Equation	R^2	Dependent variable	Independent variables
1	.793	Machinery Expenditures	Current year's income, previous year's income, previous year's capital gain, the relative price of machinery, and the time variable.
2	.691	Machinery Shipments	Same as equation 1.
3	.823	Machinery Expenditures	Same as equation 1, with the relative price of labor added.
4	.731	Machinery Shipments	Same as equation 3.
5	.672	Machinery Shipments	Same as equation 4, with current year's income dropped.
6	.658	Machinery Shipments	Same as equation 5, with the relative price of labor dropped.
7	.635	Machinery Shipments	Same as equation 2, with previous year's income dropped.

The results from using farm income in Group IV given in Table 3.14 correspond very closely to the results in Groups I and III. In general, the regression coefficients for the current year's income in expansions were always negative and during contractions, positive. With the previous year's income, the coefficients were always positive in both expansion and contraction and generally larger in contractions, as in Groups I and III. There was not a significant difference between the regression coefficients for farm income during expansions and contractions in most of these equations.

To check the effect of the intercorrelation between the current year's income and the previous year's income, equations five and six were fitted using the previous year's income only, and equation seven was fitted using the current year's income only. The previous year's income used alone in equations five and six gave coefficients consistent in sign in both expansions and contractions while the current year's income used alone in equation seven yielded a consistent sign in contractions and an inconsistent sign in expansions. This is the same result as when both the current year's income and the previous year's income were used together. The coefficients for the current year's income used alone in equation seven were nonsignificant in both contractions and expansions. The coefficients for the previous year's income used alone in equation six were significantly different from zero, but not significantly different in contractions and expansions. However, in equation five, the previous year's income used alone gave a coefficient for expansions that was significantly different from zero while the coefficient for contractions was not. There was a significant difference between the regression coefficients for expansions and contractions. This suggests that the intercor-

relation between the current and the previous years' incomes has possibly distorted the magnitude of the income coefficients and that only one of the two (probably the previous year's) incomes should be included.

TABLE 3.14 - RESULTS FROM USING FARM INCOME AS AN INDEPENDENT VARIABLE, GROUP IV

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Current Year's Income	x_{11}	-.0655*	.0943	.69	.16
		x_{12}	-.0499*	.0376	1.33	
2	Current Year's Income	x_{11}	.0064	.0754	.09	1.02
		x_{12}	-.0737*	.0301	2.45	
3	Current Year's Income	x_{11}	.0522	.0966	.54	1.12
		x_{12}	-.6317*	.0367	1.72	
4	Current Year's Income	x_{11}	.0958	.0780	1.23	2.18
		x_{12}	-.0853*	.0296	2.88	
7	Current Year's Income	x_{11}	.0081	.0299	.27	.95
		x_{12}	-.0133*	.0237	.56	
1	Previous Year's Income	x_{11}	.1585	.0968	1.64	.55
		x_{12}	.1024	.0385	2.66	
2	Previous Year's Income	x_{11}	.0307	.0774	.40	.07
		x_{12}	.0912	.0308	2.96	
3	Previous Year's Income	x_{11}	.1669	.0898	1.86	.71
		x_{12}	.0953	.0456	2.09	
4	Previous Year's Income	x_{11}	.0362	.0725	.50	.65
		x_{12}	.0896	.0368	2.43	
5	Previous Year's Income	x_{11}	.1221	.0462	2.64	1.98
		x_{12}	.0172	.0298	.58	
6	Previous Year's Income	x_{11}	.0550	.0302	1.82	.72
		x_{12}	.0388	.0233	1.66	

*Inconsistent with expentations

Table 3.15 presents the results from using capital gains and losses as an independent variable in Group IV. As in Group III, the regression coefficient in contractions was negative in all cases but one and positive in expansions. There was not a significant difference between the regression coefficient for contractions as compared to expansions.

TABLE 3.15 - RESULTS FROM USING CAPITAL GAINS AND LOSSES AS AN INDEPENDENT VARIABLE, GROUP IV

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Previous Year's	x_{21}	-.0069*	.0134	.52	.55
	Capital Gains	x_{22}	.0012	.0061	.20	
2	Previous Year's	x_{21}	-.00002*	.0107	.001	.39
	Capital Gains	x_{22}	.0045	.0049	.93	
3	Previous Year's	x_{21}	-.0209*	.0133	1.57	1.48
	Capital Gains	x_{22}	.0006	.0058	.10	
4	Previous Year's	x_{21}	-.0106*	.0108	.98	1.22
	Capital Gains	x_{22}	.0038	.0047	.81	
5	Previous Year's	x_{21}	-.0036*	.0100	.36	.80
	Capital Gains	x_{22}	.0055	.0052	1.06	
6	Previous Year's	x_{21}	-.0002*	.0100	.02	.46
	Capital Gains	x_{22}	.0050	.0051	.98	
7	Previous Year's	x_{21}	.0012	.0112	.11	.51
	Capital Gains	x_{22}	.0076	.0052	1.47	

*Inconsistent with expectations

The results from using the relative price of machinery as a variable in Group IV are given in Table 3.16. The introduction of the time variable changed the signs of the coefficients in both expansions and contractions from Group III. The regression coefficients were statistically signifi-

cant from zero and of about equal magnitude in contractions and expansions. Since in some cases the coefficient for contractions was larger than for expansions and in other cases the coefficient for expansions was larger than for contractions and the two about balance out, the difference between regression coefficients could not be considered significant. The test statistic for significant difference ($t_{b_i b_j}$) lends credence to this conclusion.

TABLE 3.16 - RESULTS FROM USING THE RELATIVE PRICE OF MACHINERY AS AN INDEPENDENT VARIABLE, GROUP IV

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	$t_{b_i b_j}$
1	Relative Price of Machinery as Defined	x_{41}	-365.24	211.77	1.72	.36
		x_{42}	-310.01	229.52	1.35	
2	Relative Price of Machinery as Defined	x_{41}	-231.18	169.33	1.37	.10
		x_{42}	-218.89	183.52	1.19	
3	Relative Price of Machinery as Defined	x_{41}	-489.96	225.71	2.17	.24
		x_{42}	-525.35	246.58	2.13	
4	Relative Price of Machinery as Defined	x_{41}	-340.24	182.30	1.87	.48
		x_{42}	-396.73	199.15	1.99	
5	Relative Price of Machinery as Defined	x_{41}	-172.97	184.95	.94	.36
		x_{42}	-219.01	208.43	1.05	
6	Relative Price of Machinery as Defined	x_{41}	-131.47	167.01	.79	.05
		x_{42}	-137.49	186.81	.74	
7	Relative Price of Machinery as Defined	x_{41}	-385.23	173.61	2.22	.42
		x_{42}	-437.77	182.16	2.40	

Table 3.17 gives the results from using the price of labor relative to machinery prices in Group IV. Similarly to Groups I and III, the regression coefficient for contractions was, in each case, a large negative, and the regression coefficient for expansions was not significantly different from zero. The difference between the regression coefficient for contractions as compared to expansions was very significant, statistically.

TABLE 3.17 - RESULTS FROM USING THE RELATIVE PRICE OF LABOR AS AN INDEPENDENT VARIABLE, GROUP IV

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
3	Relative Price of Labor as Defined	x_{51}	-621.98*	219.84	2.83	2.50
		x_{52}	- 31.78*	142.94	.22	
4	Relative Price of Labor as Defined	x_{51}	-478.72*	177.55	2.70	2.28
		x_{52}	- 43.29*	115.45	.38	
5	Relative Price of Labor as Defined	x_{51}	-301.59*	174.99	1.72	1.85
		x_{52}	55.20	121.55	.45	

*Inconsistent with expectations

The results from using time as an independent variable in Group IV are given in Table 3.18. The signs of the coefficients were positive in all cases for both contractions and expansions. The regression coefficients for expansions were always larger than the ones for contractions with the use of this variable. This difference was statistically significant. This finding, along with the other results are interpreted in the following section.

TABLE 3.18 - RESULTS FROM USING TIME AS AN INDEPENDENT VARIABLE, GROUP IV

Equation	Form of variable	Regression coefficient		Standard error (s_b)	Test statistics t_b	t_{bibj}
1	Time (1910=1)	x_{61}	2.83	5.08	.56	2.25
		x_{62}	13.52	4.20	3.22	
2	Time (1910=1)	x_{61}	3.37	4.06	.83	1.47
		x_{62}	8.90	3.36	2.65	
3	Time (1910=1)	x_{61}	5.14	5.14	1.00	2.62
		x_{62}	16.76	4.26	3.94	
4	Time (1910=1)	x_{61}	5.40	4.15	1.30	1.72
		x_{62}	11.55	3.44	3.36	
5	Time (1910=1)	x_{61}	1.41	4.35	.32	1.61
		x_{62}	7.76	3.50	2.22	
6	Time (1910=1)	x_{61}	1.32	4.18	.32	1.31
		x_{62}	6.48	3.34	1.94	
7	Time (1910=1)	x_{61}	6.65	4.03	1.65	1.52
		x_{62}	12.66	3.37	3.75	

