A PARTIAL TEST OF THE RELATION BETWEEN AGGREGATE INVESTMENT IN AGRICULTURE AND CERTAIN ECONOMIC FLUCTUATIONS

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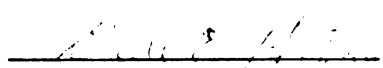

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by

George K. Dike

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ABSTRACT

A PARTIAL TEST OF THE RELATION BETWEEN
AGGREGATE INVESTMENT IN AGRICULTURE AND CERTAIN
ECONOMIC FLUCTUATIONS

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The primary purpose of this dissertation was to study the relation between changes in the way value is added to inputs in the agricultural sector and subsequent changes in agricultural investment. This study involves the acceleration principle and is a partial testing of a theory of the business cycle such as introduced by J. R. Hicks. According to the Hicks type theory, business cycles are caused by interaction of the accelerator and multiplier. Such theories are sometimes used to explain cycles which are caused by fluctuations in capital investment. This study seeks to gain insight into the interdependence between agriculture and the rest of the economy by studying patterns of investment in agriculture.

The multiplier-accelerator theories referred to in this study are used to explain cycles which are caused by fluctuations in capital investment. Changes in value added in the agricultural sector could contribute pressures to the total economic activity ranging from complete sympathy with to being directly opposed to the total cyclical pattern of economic activity. It would be useful to understand the relation of agriculture to the total economy with greater precision in this respect.

According to the multiplier-accelerator theories, the amount of induced investment must be sufficiently great in order to insure that subsequent changes in value added respond in a consistent manner to at least maintain a cyclical pressure on the total economy. One purpose of

this study was to measure the amount of induced investment in the agricultural sector.

The method used was to fit equations similar in form to Hick's equations, by the method of multiple regression. Data on investment categories and value added were expressed as deflated changes from annual observations. The regression coefficients obtained represent measures of the amount of induced investment.

Results of this study indicate that the amount of induced investment in agriculture generated by changes in value added in the agricultural sector is not very substantial at all. The estimates indicate that the ratio of induced investment in all categories in agriculture to changes in the value added by agriculture is quite uniformly recorded as less than one. These small investment coefficients do not lend much support to the appropriateness of these theories in this case. On the other hand, a review of the various time series examined does reveal some interesting trends between time periods examined.

In the post World War II years changes in agricultural inventories, particularly livestock, have become much more sensitive to changes in value added in the agricultural sector, as compared to pre-World War II years. At the same time, changes in investment in fixed capital items were not significantly different in sensitivity to changes in value added. Investment in fixed capital was rather unresponsive in every time period examined. On the other hand the simple correlation between a measure of the business cycle or level of total economic activity and investment in agriculture appears at a high level of significance in enought instances to encourage the belief that investment in agriculture is highly sensitive to the well-being of the total economy.

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Full responsibility for errors in this thesis is born by the author.

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INTRODUCTION

This study represents a partial attempt to test the usefulness of a multiplier-accelerator theory as an explanation of the relationship between investment and output in agriculture. The study is submitted as a contribution to the growing volume of material on the subject of capital formation in agriculture. Much of the increased interest in this area can probably be related to Tostlebe's study sponsored by the National Bureau of Economic Research.[1] Renewed interest and activity in the search for the determinants of investment is evidenced by such research as the recent empirical study of Meyer and Kuh.[2]

Without doubt, there has been a tremendous rise in agricultural production in recent years as well as over the past 50 years. To be sure, technological advances which were not capital-demanding have made possible some of this growth.[3] Many of the techniques which raise productivity, however, require a substantial flow of investment funds into agriculture.

An adequate understanding of the determinants of agricultural investment, however, calls for more study. This dissertation will be an investigation of how farmers' adjustments of inventories and capital stocks have been associated with changes in the aggregate demand for farm products.

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[1]A. S. Tostlebe, Capital in Agriculture: Its Formation and Financing Since 1870. Princeton University Press, 1957.

[2]J. R. Meyer and E. Kuh, The Investment Decision. The Harvard University Press, Cambridge, 1957.

[3]Tostlebe, op. cit., pp. 104-105; T. W. Shultz, Reflections on Agricultural Production, Output and Supply, Journal of Farm Economics, Vol. XXXVIII, No. 3, August 1956, pp. 753-756.