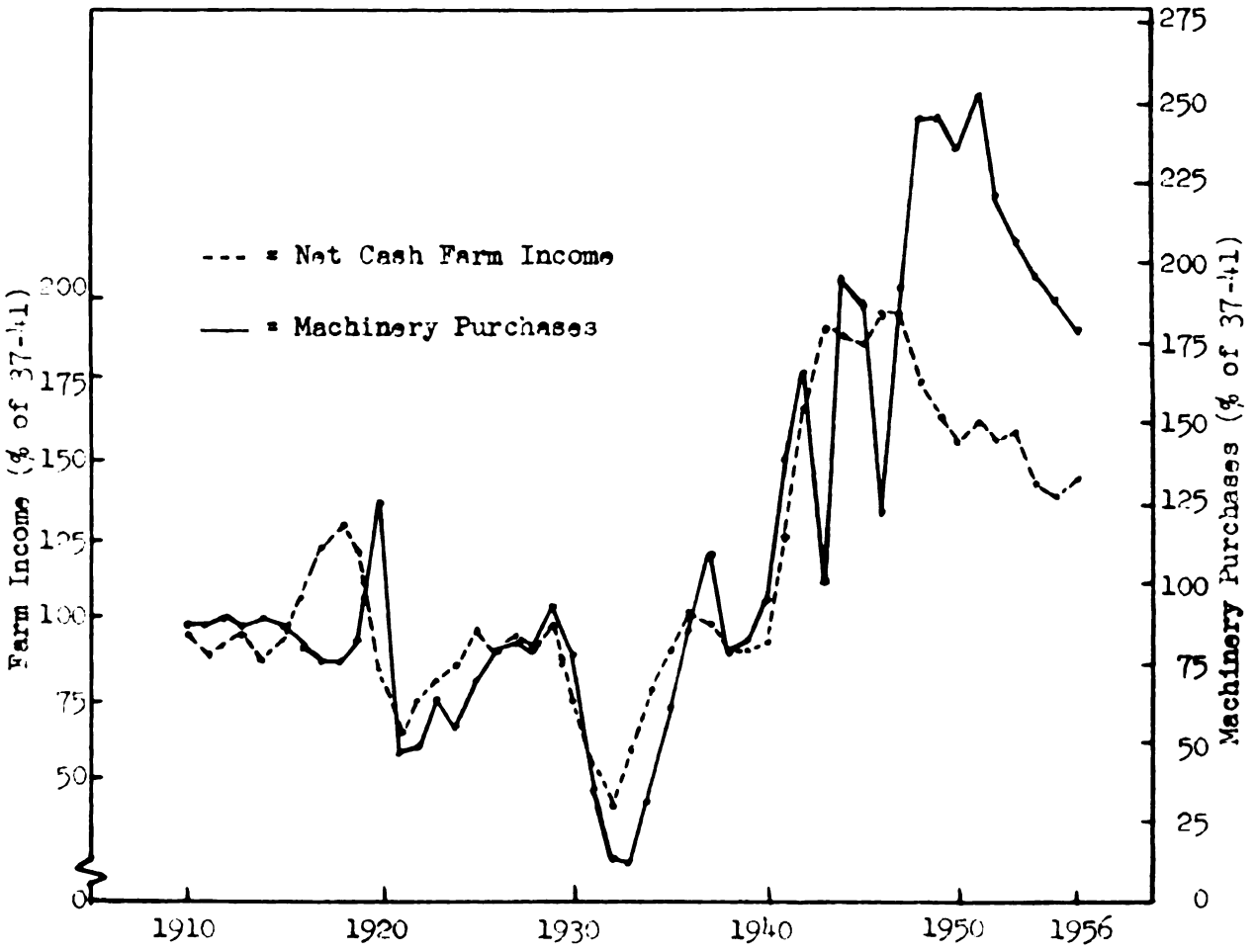
Recapitulation and Interpretation of Results

The results from the preceding groups of equations are summarized and interpreted from an overall standpoint under the heading of each independent variable. Emphasis is placed upon interpretations of differences in the relationships of variables over the business cycle that occurred in the analysis since this was the purpose of the investigation.

Farm income. The results from the fitted equations indicated that income changes during contractions are more closely related to machinery purchases than similar changes in expansions. Farm income changes may have a greater influence on machinery purchases during contractions because: (1) farmers may be more careful or pessimistic as a result of a general business decline and (2) credit may be harder to obtain with lower incomes, thus multiplying the effect of the income decline. We expect expenditures on machinery to be reduced as income is reduced; however, the reduction in expenditures appears to be more than proportional to income decreases, judging from the regression coefficients.

When both income of the current year and of the preceding year were used as variables, it was found that the previous year's income had consistent signs during contractions and inconsistent signs during expantions. Examination of the relation between farm income and farmers' expenditures on tractors and machinery in Figure 3.0 suggests that farmers reduce expenditures as a result of farm income decreases more rapidly (in the current year) than they increase expenditures as a result of farm income increases (involves a lag of about one year). While this phenomenon has not occurred in all cases of farm income increases and decreases, the relation does appear to have some degree of regularity.

Figure 3.0 - Machinery Purchases by Farmers Related to Net Cash Farm Income, United States, 1910-56.



Source: See Appendix II, Tables 1 and 3.

The relation found here could well be the reason for a positive coefficient for current farm income in contractions and a negative coefficient in expansions.

Since farm income was selected in part as a measure of the marginal efficiency of capital, why does a different relation hold between income increases and decreases and the rate of machinery purchase? Dillard gives a very plausible answer in this connection.

> The turning point from expansion to contraction is thus explained by a collapse in the marginal efficiency of capital. The change from an upward to downward tendency takes place suddenly, and in this respect differs from the turning point from contraction to expansion, which occurs more gradually and often imperceptibly.[2]

This appears to be a fairly substantial reason for the results obtained and the relation evident in Figure 3.0. The relation suggests that perhaps variables pertaining to direction of income change should be included in the analysis. Also involved would be investigation of the duration of such changes. Unfortunately, no systematic approach exists for the treatment of variables of this nature. Using such variables requires specific assumptions which might prove incorrect. This would, of course, lead to classifications which are incorrect since other classifications would fit the case equally well. Since no systematic method of examining the results of alternative classifications has been developed, no attempts at including variables dealing with direction and duration have been made.

Capital gains and losses. Indications from the fitted equations suggest that capital gains and losses were associated with machinery purchases during expansions, but that capital gains and losses were not as

---

2. Dillard, op. cit., p. 270.

closely related to machinery purchases during contractions. Figure 3.1 shows the relation between capital gains and losses and machinery purchases plotted over time. This relation exhibits a lag of about one year between the capital gain or loss which leads machinery purchases. The results from the fitted equations also indicated this relation. The relation in Figure 3.1 appears to have been closer before World War II than since, but the relation between the previous year's capital gain and the current year's machinery purchase has still moved generally in the same direction. This may be caused by a reduction in the importance of external credit as a source of capital formation since the war, for income and savings accumulated during the war period may have been more important.[3]

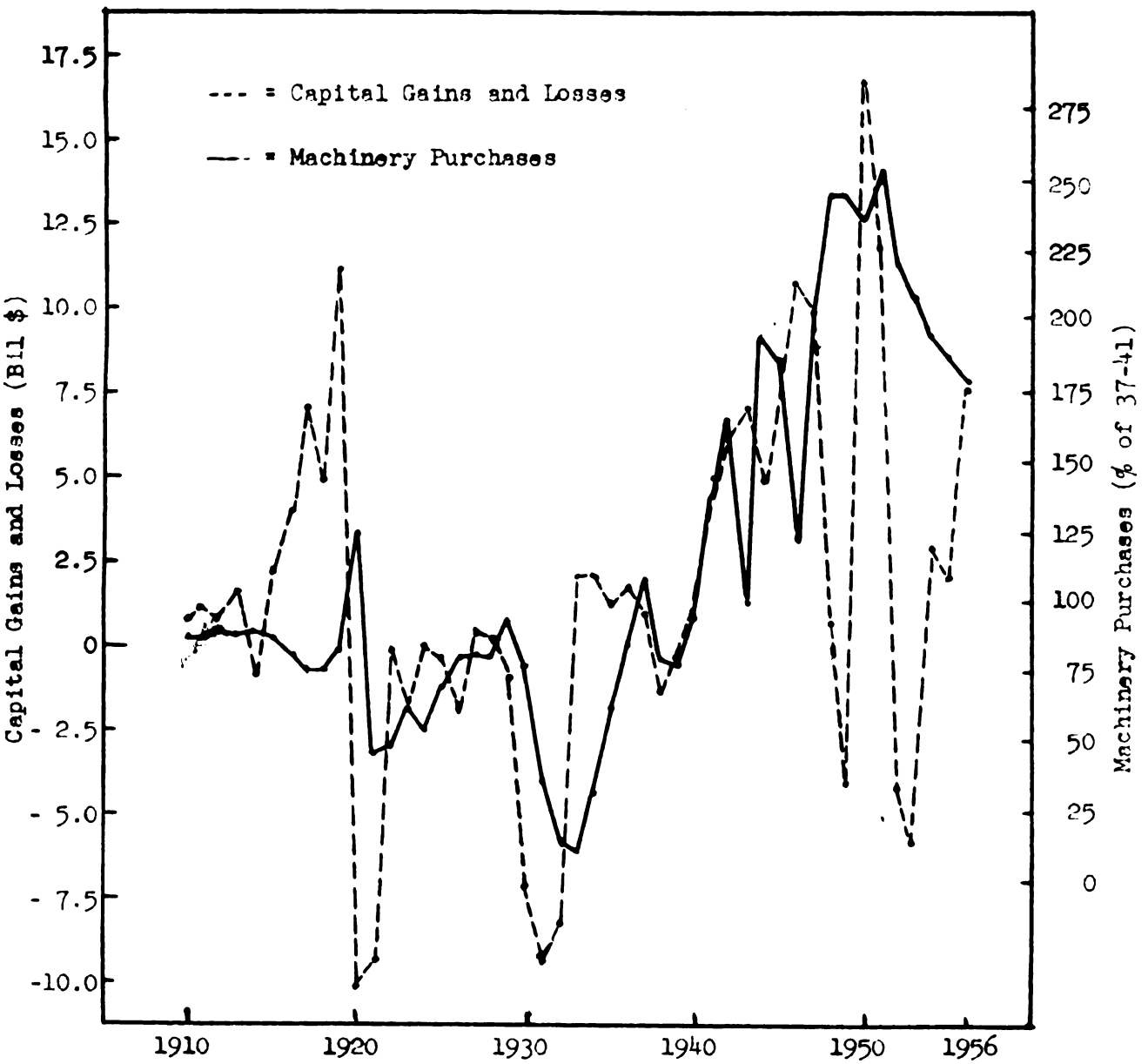
The regression coefficients were, in some cases, significantly different from zero, particularly in expansions, and were not significantly different from zero during contractions. This could be caused by one of two things; either capital gains were not important in machinery purchases, or the measure of capital gains used was not accurate enough. There does not appear to be any particular reason for favoring either of these causes over the other. In general, however, more support is marshalled for the hypothesis that capital gains and losses have been important during expansions with respect to machinery purchases than the hypothesis that capital gains and losses have been important during contractions in influenging machinery purchases.

Since capital gains and losses are of the "paper" variety, and as such are not realized as income by those who hold properties on which they

---

3. In this regard, see Tostlebe, Alvin S., Capital in Agriculture: Its Formation and Financing since 1870, a study by the National Bureau of Economic Research, Princeton, University Press, 1957, pp. 144-153.

Figure 3.1 - Machinery Purchases by Farmers Related to Capital Gains and Losses in Holding Real Estate, Crops, and Livestock, United States, 1910-56.