It is envisioned in particular as a contribution to the research called for by Professor Dale E. Hathaway in his recent article.[4]

[4]D. E. Hathaway, Agriculture and the Business Cycle, Policy for Commercial Agriculture, Joint Committee Print, 85th Congress, 1st session, November 22, 1957.

CHAPTER I

THE PROBLEM AND THE METHOD

From 1910 to 1945 short-run changes in the price of agricultural products seemed clearly to reflect changes in demand. Thus, these prices fell considerably during contractions of the total economy and advanced during expansions. This view is broadly consistent with the traditional observation made by many economists that changes in the price of raw materials including primary foodstuffs are "demand determined." An expanding economy means increasing levels of income and employment and, thus, substantial and direct stimulation of demand. But an increase in the supply of agricultural products requires, relatively, a considerable time. With supply inelastic in short periods, an increase in demand depletes stocks and fosters an increase in price.

It is known that the index of prices received for agricultural products has demonstrated cyclical fluctuations which have been far more extreme in amplitude than measures of the general level of demand, such as total wages paid. Under such circumstances, measures of well-being in agriculture tend to be far more volatile than the same measures for the total economy.

Agricultural inputs, on the other hand, are ordinarily supplied through an imperfect market, and their supply is more flexible than the supply of primary foodstuffs. Costs of these inputs have not demonstrated the volatility of prices received by farmers. With farm profits shaped by the difference between prices paid and prices received, it is easy to suggest that the level of well-being in Agriculture conforms to a pattern roughly correspondent with the level of economic activity in the total

economy. This is largely because prices received by farmers have tended to fluctuate widely and in phase with the business cycle.[5]

But recently the apparent clarity of the association of profits and prices received has become obscured. In recent years there have been stabilizing influences in the general economy which have tended to smooth out or dampen large fluctuations in aggregate demand. This reduction of extreme fluctuations in aggregate demand results in a dampening of the fluctuations in the prices of agricultural products. Some of the stabilizing influences which have smoothed out demand pressures, as suggested by Mr. Arthur F. Burns,[6] are:

With respect to income flows,

> The corporate practice of maintaining a smooth flow of dividends to stockholders:
>
> The impact of the progressive federal income tax and other automatic and formula devices such as unemployment insurance benefits:
>
> Private and public retirement programs.

With respect to employment,

> As an economy develops and becomes more mature, production and employment shift away from primary production (agriculture and basic raw material industries which tend to be volatile) toward the more stable manufacturing and service industries.

With respect to consumer spending,

> Consumer spending has remained at a high level because of

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[5]Willard W. Cochrane and Walter W. Wilcox, Economics of American Agriculture, 2nd edition, Prentice-Hall, Englewood Cliffs, N. J., 1960, pp. 287 ff.

[6]A. F. Burns, Progress Toward Economic Stability, American Economic Review, Vol. I, No. 1, March 1960, pp. 1-19.

increasing sophistication of consumers embracing rising expectations and initiative.

With respect to financial reform,

Such things as the insurance of bank deposits.

Not only has the presence of the above influences obscured the statistical clarity of the relation between fluctuations of aggregate demand and the well-being of agriculture, but most measures of well-being of agriculture have in recent years traced a pattern completely out of phase with the general economy's periods of expansion and contraction.[7] What explanations of investment motivation can be advanced to explain the shift and to what extent is agricultural investment now out of phase with the total investment flow of the general business cycle? These questions invite a detailed examination of agricultural investment. A careful introduction to such a study requires a clear definition of the term "investment."

In economics, investment at the general economy level has usually been defined as that part of production which is purchased during a specific period of time for purposes other than current consumption. This consists of producers' plant and equipment, residential structure, the change in inventories, and net foreign balances. In agriculture, fixed capital investment includes all kinds of construction, the purchase of wheeled vehicles as well as other machinery and equipment. Changes in agricultural inventories represent the net change in inventory stocks held, which are predominantly livestock and crops. Fixed capital can be

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[7]We have accepted for the purposes of this study the historical expansions and contractions of the business cycle as established by research of the National Bureau of Economic Research, Inc., 261 Madison Avenue, New York 16, New York.