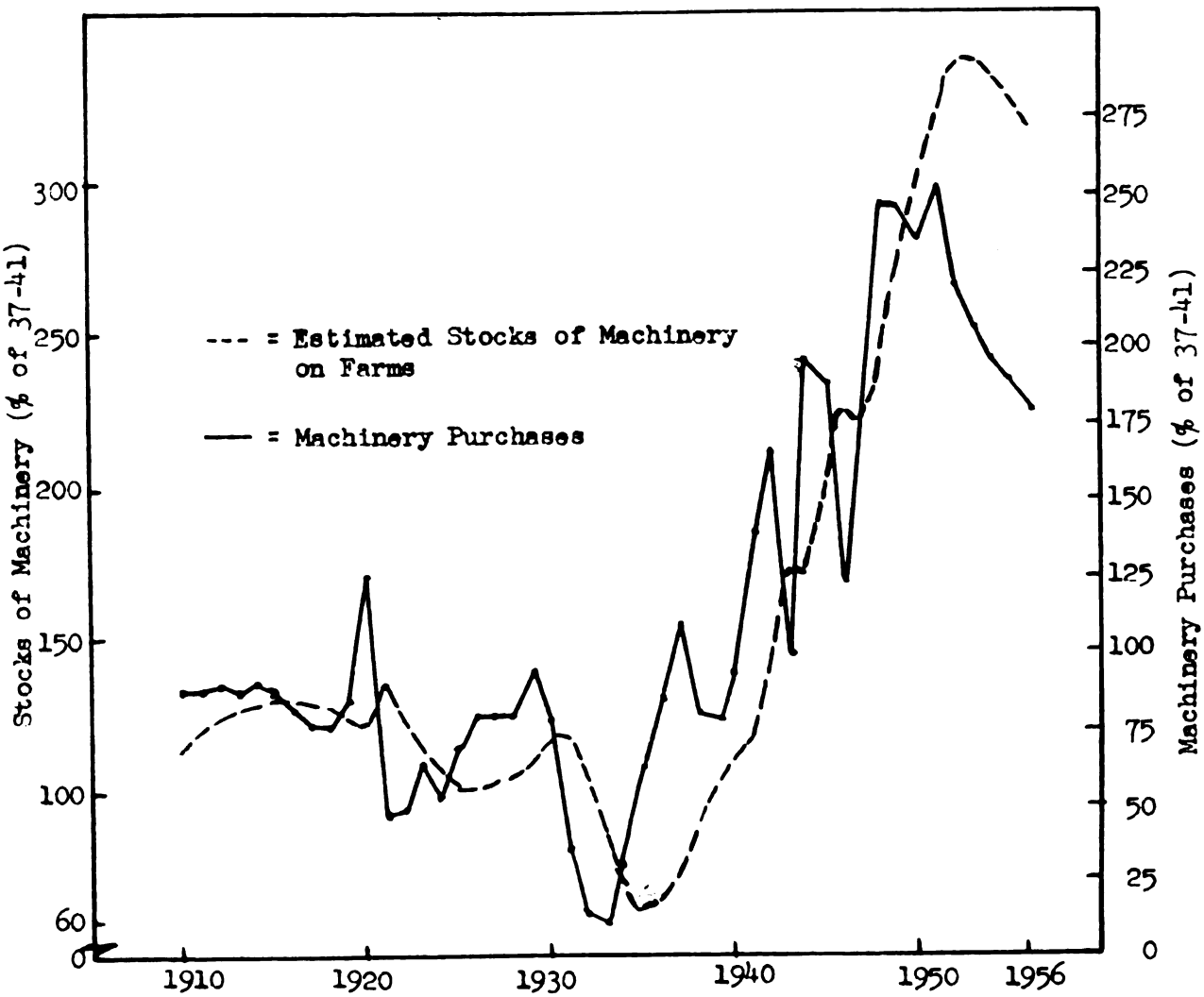
Source: See Appendix II, Tables 1 and 4.

accrue, there may be some degree of "money illusion" in such gains. This observation is suggested by the improved results from using capital gains in current dollars rather than in deflated (constant) dollars. Why should this illusion operate in connection with capital gains? Equity positions of farmers are in money terms; thus a $10,000 mortgage on a $20,000 holding seems very serious both to the farmer and to financial institutions. However, let the value of this property increase to $30,000 through price level increases, and the $10,000 mortgage does not appear to be nearly so serious. As a result of the capital gain, the farmer is more likely to use more credit which is now more available. If capital gains are truly nonsignificant in the determination of machinery purchases, perhaps the nonsignificant regression coefficients of equations one and two in Group III which used deflated capital gains are the correct answer. Conversely, capital gains and losses, more accurately measured, may be of more importance than indicated by the results. It appears that this is an area which should be investigated in greater detail.

Stocks of machinery on farms. The results from the use of the stocks of machinery variable in the first group of equations have been interpreted in that section as a reflection of the influence of new technology in agriculture. The relation between estimated stocks of machinery and machinery purchases as shown in Figure 3.2 has been close by definition.

Technological advances have continued over the period studied, thus overpowering the relationship between stocks of machinery on hand and machinery purchases. The influence of technology on the coefficients of the stock variable appeared to be greater in expansions than in contractions. Since the time variable was included in later analyses to obtain a measure of the relationship between technological trend and machinery

Figure 3.2 - Machinery Purchases by Farmers Related to Estimated Stocks of Machinery on Farms, United States, 1910-56.



Source: See Appendix II, Tables 1 and 5.

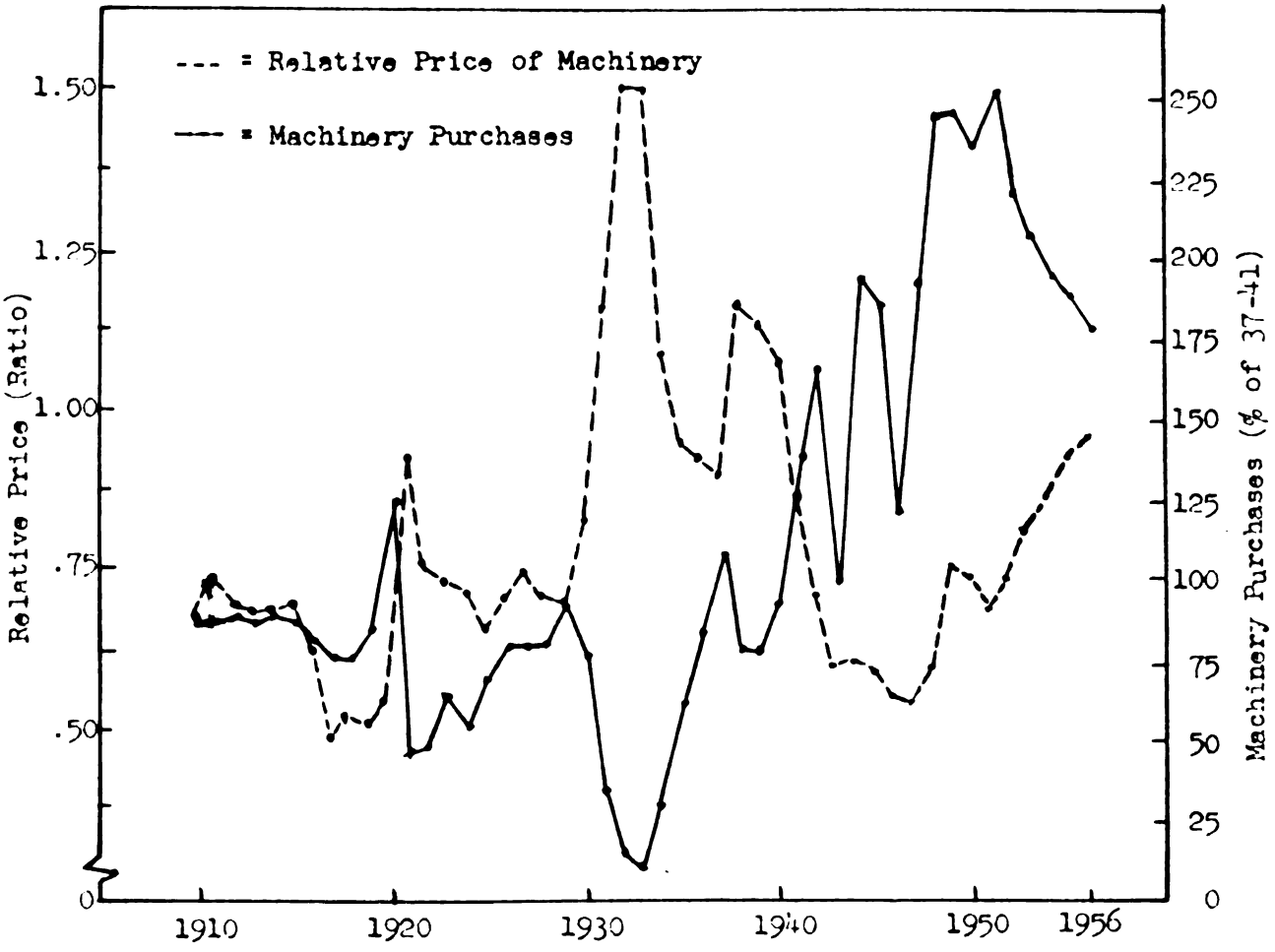
purchases, further discussion of the stocks variable appears to be superfluous.

The "real" price of machinery. The use of the price of machinery relative to prices received by farmers resulted in the conclusion that this variable is associated with machinery purchases in contractions and in expansions in about the same manner. In the first group of equations, the relative price of machinery appeared to be of more importance in contractions. This tendency was not produced in all of the equations of the group, however. In Group III, the regression coefficients were inconsistent in sign. This inconsistency was cleared up for some reason by the inclusion of the time variable in Group VI. Inclusion of the time variable did not affect either the sign or magnitude of other variables included in the equations, however. The regression coefficients in Group IV indicated no pattern of consistency in greater magnitude for either contraction or expansion.

Figure 3.3 shows the relation between the relative price of machinery and machinery purchases plotted over time. The relationship appears to be a quite consistent inverse one, with purchases of machinery rising and falling as the relative price of machinery falls and rises respectively. From the findings of the analysis, it appears that farmers respond to changes in the relative price of machinery in a similar manner in contractions and expansions.

The "real" price of labor. In each of the groups of equations, the price of labor relative to the price of machinery had regression coefficients for contractions that were inconsistent and significently different from zero and regression coefficients for expansions that were either positive or negative and nonsignificant from zero. These results indicate

Figure 3.3 - Machinery Purchases by Farmers Related to the Relative Price of Machinery, United States, 1910-56.



Source: See Appendix II, Tables 1 and 6.

that there is a possible substitution of machinery for labor in expansions, although the results were not significant, statistically. On the other hand, in contractions, there are influences present that are not conducive to this substitution. This may be explained in part by the magnitude of the outlay that must be made for machinery as contrasted to hired labor, i.e., machinery purchases require a much greater outlay than labor, thus committing more resources and increasing the dangers of illiquidity.

Another possible explanation for the apparent lack of substitution of machinery for labor in contractions is that since the marginal efficiency of capital is low, machinery is not purchased, and, in addition, neither is labor hired. Checking this hypothesis requires aggregative labor input data in a form not now available.

The price of hired farm labor relative to the price of machinery is related to machinery purchases over time in Figure 3.4. The contractions other than 1921 and the early 30's appear to be quite important in the formation of the regression coefficients since these two periods appear to display a direct relationship in Figure 3.4.

While the relative price of labor and farm income are intercorrelated, it is doubtful if the intercorrelation distorts the results with this variable so seriously. Exclusion of the relative price of labor from some of the equations did not appear to alter the results of farm income significantly, hence we would not expect the results of the relative price of labor to be changed significantly if income were dropped from the formulations.

Further interpretation of the results obtained from the use of the relative price of hired farm labor is deemed necessary. In Cromarty's investigation of the demand for farm tractors and machinery, a negative

Figure 3.4 - Machinery Purchases by Farmers Related to the Relative Price of Farm Labor, United States, 1910-56

Source: See Appendix II, Tables 1 and 7.

regression coefficient for the relative price of farm labor was obtained, corresponding with the results obtained in this study. Here, negative coefficients were obtained for contractions and nonsignificant positive coefficients were obtained for expansions. Cromarty interpreted the negative coefficient as being the result of the price of hired farm labor being an endogenous, rather than independent, variable. This in effect means that the relative price of hired farm labor is not important in the substitution of machinery for labor, other influences being much more important. On this basis, he used the industrial wage rate as a variable, to get the effect of higher nonfarm wages (thus attracting labor from farms) on farm machinery purchases. In this case he obtained consistent results.[4] An observation in connection with the importance of the relative price of hired labor in machinery purchases appears appropriate. Suppose a farmer has a tractor and other tractor powered machinery on his farm. Now suppose the price of hired labor decreases relative to the price of machinery. The farmer would be more likely, it appears, even under these conditions to buy, say, a cultivator for the tractor, than to hire labor to work in its place.

It should be pointed out that hired labor has probably not been the important part of the farm labor force, family labor being considered much more important. Thus, we cannot expect to obtain the important part of machinery - labor substitution by looking only at hired labor prices. As previously mentioned, employment opportunities in the nonfarm economy are probably very important in the movement of both hired and family labor from the farm. These opportunities are in turn closely related to the classification of expansion and contraction used in this study. Thus, we

---

4. Cromarty, op. cit.

expect the greatest movement of labor from the farm during expansions and hence the greatest substitution of machinery for labor during those times.

Time as a variable. One of the features which has characterized American agriculture has been the rapid development of new technology. Technological advances become available for adoption as they are discovered over time. However, adoption is not automatic -- conditions must be favorable for adoption to take place. These conditions are considered to be more favorable in expansions than in contractions.

To obtain a measure of the relationship between the "trend" of technological development and farm tractor and machinery purchases, the time variable was introduced into the formulations in Group IV. The result from this addition was that the regression coefficient for expansions was larger and significantly different from the regression coefficient for contractions. Thus, it appears that the effect of technological development has been greater in expansions than in contractions, meaning that these have been the periods when new technologies were adopted because of conditions present. This result lends credence to the hypothesis that the rate at which new inputs are purchased varies over the business cycle, indicating that inputs in agriculture are added at a faster rate during business expansions than during business contractions. It suggests the presence of new technology has had a much greater influence during expansions when conditions have lead to better expectations of the future and the means of purchase were available.

Expenditures versus shipments. The question of which is more appropriate dependent variable -- expenditures on machinery by farmers, or machinery shipments to dealers -- should be resolved.

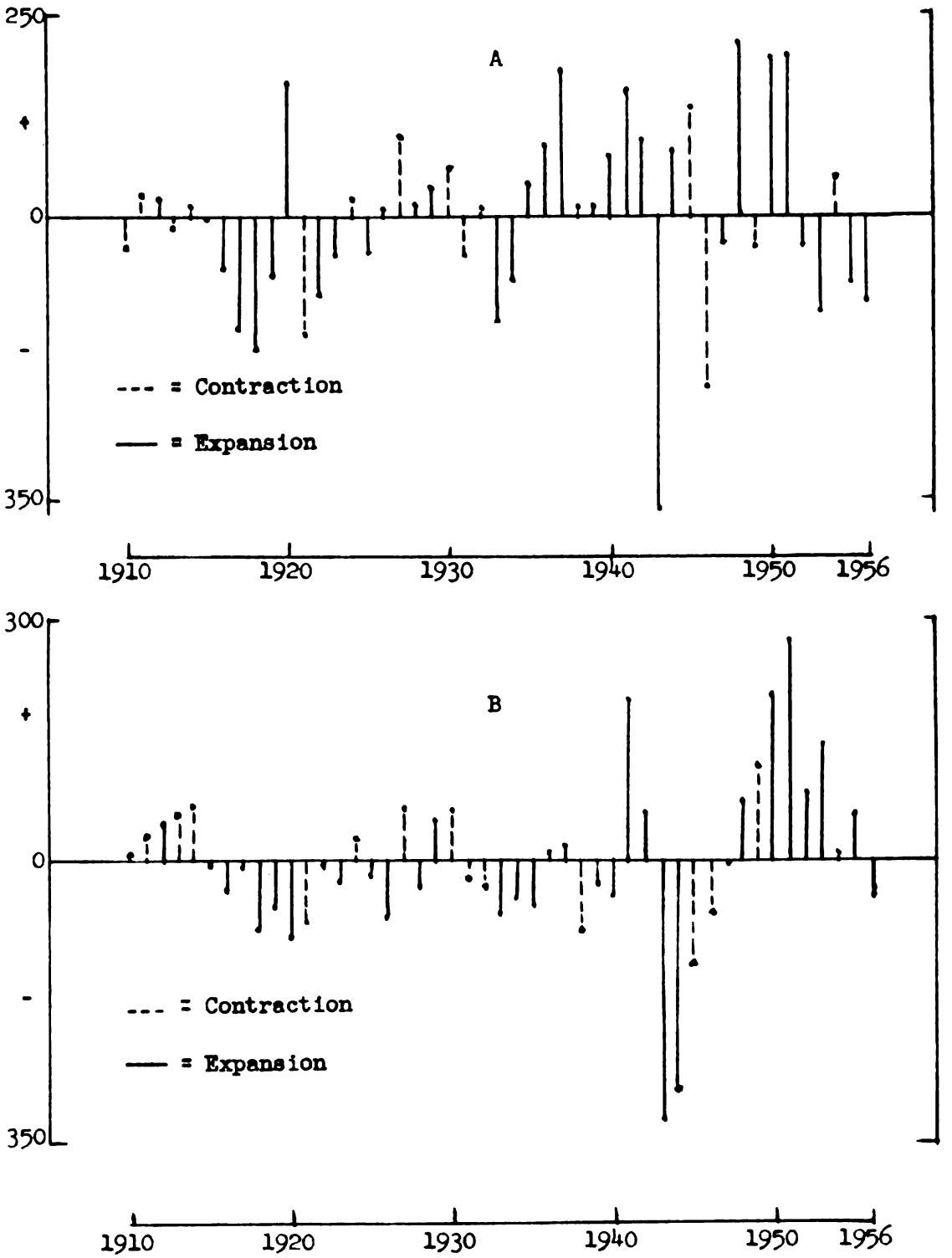
In the fitted equations, there were four sets of equations, each set including the same independent variables. One of each set had expenditures as the dependent variable, while the other had shipments as the dependent variable. The results of these equations were very similar whether fitted with expenditures or shipments. From this we may conclude that either is equally good for our purposes. This is what we would expect from appendix Tables 1 and 2 which show that these two series move closely together over time.

Variation in the unexplained residual. The use of the model employing synthetic variables was based upon the assumption that the error term or unexplained residual of predicted from actual machinery purchase was from the same distribution in contractions and expansions. That is to say, the unexplained residual for contraction years was assumed not to differ in magnitude in a regular pattern from the unexplained residual for expansion years. Due to the enormity of the task of computing the residuals for each of the fitted equations, it was decided that only a limited number of equations should be examined in this regard. It was felt that the residuals of the equations which were examined gave a fair indication of the results of the other equations. Equations from Groups I, III and IV were selected for this purpose. No equation was selected from Group II because the formulations there were not investigated extensively for reasons given when that group was discussed.

The residuals from equation one, Group I, are given in Figure 3.5 (A). The residuals for contractions do not appear to differ in a regular pattern in magnitude from those for expansions in this equation. There does appear to be some relation between these residuals and time. Time as a variable was not included in this equation, it will be remembered.

Figure 3.5 - Unexplained Residuals (Mil $)

A. Equation 1, Group I B. Equation 4, Group III



The greatest deviation, as in the residuals of other equations that were plotted, was in 1943 when there were serious wartime shortages.

Figure 3.5 (B) gives the residuals from equation four, Group III. These residuals appear to demonstrate a cyclical behavior and were not considered to be random from the pattern they displayed. The cyclical pattern of these residuals indicate that the formulation in this case was not satisfactory.

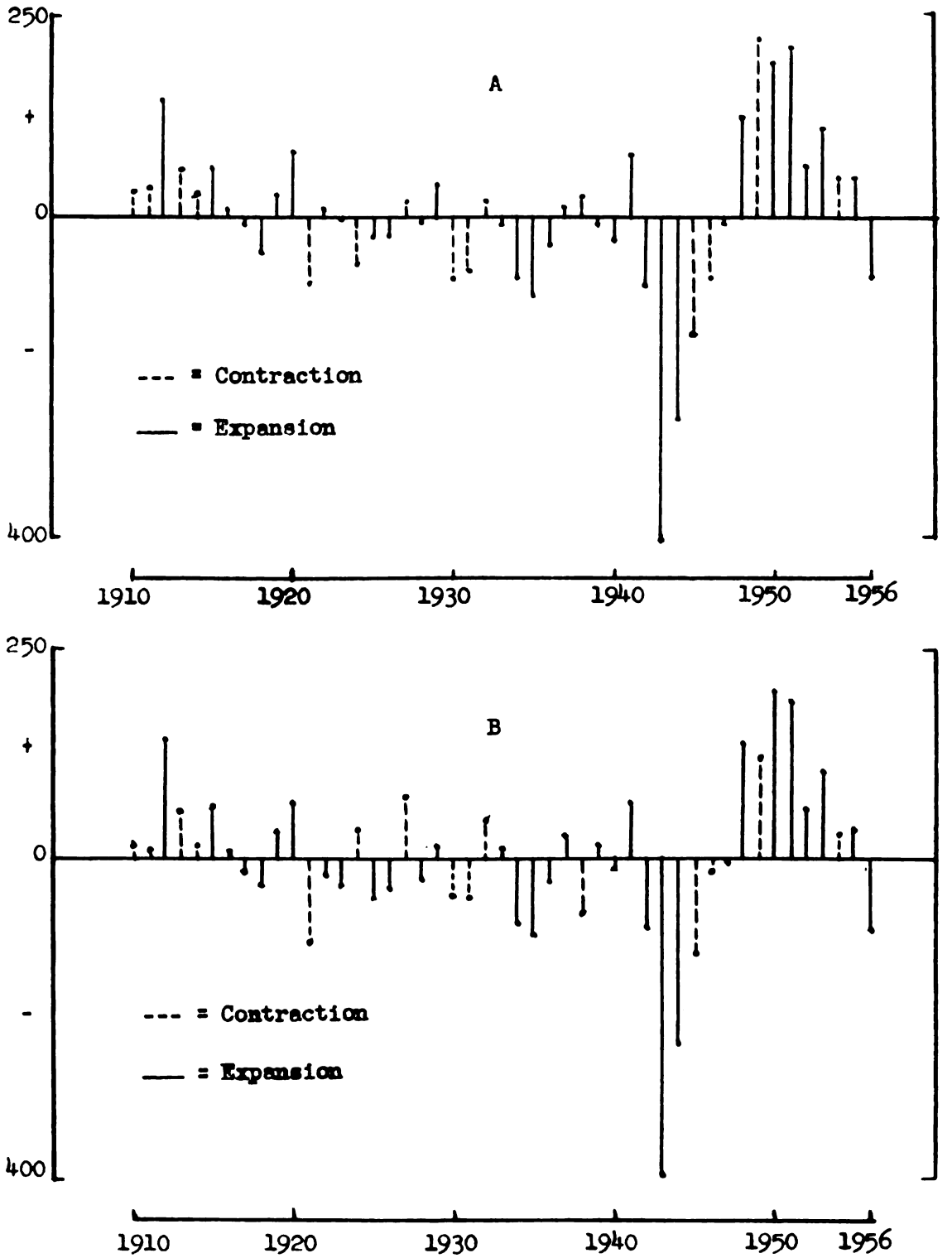
The residuals from equation six, Group IV, are given in Figure 3.6 (A). The residuals in this case appear to be more random in nature, and there does not appear to be a consistent difference in the magnitude of contraction year residuals as compared to expansion year residuals. Purchases were over-estimated during the war years when there were shortages and under-estimated after the war when backlogs of machinery orders existed.