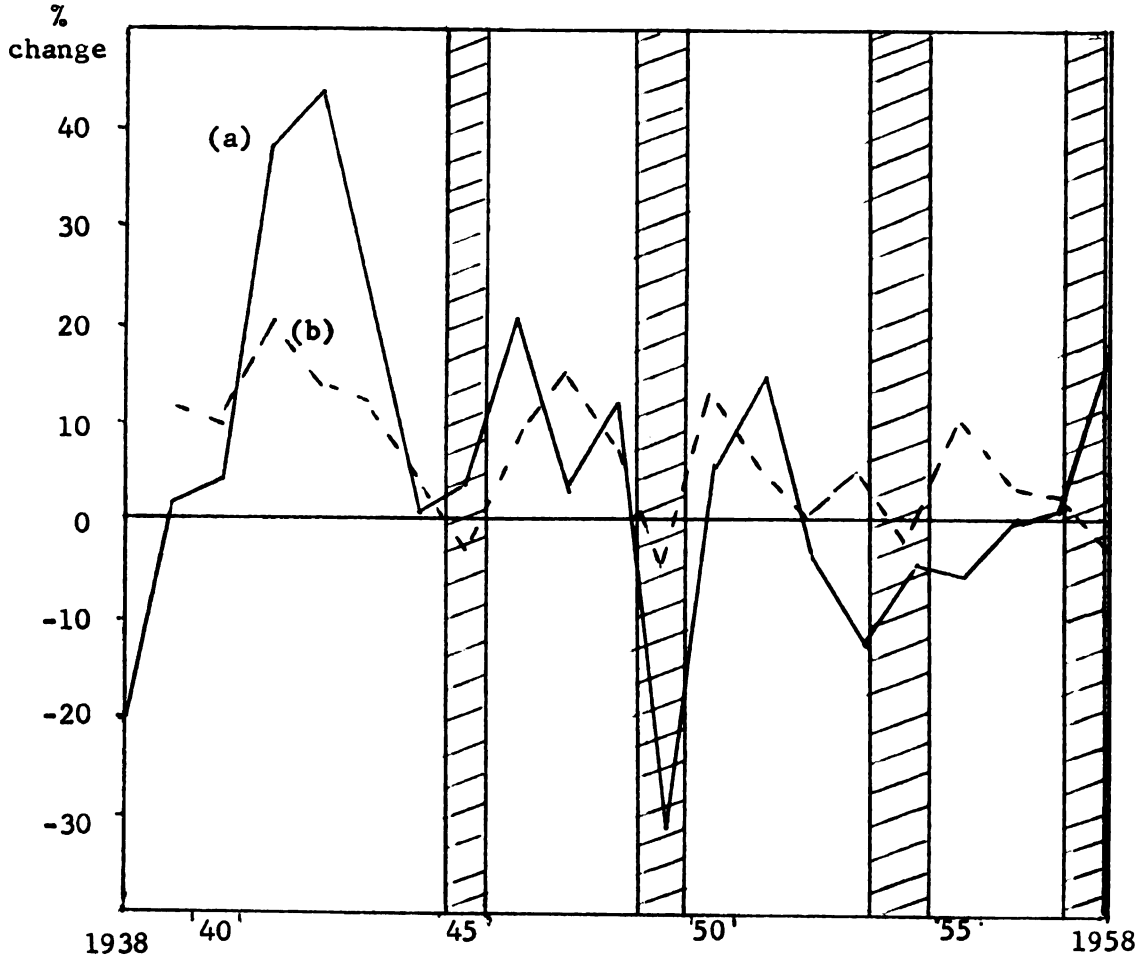
sub-divided into replacement investment and new or net investment. New investment creates or expands productive capacity.

The social importance of the level of income and employment has been impressed upon us in the last 30 years. As a result of the "Keynesian Revolution" and succeeding developments in economic theory, our understanding of the forces determining the level of income and employment has been improved. According to Keynesian theory, the level of income and employment depends on the level of total demand, which is made up of consumption expenditures and investment expenditures. Consumption depends rather directly on available income and can be said thus to be relatively passive. Investment, on the other hand, is volatile and the effect of this volatility is both multiplicative and on subsequent income cumulative. This explanation is advanced because it appears that changes in income are some multiple of changes in investment. It follows that with respect to its magnitude, investment, because of its volatility, fluctuates relatively much more widely over the business cycle than does consumption. This is the reason continuing investment expansion is regarded as an essential for long-run growth, and the reason volatility in investment is considered a major source of short-run disturbances in economic activity.