Figure 3.6 (B) gives the residuals from equation five, Group IV, which was the same as equation six when the relative price of labor added. Residuals for contractions are of about equal magnitude as those for expansions in this equation. The distribution of residuals appears to be fairly random with over-estimation occurring during the war and under-estimation following the war.

In general, from the inspection of these residuals, it appears that the assumption necessary for the use of the model employed in this study was valid; the residuals for contractions do not appear to be of different magnitude from those for contractions. Addition of the time variable in Group IV improved the pattern of the residuals considerably from Group I and Group III, further indicating the usefulness of the time variable.

Figure 3.6 - Unexplained Residuals (Mil $)

A. Equation 6, Group IV B. Equation 5, Group IV



CHAPTER IV

SUMMARY AND CONCLUSIONS

The study was developed to determine if different relationships exist between variables associated with farmers' purchases of tractors and machinery and these purchases during different phases of the business cycle. The period of time included in the investigation covered the years 1910 through 1956. Twenty equations in all, linear in the original variables, were fitted by least squares techniques in the four groups of equations examined in the analysis. The single equation models were constructed with the use of synthetic variables so that relationships of variables during contractions could be compared with the relationships of corresponding variables during expansions. Using such models, it was possible to obtain indications of the differences in the relationships between the independent variables and machinery purchases during expansions and contractions of the general economy.

The results of the analysis indicated that the relationships between variables have differed in different phases of the business cycle. With respect to each independent variable, these differences may be summarized as follows:

1. Changes in farm tractor and machinery purchases appear to have a closer relationship with changes in farm income in contractions than in expansions. Regression coefficients for the income variable during contractions were consistently larger than those for expansions. The results also suggest farm income has been of major importance in financing new capital investment in recent decades.

2. Farm tractor and machinery purchases appear to be related to capital gains and losses during expansions, but the statistical results failed to support the hypothesis that these purchases are associated with capital gains and losses during contractions. The relation between capital gains and losses and farm tractor and machinery purchases appears to have been closer in years prior to World War II than since. This suggests that perhaps external credit sources have played a less important role in agricultural capital formation after the war than prior to that time. While this may be the case, there is not reason for assuming that external sources will continue to be less important than internal sources of finance.

3. The stock of machinery on farms as used in this study is admittedly a rough approximation, at best. Results indicated that "technological trend" has overpowered the relation of this variable with farm tractor and machinery purchases. This appears to be the case, more so in expansions than in contractions.

4. Regarding the "real" price of machinery, the results did not reveal a consistent difference in the relationship during contractions as compared to expansions. The results from the first group of equations suggested that this variable is more closely related with machinery purchases during contractions; however, results from other groups did not display this consistency. The series, when plotted, indicated the relation has been consistently inverse. When one assesses these findings, the conclusion which appears to be most tenable is that the relationship during expansions and contractions has been approximately the same.

5. There was a significant difference between the regression coefficient for the relative price of hired farm labor during contractions and expansions. However, the sign of the coefficient for contractions was

inconsistent and the coefficient significant, while the coefficient for expansions was consistent in sign but nonsignificant. Thus, the hypothesis that the relative price of hired farm labor has been important in machinery-labor substitution was not supported by these findings. However, hired labor probably has not been the important part of the labor involved in machinery-labor substitution.

6. The time variable, insofar as it reflects the development of technology for use in agriculture, indicates that farm tractor and machinery purchases during expansions have been more closely related to the presence of new technology than during contractions. New technology appears to have been adopted at a faster rate during expansions than during contractions.

The classification used in this study appears to be useful since consistent differences in the relationships of variables were found in the analysis. Apparently farmers do respond differently to certain changes during different phases of the nonfarm business cycle. This appears to be particularly so in the case of technological development, as represented by calendar time, and the results in the cases of income and capital gains displayed consistent differences between contractions and expansions. There was a statistically significant difference between the regression coefficients for the relative price of hired farm labor in expansions and contractions. However, it does not appear that the price of hired farm labor relative to the price of farm tractors and machinery is an important factor in the purchase of farm machinery and tractors. This conclusion in itself is important, but the significant difference between contractions and expansions does not appear to be an important finding. In total, it does appear the relationships between variables

have not been the same during expansions and contractions from the findings of this study.

Reference cycles of the general economy developed by the National Bureau of Economic Research, along with changes in gross national product, were used in making the classification. Thus, periods of contraction and periods of expansion are in terms of the general economy rather than in terms of agriculture itself. Upswings and downswings in the farm economy have not always been concurrent with similar changes in the nonfarm economy. This suggests the need for the development of reference cycles for the farm economy based upon series in agriculture similar to those used in developing series for the general economy. Then, using these as a basis for classification, it would be possible to investigate the response of agricultural producers to changes in variables in upswings and downswings in the farm economy to determine if the reactions of agricultural producers during contractions were different from those made during expansions. It appears that this method would give clues to whether reactions of farmers during periods of contraction were reversals of the actions taken during expansion periods. This, of course, refers to the non-reversible nature of the supply curve for agriculture which has been discussed at several points in recent literature. Much of the success of using this method in an overall sense will depend upon ability to measure input flows into and out of agriculture, which is a very difficult problem in itself. In the case of tractors and machinery, flows out of agriculture were assumed to be negligible because of their low salvage value outside of agriculture.

There is also a need to develop methods of examining alternative classifications in doing studies of this nature; so that the most useful

classification, in terms of the purpose of the study, is selected. For example, the farm income variable appears to exhibit a lag in expansions from contraction periods, but not in contractions from expansion periods. The classifications, then, would have to deal with direction and duration of the change being classified.

The results from the use of the method outlined in this study suggest that the use of time series analysis in the usual manner may tend to mask the difference in relationships between independent and dependent variables during expansions and contractions and that perhaps some of these relationships should be re-examined in this regard. However, limitations of form and accuracy of data encountered in conventional time series methods are not alleviated here. In addition, particularly when only a small number of observations are available, the use of twice as many variables makes statistically significant results harder to obtain because of the literal "burning up" of degrees of freedom. This latter point may be compensated in part by closer fits from using "split variables" although this aspect was not checked in this study.

It should be recognized that the relationships analyzed in this study are associations between variables as they have been estimated to occur over time. Thus, the findings fall short of the most desired goal -- that of determing cause-effect relationships. However, limitations as to a suitable theory to use in this regard, along with accurate data to test the theory, make the determination of the lines of causality impossible to achieve. These problems are inherent in investigations of this nature; hence, these shortcomings are by no means unique to this study.

The demand models used in this analysis are admittedly naive in nature and probably far too simplified. This is probably particularly

true with respect to expectations of the future which agricultural producers hold, represented by farm income, primarily, in this study. However, there are no apparent reasons why the techniques used in this study cannot be applied to more refined models in investigations of agricultural producers responses during different phases of the business cycle.

BIBLIOGRAPHY

Ackley, Gardner, An Introduction to Macroeconomic Theory, preliminary edition for student use, Gardner Ackley, University of Michigan, Sept. 1957.

Bradford, L. A. and Johnson, G. L., Farm Management Analysis, Wiley and Sons, Inc., New York, 1953.

Burk, Marguerite, "Studies of the Consumption of Food and Their Uses," Journal of Farm Economics, Vol. 38, 1956.

Burns, Arthur F., and Mitchell, Wesley C., Measuring Business Cycles, National Bureau of Economic Research, New York, 1947.

Cromarty, William A., The Demand for Farm Machinery and Tractors, Agricultural Experiment Station, East Lansing, Technical Bulletin (In Process).

Dillard, Dudley, The Economics of J. M. Keynes, Prentice-Hall, Inc., New York, 1948, p. 142.

Economic Statistics Bureau of Washington, D.C., Handbook of Basic Economic Statistics, July 15, 1958.

Federal Reserve Bank of San Francisco, Monthly Review, July 1956.

Goldsmith, Raymond W., A Study of Saving in the United States, Vol. 1 Princeton University Press, 1955.

Goulden, Cyril H., Methods of Statistical Analysis, Wiley, New York, 1952

Hathaway, Dale E., "Agriculture and the Business Cycle", Policy for Commercial Agriculture, Its Relation to Economic Growth and Stability, Joint Economic Committee Print, November 22, 1957.

Johnson, Glenn L., "Allocative Efficiency of Agricultural Prices -- As Affected by Changes in the General Level of Employment", unpublished doctor of philosophy dissertation, Department of Economics, University of Chicago, 1949.

_____. "Sources of Expanded Agricultural Production" in Policy for Commercial Agriculture, Its Relation to Economic Growth and Stability, Joint Economic Committee Print, November 22, 1957.

_____. "Supply Function - Some Facts and Notions", Agricultural Adjustment Problems in a Growing Economy, edited by Heady, et al., Iowa State College Press, 1958.

Kalecki, M., "The Principle of Increasing Risk", Economics, New Series Vol. IV, 1937.

Keynes, J. M., The General Theory of Employment, Interest and Money, Harcourt, Brace and Company, 1935.

Koopmans, T. C., "Measurement Without Theory", Review of Economic Statistics, Vol. XXIX, No. 3, Aug. 1947.

Mills, Fredrick C., Introduction to Statistics, Henry Holt Company, New York, 1956.

Morelle, Wilellyn, "Interest Rates on Farm Loans", Farm Loans at Commercial Banks, Board of Governors of the Federal Reserve System, Washington, D. C., 1957.

Nerlove, Marc, Distributed Lags and Demand Analysis for Agricultural and Other Commodities, Agriculture Handbook No. 141, AMS, USDA, June, 1958.

Schultz, Theodore W., Agriculture In An Unstable Economy, McGraw-Hill, New York, 1945.

Shackle, G. L. S , Uncertainty in Economics, Cambridge University Press, 1955.

Siegel, Irving H., "Technological Change And Long-Run Forecasting", The Journal of Business of The University of Chicago, Volume 26, July, 1953.

Snedecor, George W., Statistical Methods, The Iowa State College Press, Ames, Iowa, 1956.

Theil, H., Linear Aggregation of Economic Relations, North-Holland Publishing Company, Amsterdam, 1954.

Thomsen, F. L. and Foote, R. J., Agricultural Prices, McGraw-Hill, New York, 1952.

Tostlebe, Alvin S., Capital in Agriculture: Its Formation and Financing since 1870, a study by the National Bureau of Economic Research, Princeton, University Press, 1957.

United States Department of Agriculture, Balance Sheet of Agriculture, Agricultural Research Service, Washington, 1951-57 annual issues.

_____. Farm Income Situation 164, Agricultural Marketing Service, July 1957.

_____. Farm Real Estate Market, Agricultural Marketing Service, July 1956.

United States Department of Agriculture, Income Parity for Agriculture, Part II - Expenses of Agricultural Production, Sec. 3, Washington, 1940.

_____. Major Statistical Series of the U. S. Department of Agriculture, Vol. 3, Gross and Net Farm Income, Agriculture Handbook, No. 118, December 1957.

United States Government Printing Office, Economic Report of the President, Washington, 1957.

Wilcox, W. W., and Cochrane, W. W., Economics of American Agriculture, Prentice-Hall, 1951.

APPENDIX I

STATISTICAL TEST OF SIGNIFICANT DIFFERENCE BETWEEN CORRESPONDING REGRESSION COEFFICIENTS

TEST OF SIGNIFICANT DIFFERENCE BETWEEN CORRESPONDING REGRESSION COEFFICIENTS

The regression coefficients for corresponding variables were tested for significant difference by using the test statistic:

$$t = \frac{bi - bj}{S\sqrt{s^{ii} + s^{jj} - 2s^{ij}}}$$

where the i th and j th regression coefficients are for corresponding variables in contraction and expansion years, S is the standard error of the estimate, and $_s ij$ is an element of the inverse matrix $(sij)^{-1}$, moments being defined as:

$$s_{ij} = \sum_{n=1}^{N} Xin \; Xjn \; .$$

the appropriateness of the elements under the radical was derived from the expected value:

$$E\left[(bi - \beta i) - (bj - \beta j)\right]^2 =$$
$$E\left[(bi - \beta i)^2 + (bj - \beta j)^2 - 2(bi - \beta i)(bj - \beta j)\right]$$

where βi and βj are the true regression coefficients. This test is given in Snedecor.[1] Also included in Snedecor's book is a discussion of elements of an inverse matrix.[2]

---

1. Snedecor, George W., Statistical Methods, The Iowa State College Press, Ames, Iowa, 1956, p.442.

2. Ibid., pp.438-441. See also in this regard, Goulden, Cyril H., Methods of Statistical Analysis, Wiley, New York, 1952, Chapter 8.

APPENDIX II

TIME SERIES USED IN THE ANALYSIS

TABLE 1 - EXPENDITURES ON FARM TRACTORS AND MACHINERY, U.S., 1910-56

Year	Gross expenditure current Mil.$ (1)	Index of machinery and tractor prices (1937-41=100) (2)	Machinery purchases (3)	Year	Gross expenditure current Mil.$ (1)	Index of machinery and tractor prices (1937-41=100) (2)	Machinery purchases (3)
1910	264	64.5	409	1934	135	90.5	149
1911	265	64.5	411	1935	278	94.6	294
1912	269	64.5	417	1936	383	97.5	393
1913	263	64.5	408	1937	504	100.1	504
1914	272	64.5	422	1938	389	104.0	374
1915	272	66.5	409	1939	366	99.1	369
1916	267	69.7	383	1940	438	99.5	440
1917	282	79.4	357	1941	649	99.8	650
1918	359	100.0	359	1942	816	104.8	779
1919	406	103.2	393	1943	499	106.9	467
1920	629	107.1	587	1944	1,016	111.3	913
1921	229	103.2	222	1945	990	113.3	874
1922	214	92.3	232	1946	685	119.5	573
1923	289	96.0	301	1947	1,244	137.6	904
1924	243	96.0	253	1948	1,820	158.9	1,145
1925	314	96.2	326	1949	2,022	176.1	1,148
1926	357	96.5	370	1950	1,957	178.0	1,099
1927	366	96.9	378	1951	2,270	192.0	1,182
1928	364	96.6	377	1952	2,033	196.8	1,033
1929	421	95.9	439	1953	1,890	195.7	966
1930	351	96.1	365	1954	1,793	197.5	908
1931	156	94.2	166	1955	1,778	200.8	885
1932	61	90.0	68	1956	1,722	208.1	827
1933	59	97.8	60				

Source: Col. 1, Farm Income Situation 164, July, 1957, Table 19, p.36. Col. 2, 1910-1922, Policy for Commercial Agriculture, op. cit., Table C-9, p. 853, 1923-56, AMS Constructed Index for Retail Tractor and Machinery Prices, from the files of William Cromarty, Agricultural Economics Department, M.S.U.. Col. 3, Col. 1 divided by Col. 2.

TABLE 2 - TRACTOR AND MACHINERY SHIPMENTS TO DEALERS, U.S., 1910-56

Year	Shipments current Mil.$ (1)	Index of tractor and machinery prices (1937-41=100) (2)	Shipments (3)	Year	Shipments current Mil.$ (1)	Index of tractor and machinery prices (1937-41=100) (2)	Shipments (3)
1910	207	64.5	381	1934	221	90.5	244
1911	212	64.5	389	1935	272	94.6	288
1912	237	64.5	427	1936	366	97.5	375
1913	231	64.5	418	1937	463	100.1	463
1914	217	64.5	396	1938	384	104.0	369
1915	196	66.5	355	1939	379	99.1	382
1916	196	69.7	341	1940	387	99.5	389
1917	261	79.4	389	1941	535	99.8	536
1918	342	100.0	402	1942	512	104.8	489
1919	437	103.2	483	1943	296	106.9	277
1920	530	107.1	555	1944	546	111.3	491
1921	177	103.2	232	1945	606	113.3	535
1922	173	92.3	247	1946	718	119.5	601
1923	298	96.0	310	1947	1,082	137.6	786
1924	263	96.0	274	1948	1,453	158.9	914
1925	329	96.2	342	1949	1,492	176.1	847
1926	346	96.5	359	1950	1,496	178.0	840
1927	366	96.9	378	1951	1,852	192.0	965
1928	376	96.6	389	1952	1,589	196.8	807
1929	420	95.9	438	1953	1,471	195.7	752
1930	290	96.1	302	1954	1,229	197.5	622
1931	195	94.2	207	1955	1,402	200.8	698
1932	167	90.0	186	1956	1,173	208.1	564
1933	153	97.8	156				

Source: Col. 1, 1910-22, Income Parity for Agriculture, Part II - Expenses of Agriculture Production, Sec. 3, U.S.D.A., Washington, D.C., 1940, Table 28, p.65 adjusted to 1923-56 estimates by adding the mean difference between the series for 1923-30 which is 60; 1923-56 reproduced from Fact for Industry from the files of William Cromarty, Agricultural Economics Department, M.S.U. Col. 2, same as for Col. 2, Table 1. Col. 3, Col. 1 divided by Col. 2.

TABLE 3 - NET CASH FARM INCOME, U.S., 1910-56

Year	Farm income Mil.$ (1)	Prices paid by farmers (1937-41=100) (2)	Income Mil.$ (3)	Year	Farm income Mil.$ (1)	Prices paid by farmers (1937-41=100) (2)	Income Mil.$ (3)
1910	3,740	76.4	4,895	1934	3,718	94.5	3,934
1911	3,535	77.2	4,579	1935	4,418	97.6	4,527
1912	3,776	79.5	4,750	1936	5,074	97.6	5,199
1913	3,890	79.5	4,893	1937	5,267	103.1	5,109
1914	3,648	81.1	4,498	1938	4,471	97.6	4,581
1915	3,967	82.7	4,797	1939	4,621	96.9	4,769
1916	4,945	91.3	5,416	1940	4,629	97.6	4,743
1917	7,310	116.5	6,275	1941	6,750	104.7	6,447
1918	9,058	136.2	6,651	1942	10,164	119.7	8,491
1919	9,690	155.1	6,248	1943	13,252	134.6	9,845
1920	7,268	168.5	4,313	1944	13,825	143.3	9,648
1921	3,937	122.0	3,227	1945	14,186	149.6	9,482
1922	4,396	118.9	3,697	1946	16,342	163.8	9,977
1923	5,123	125.2	4,092	1947	18,979	189.0	10,042
1924	5,509	126.0	4,372	1948	18,254	204.7	8,917
1925	6,296	129.1	4,877	1949	16,528	197.6	8,364
1926	5,843	126.0	4,637	1950	16,086	201.6	7,979
1927	6,004	125.2	4,796	1951	18,412	222.0	8,294
1928	5,950	127.6	4,663	1952	18,022	226.0	7,974
1929	6,383	126.0	5,066	1953	17,694	219.7	8,054
1930	4,599	118.9	3,868	1954	16,192	221.3	7,317
1931	2,788	102.4	2,723	1955	15,695	221.3	7,092
1932	1,763	88.2	1,999	1956	16,418	225.2	7,290
1933	2,568	85.8	2,993				

Source: Col. 1, Farm Income Situation 164, Total of cash receipts, Table 11, p.28 minus the sum of taxes on farm property, interest on farm mortgage debt, Table 15, p.32 and current farm operating expenses excluding hired labor, Table 16, p.33. Col. 2, Policy for Commercial Agriculture, op.cit., Table C-9, p.853. Col. 3, Col. 1 divided by Col. 2.

TABLE 4 - CAPITAL GAINS AND LOSS BY FARMERS IN HOLDING REAL ESTATE, LIVESTOCK AND CROP INVENTORIES, U.S., 1909-1956

Year	Real Estate Mil.$	Livestock Mil.$	Crops Mil.$	Total Mil.$
	(1)	(2)	(3)	(4)
1909	900	676	147	1,722
1910	900	298	- 237	961
1911	932	- 155	323	1,100
1912	822	591	- 510	903
1913	815	348	431	1,594
1914	- 345	- 145	- 315	- 805
1915	2,357	- 155	68	2,270
1916	2,922	574	898	4,194
1917	4,046	1,291	1,742	7,079
1918	4,153	478	284	4,915
1919	11,341	- 280	89	11,150
1920	-5,369	-1,896	-2,879	-10,144
1921	-7,029	-1,291	- 906	- 9,226
1922	- 929	271	650	- 8
1923	-2,031	- 182	233	- 1,980
1924	- 546	188	555	197
1925	- 182	536	- 591	- 238
1926	-1,874	220	- 348	- 2,002
1927	- 849	489	223	340
1928	- 217	549	- 52	280
1929	- 719	- 158	75	- 802
1930	-4,765	-1,707	- 553	- 7,025
1931	-7,118	-1,425	-1,030	- 9,573
1932	-6,899	- 666	- 571	- 8,136
1933	999	123	785	1,907
1934	644	601	816	2,061
1935	597	1,723	-1,057	1,264
1936	884	- 32	866	1,718
1937	- 78	50	-1,359	1,016
1938	-1,120	- 32	- 335	- 1,487
1939	- 483	- 188	362	- 309
1940	697	136	- 16	817
1941	2,597	1,461	786	4,844
1942	3,494	2,080	593	6,167
1943	6,014	- 362	1,372	7,024
1944	5,009	- 102	- 30	4,877
1945	6,354	1,018	44	7,416
1946	7,234	2,644	897	10,775
1947	4,996	1,946	2,821	9,763
1948	2,738	1,393	-3,515	617
1949	-1,597	-1,992	- 547	- 4,135
1950	11,315	4,227	1,181	16,724
1951	9,197	1,383	1,320	11,900

TABLE 4 - (Continued)

Year	Real Estate Mil.$ (1)	Livestock Mil.$ (2)	Crops Mil.$ (3)	Total Mil.$ (4)
1952	641	-5,132	200	- 4,290
1953	-1,948	-2,697	-1,289	- 5,934
1954	4,092	- 660	- 636	2,796
1955	3,872	- 732	-1,220	1,920
1956	6,817	303	547	7,666

Source: Col. 1, from Col. 6, Table 4a. Col. 2 from Col. 6 Table 4b. Col. 3, from Col. 6, Table 4c.

TABLE 4a - COMPUTATION OF CAPITAL GAINS AND LOSSES BY FARMERS IN HOLDING FARM REAL ESTATE, U.S., 1909-1956

Year	Annual change in value current Mil.$	Value current Mil.$	Value in constant Mil.$	% year was of previous year -100 %	Change due to physical change current Mil.$	Change due to price change current Mil.$
	(1)	(2)	(3)	(4)	(5)	(6)
1909	-	-	-	-	-	900[a]
1910	1,249	34,793	27,857	-	-	900[a]
1911	1,256	36,042	28,114	0.9	324	932
1912	1,158	37,298	28,363	0.9	336	822
1913	1,123	38,456	28,592	0.8	308	815
1914	11	39,579	28,848	0.9	356	- 345
1915	2,674	39,590	29,089	0.8	317	2,357
1916	3,260	42,264	29,330	0.8	338	2,922
1917	4,456	45,524	29,580	0.9	410	4,046
1918	4,553	49,980	29,821	0.8	400	4,153
1919	11,777	54,533	30,062	0.8	436	11,341
1920	-4,839	66,310	30,306	0.8	530	-5,369
1921	-7,459	61,471	30,089	-0.7	-430	-7,029
1922	-1,307	54,012	29,890	-0.7	-378	- 929
1923	-2,242	52,705	29,760	-0.4	-211	-2,031
1924	-1,000	50,463	29,493	-0.9	-454	- 546
1925	- 479	49,463	29,320	-0.6	-297	- 182
1926	-1,237	48,984	29,687	1.3	637	-1,874
1927	- 133	47,747	30,124	1.5	716	- 849
1928	354	47,614	30,483	1.2	571	- 217
1929	- 95	47,968	30,887	1.3	624	- 719
1930	-4,143	47,873	31,290	1.3	622	-4,765
1931	-6,550	43,730	31,711	1.3	568	-7,118
1932	-6,378	37,180	32,163	1.4	521	-6,899
1933	1,399	30,802	32,595	1.3	400	999
1934	1,063	32,201	33,027	1.3	419	644
1935	996	33,264	33,431	1.2	399	597
1936	953	34,260	33,490	0.2	69	884
1937	- 43	35,213	33,536	0.1	35	- 78
1938	-1,085	35,170	33,559	0.1	35	-1,120
1939	- 449	34,085	33,581	0.1	34	- 483
1940	764	33,636	33,637	0.2	67	697
1941	3,147	34,400	34,161	1.6	550	2,597
1942	4,057	37,547	34,669	1.5	563	3,494
1943	6,596	41,604	35,168	1.4	582	6,014
1944	5,684	48,200	35,677	1.4	675	5,009
1945	7,162	53,884	36,212	1.5	808	6,354
1946	7,417	61,046	36,315	0.3	183	7,234
1947	5,201	68,463	36,416	0.3	205	4,996

TABLE 4a - (Continued)

Year	Annual change in value current Mil.$	Value current Mil.$	Value in constant Mil.$	% year was of previous year -100 %	Change due to physical change current Mil.$	Change due to price change current Mil.$
	(1)	(2)	(3)	(4)	(5)	(6)
1948	2,959	73,664	36,522	0.3	221	2,738
1949	-1,367	76,623	36,627	0.3	230	-1,597
1950	11,542	75,256	36,728	0.3	226	11,316
1951	9,197	86,798	36,732	0.0	0	9,197
1952	641	95,995	36,737	0.0	0	641
1953	-1,948	96,636	36,730	0.0	0	-1,948
1954	4,092	94,688	36,729	0.0	0	4,092
1955	3,872	98,780	36,721	0.0	0	3,872
1956	6,817	102,652	36,727	0.0	0	6,817
1957	-	109,469	36,722	-	-	-

[a]Estimated at 1911 rate

Source: Col. 1, computed from Col. 2. Col. 2, Farm Real Estate Market, July 1956, p. 9, value on March 1. Col. 3, obtained by dividing Col. 2 by index of value per acre (1940=100), Farm Real Estate Market, July 1956, p.9. Col. 4, computed from Col. 3. Col. 5, Col. 4 times Col. 2. Col. 6, Col. 1 minus Col. 5.

TABLE 4b - COMPUTATION OF CAPITAL GAINS AND LOSSES BY FARMERS IN HOLDING LIVESTOCK INVENTORIES, U.S., 1909-1956

Year	Annual change in value current Mil.$ (1)	Value beginning of year current Mil.$ (2)	Total inventory in constant end of year Mil.$ (3)	% year was of previous year -100 % (4)	Change due to physical change current Mil.$ (5)	Change due to price change current Mil.$ (6)
1908	-	-	6,626	-	-	-
1909	598	4,316	6,506	-1.8	- 78	676
1910	352	4,914	6,577	1.1	54	298
1911	- 229	5,266	6,484	-1.4	- 74	- 155
1912	611	5,037	6,513	0.4	20	591
1913	500	5,648	6,687	2.7	153	348
1914	144	6,148	6,999	4.7	289	- 145
1915	65	6,292	7,246	3.5	220	- 155
1916	707	6,357	7,396	2.1	134	574
1917	1,489	7,064	7,601	2.8	198	1,291
1918	469	8,553	7,597	-0.1	- 9	478
1919	- 542	9,022	7,376	-2.9	-262	- 280
1920	-2,100	8,480	7,201	-2.4	-204	-1,896
1921	-1,310	6,380	7,181	-0.3	- 19	-1,291
1922	296	5,070	7,216	0.5	25	271
1923	- 295	5,366	7,063	-2.1	-113	- 182
1924	- 50	5,071	6,732	-4.7	-238	188
1925	365	5,021	6,501	-3.4	-171	536
1926	134	5,386	6,396	-1.6	- 86	220
1927	506	5,520	6,418	0.3	17	489
1928	567	6,026	6,436	0.3	18	549
1929	- 79	6,593	6,514	1.2	79	- 158
1930	-1,655	6,514	6,565	0.8	52	-1,707
1931	-1,304	4,859	6,729	2.5	121	-1,425
1932	- 572	3,555	6,989	3.9	139	- 666
1933	186	2,983	7,137	2.1	63	123
1934	309	3,169	6,481	-9.2	-292	601
1935	1,706	3,478	6,450	-0.5	- 17	1,723
1936	- 120	5,184	6,338	-1.7	- 88	- 32
1937	- 31	5,064	6,238	-1.6	- 81	50
1938	59	5,033	6,352	1.8	91	- 32
1939	41	5,092	6,641	4.5	229	- 188
1940	192	5,133	6,711	1.1	56	136
1941	1,749	5,325	7,075	5.4	288	1,461
1942	2,568	7,074	7,562	6.9	488	2,080
1943	43	9,642	7,880	4.2	405	- 362
1944	- 673	9,685	7,418	-5.9	-571	- 102
1945	730	9,012	7,182	-3.2	-288	1,018
1946	2,235	9,742	6,880	-4.2	-409	2,644
1947	1,407	11,977	6,569	-4.5	-539	1,946

TABLE 4b - (Continued)

Year	Annual change in value current Mil.$	Value beginning of year current Mil.$	Total inventory in constant end of year Mil.$	% year was of previous year -100 %	Change due to physical change current Mil.$	Change due to price change current Mil.$
	(1)	(2)	(3)	(4)	(5)	(6)
1948	1,273	13,384	6,507	-0.9	-120	1,393
1949	-1,757	14,657	6,614	1.6	235	-1,992
1950	4,227	12,900	4,800	0.0	0	4,227
1951	2,462	17,127	5,100	6.3	1,079	1,383
1952	-4,740	19,589	5,200	2.0	392	-5,132
1953	-2,979	14,849	5,100	-1.9	-282	-2,697
1954	- 660	11,870	5,100	0.0	0	- 660
1955	- 508	11,210	5,200	2.0	224	- 732
1956	506	10,702	5,100	-1.9	203	303
1957	-	-	5,000	-	-	-

Source: Col. 1, computed from Col. 2. Col. 2, 1909-49, Goldsmith, Raymond W., A Study of Saving in the United States, Vol. I, Princeton Univ. Press, 1955, Table A-32, p. 797; 1950-57, Balance Sheet of Agriculture, ARS, USDA, Washington, D.C., 1951-57 annual issues. Col. 3, 1908-49, Goldsmith, Raymond W., op cit., Table A-31, p. 795; 1950-56, Balance Sheet of Agriculture, op. cit., 1951-57 annual issues. Col. 4, computed from Col. 3. Col. 5, Col. 2 times Col. 4. Col. 6, Col. 1 minus Col. 5.

TABLE 4c - COMPUTATION OF CAPITAL GAINS AND LOSSES BY FARMERS IN HOLDING CROP INVENTORIES, U.S., 1909-1956

Year	Annual change in value current Mil.$ (1)	Value beginning of year current Mil.$ (2)	Total inventory in constant end of year Mil.$ (3)	% year was of previous year -100 % (4)	Change due to physical change current Mil.$ (5)	Change due to price change current Mil.$ (6)
1908	-	-	2,818	-	-	-
1909	336	2,203	3,061	8.6	189	147
1910	- 130	2,539	3,191	4.2	107	- 237
1911	34	2,409	2,808	-12.0	- 289	323
1912	145	2,443	3,561	26.8	655	- 510
1913	- 19	2,588	2,940	-17.4	- 450	431
1914	101	2,569	3,415	16.2	416	- 315
1915	212	2,670	3,599	5.4	144	68
1916	365	2,882	2,932	-18.5	- 533	898
1917	2,251	3,247	3,392	15.7	510	1,742
1918	152	5,498	3,312	- 2.4	- 132	284
1919	72	5,650	3,302	- 0.3	- 17	89
1920	-1,477	5,722	4,111	24.5	1,402	-2,879
1921	-1,836	4,245	3,211	-21.9	- 930	- 906
1922	679	2,409	3,250	1.2	29	650
1923	239	3,088	3,256	0.2	6	233
1924	252	3,327	2,960	- 9.1	- 303	555
1925	- 194	3,579	3,288	11.1	397	- 591
1926	- 480	3,385	3,160	- 3.9	- 132	- 348
1927	159	2,905	3,090	- 2.2	- 64	223
1928	3	3,064	3,146	1.8	55	- 52
1929	- 94	3,067	2,974	- 5.5	- 169	75
1930	- 776	2,973	2,752	- 7.5	- 223	- 553
1931	- 533	2,197	3,374	22.6	497	-1,030
1932	- 463	1,664	3,593	6.5	108	- 571
1933	576	1,201	2,968	-17.4	- 209	785
1934	230	1,777	1,988	-33.0	- 586	816
1935	- 39	2,007	2,995	50.7	1,018	-1,057
1936	248	1,968	2,056	-31.4	- 618	866
1937	- 40	2,216	3,280	59.5	1,319	-1,359
1938	- 270	2,176	3,378	3.0	65	- 335
1939	265	1,906	3,206	- 5.1	- 97	362
1940	93	2,171	3,365	5.0	109	- 16
1941	926	2,264	3,575	6.2	140	786
1942	1,174	3,190	4,224	18.2	581	593
1943	1,110	4,364	3,876	- 8.2	- 262	1,372
1944	205	5,474	3,971	4.3	235	- 30
1945	- 47	5,679	3,909	- 1.6	- 91	44
1946	1,201	5,632	4,121	5.4	304	897
1947	1,912	6,833	3,573	-13.3	- 909	2,821

TABLE 4c - (Continued)

Year	Annual change in value current Mil.$	Value beginning of year current Mil.$	Total inventory in constant end of year Mil.$	% year was of previous year -100 %	Change due to physical change current Mil.$	Change due to price change current Mil.$
	(1)	(2)	(3)	(4)	(5)	(6)
1948	-1,215	8,745	4,514	26.3	2,300	-3,515
1949	-1,571	7,530	3,901	-13.6	-1,024	- 547
1950	984	6,567	3,200	- 3.0	- 197	1,181
1951	852	7,551	3,000	- 6.2	- 468	1,320
1952	- 77	8,403	2,900	- 3.3	- 277	200
1953	- 715	8,326	3,100	6.9	575	-1,290
1954	102	7,611	3,400	9.7	738	- 636
1955	- 765	7,713	3,600	5.9	455	-1,220
1956	352	6,948	3,500	- 2.8	- 195	547
1957	-	7,300	-	-	-	-

Source: Col. 1, computed from Col. 2. Col. 2, 1909-1949, Goldsmith, Raymond W., op. cit., Table A-32, p.797; 1950-56, Balance Sheet of Agriculture, op. cit., 1951-57 annual issues. Col. 3, same source as Col. 2. Col. 4, computed from Col. 3. Col. 5, Col. 2 times Col. 4. Col. 6, Col. 1 minus Col. 5.

TABLE 5 - STOCKS OF MACHINERY ON FARMS, U.S., 1910-1956

Year	Expenditures on tractors & machinery (constant $) (1)	Machinery stocks (sum of 8 previous years weighted linearly) (2)	Year	Expenditures on tractors & machinery (constant $) (1)	Machinery stocks (sum of 8 previous years weighted linearly) (2)
1902	356	-	1930	365	13,166
1903	271	-	1931	166	13,410
1904	298	-	1932	68	11,929
1905	302	-	1933	60	9,799
1906	362	-	1934	149	7,790
1907	363	-	1935	294	6,759
1908	344	-	1936	393	7,109
1909	412	-	1937	503	8,335
1910	409	12,692	1938	374	10,425
1911	411	13,256	1939	369	11,419
1912	417	13,783	1940	440	12,364
1913	408	14,218	1941	650	13,674
1914	422	14,462	1942	779	16,292
1915	409	14,712	1943	467	19,352
1916	383	14,798	1944	913	19,286
1917	355	14,630	1945	874	22,615
1918	359	14,199	1946	573	25,112
1919	393	13,857	1947	904	24,830
1920	587	13,837	1948	1,145	26,997
1921	222	15,387	1949	1,148	30,557
1922	232	13,847	1950	1,099	33,436
1923	301	12,573	1951	1,182	35,425
1924	253	12,041	1952	1,033	37,758
1925	326	11,233	1953	966	38,184
1926	370	11,139	1954	908	37,954
1927	378	11,426	1955	885	37,168
1928	377	11,766	1956	827	35,863
1929	439	12,113			

Source: Col. 1, 1902-1909, Goldsmith, Raymond W., op. cit., tractors, Table A-18, p.777 and machinery Table A-16, p.773 adjusted to FIS series by subtracting the mean difference between the series from 1910-18 which was 193; 1910-56, from Col. 3, Table 1. Col. 2, obtained by weighting eight previous years expenditure linearly, i.e. for 1910 value, 1902 expenditure times one, 1903 expenditure times two, etc.

TABLE 6 - RELATIVE PRICE OF MACHINERY, U.S., 1910-56

Year	Index of tractor and machinery prices (1937-41=100) (1)	Prices received by farmers (1937-41=100) (2)	Ratio (relative price) (3)	Year	Index of tractor and machinery prices (1937-41=100) (1)	Prices received by farmers (1937-41=100) (2)	Ratio (relative price) (3)
1910	64.5	97	.66	1934	90.5	84	1.08
1911	64.5	87	.74	1935	94.6	101	.94
1912	64.5	92	.70	1936	97.5	106	.92
1913	64.5	95	.68	1937	100.1	113	.89
1914	64.5	94	.69	1938	104.0	90	1.16
1915	66.5	92	.70	1939	99.1	88	1.13
1916	69.7	111	.63	1940	99.5	93	1.07
1917	79.4	165	.48	1941	99.8	115	.87
1918	100.0	191	.52	1942	104.8	148	.71
1919	103.2	202	.51	1943	106.9	179	.60
1920	107.1	196	.55	1944	111.3	183	.61
1921	103.2	115	.93	1945	113.3	192	.59
1922	92.3	122	.76	1946	119.5	219	.55
1923	96.0	132	.73	1947	137.6	257	.54
1924	96.0	133	.72	1948	158.9	267	.60
1925	96.2	145	.66	1949	176.1	232	.76
1926	96.5	135	.71	1950	178.0	240	.74
1927	96.9	130	.75	1951	192.0	281	.68
1928	96.6	138	.70	1952	196.8	268	.73
1929	95.9	138	.69	1953	195.7	240	.81
1930	96.1	116	.83	1954	197.5	231	.85
1931	94.2	81	1.16	1955	200.8	219	.92
1932	90.0	60	1.50	1956	208.1	218	.95
1933	97.8	65	1.50				

Source: Col. 1, same as Col. 2, Table 1. Col. 2, Policy for Commercial Agriculture, op. cit., Table C-8, p.852. Col. 3, Col. 1 divided by Col. 2.

TABLE 7 - RELATIVE PRICE OF FARM LABOR, U.S., 1910-56

Year	Index of farm wage rates (1937-41=100) (1)	Index of tractor and machinery prices (1937-41=100) (2)	Ratio (relative price) (3)	Year	Index of farm wage rates (1937-41=100) (1)	Index of tractor and machinery prices (1937-41=100) (2)	Ratio (relative price) (3)
1910	72.0	64.5	1.12	1934	74.3	90.5	.82
1911	73.5	64.5	1.14	1935	80.3	94.6	.85
1912	75.8	64.5	1.18	1936	85.5	97.5	.88
1913	78.0	64.5	1.21	1937	96.8	100.1	.97
1914	75.8	64.5	1.18	1938	97.5	104.0	.94
1915	75.8	66.5	1.14	1939	95.3	99.1	.96
1916	84.0	69.7	1.21	1940	96.8	99.5	.97
1917	105.8	79.4	1.33	1941	113.3	99.8	1.14
1918	132.8	100.0	1.33	1942	147.8	104.8	1.41
1919	154.5	103.2	1.50	1943	196.5	106.9	1.84
1920	180.8	107.1	1.69	1944	238.5	111.3	2.14
1921	117.0	103.2	1.13	1945	269.3	113.3	2.38
1922	115.5	92.3	1.25	1946	290.3	119.5	2.43
1923	129.0	96.0	1.34	1947	314.3	137.6	2.28
1924	136.5	96.0	1.42	1948	331.5	158.9	2.09
1925	135.8	96.2	1.41	1949	322.5	176.1	1.83
1926	137.3	96.5	1.42	1950	318.8	178.0	1.79
1927	138.0	96.9	1.42	1951	352.5	192.0	1.84
1928	138.0	96.6	1.43	1952	377.3	196.8	1.92
1929	139.5	95.9	1.45	1953	384.8	195.7	1.97
1930	132.8	96.1	1.38	1954	382.5	197.5	1.94
1931	104.3	94.2	1.11	1955	387.0	200.8	1.93
1932	78.0	90.0	.87	1956	402.0	208.1	1.93
1933	66.0	97.8	.67				

Source: Col. 1, Policy for Commercial Agriculture, op. cit., Table C-9, p.853. Col. 2, same source as for Col. 2, Table 1. Col. 3, Col. 1 divided by Col. 2.

TABLE 8 - PERCENT OF LABOR FORCE EMPLOYED, U.S., 1910-56

Year	% labor force employed	Year	% labor force employed
1910	100	1934	78
1911	97	1935	80
1912	99	1936	83
1913	99	1937	86
1914	94	1938	81
1915	93	1939	83
1916	98	1940	85
1917	103	1941	92
1918	105	1942	101
1919	99	1943	109
1920	97	1944	111
1921	87	1945	108
1922	91	1946	96
1923	96	1947	96
1924	93	1948	97
1925	95	1949	94
1926	96	1950	95
1927	95	1951	97
1928	95	1952	97
1929	97	1953	98
1930	91	1954	95
1931	83	1955	96
1932	77	1956	96
1933	75		

Source: 1910-45, Johnson, Glenn L., "Allocative Efficiency of Agricultural Prices -- As Affected by Changes in the General Level of Employment", unpublished doctor of philosophy dissertation, Department of Economics, University of Chicago, 1949, Plate VI, p.61; 1946-56, Economic Report of the President, United States Government Printing Office, Washington, 1957, Table E-17, p.140.