There are concepts which may be useful in examining some aspects of investment motivation. One of these involves the need for greater productive capacity to meet an increase in demand for final product. A modification of this concept involves the belief that businessmen attempt to adjust inventories to the volume of business. Here the accelerator principle is involved.

The accelerator principle may be said to be a special case of "the hypothesis that the fluctuations over time of one economic magnitude

FIGURE 1. CHANGES IN FARM INCOME COMPARED TO CHANGES IN GENERAL ECONOMIC ACTIVITY, 1938 to 1958



(a) The solid line shows the percent change in net farm income from the previous year. Adapted from The Farm Income Situation (179) Agricultural Marketing Service, U.S. Department of Agriculture.

(b) The broken line shows the percent change in an index of economic activity from the previous year. Adapted from a composite of coinciding indicators published in Occasional Paper 31, National Bureau of Economic Research, New York, 1960.

The cross hatched areas indicate periods of contraction for the economy as determined by the National Bureau of Economic Research, New York, 1960.

This figure shows that prior to 1952 one measure of Agricultural income moved in phase with the general economic climate. From 1952 to 1958 the same measure was out of phase with total economic activity.

are determined to some extent by the rate of change in another variable, not by its absolute level."[8]

The development of theories of investment in agriculture is complicated by differences in type of farming areas, regional patterns, level of internal financing used, type of farm organization, and the associated variance in liquidity positions of farmers as well as how risk and uncertainty are dealt with under such a wide range of conditions. Despite these complexities, the investment behavior of farmers who see a need for greater capacity or who wish to adjust inventories to the volume of business remains a subject which is at best incompletely understood and well worth examining. Aggregative theory makes a major distinction between autonomous investment and induced investment.[9] It is the purpose of this study to investigate the relative importance of these two types of investment in the agricultural sector and to attempt to measure the extent that variation in induced investment is associated with variation in value added to output in agriculture. All of this is set within the context of fluctuations in the general business cycle. It is hoped that insight gained from this examination will help in some degree to explain changes in the income position of farmers.

The Problem Framework

The recent tendency of net farm income to appear "out of phase" with the expansions and contractions of the total economy and the unsatisfactory returns to factors of production have been given emphasis by some agri-

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[8]Paul Winding, Some Aspects of the Acceleration Principle, North Holland Publishing Company, Amsterdam, 1957, p. 9.

[9]Autonomous investment is that investment associated with population growth, new products, and new processes. Induced investment is that investment associated (via the accelerator) with incremental changes in income in previous time periods.

cultural economists.[10] These analytical studies suggest that full employment and general economic stability will not automatically insure the attainment of satisfactory levels of well-being in the agricultural sector. If income that is generated in agriculture is shaped in a significant way by investment in agriculture, then the determinants of that investment pattern should be understood.

The traditional investment models have been of little use in agriculture. One major reason for this has been advanced in an explanation by Keith O. Campbell,[11] who points out that agricultural investment is characteristically supported by a degree of internal financing much greater than commonly acknowledged in the investment models.[12] Until more detailed information is available with respect to such volatile and transitory influences as weather and short-run fluctuations in demand, it seems appropriate as we are doing in this study to examine agricultural investment through the construction of very simple, and to some extent incomplete, models which tend to provide suggestive insights rather than clearly conclusive results. We will adapt to our use parts of existing theoretical models, primarily one of Hicks'.

Hicks, for example, uses fluctuations in capital investment actuating a multiplier-accelerator mechanism to explain business cycles.[13] The writings

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[10] See, for example, Dale E. Hathaway, Agriculture and the Business Cycle, Policy for Commercial Agriculture, Joint Committee Print, 85th Congress, 1st session (November 22, 1957). Boric C. Swerling, Agriculture and Recent Economic Conditions: Experience and Perspective, Federal Reserve Bank of San Francisco, August 1959.

[11] Keith O. Campbell, Some Reflections on Agricultural Investment, The Australian Journal of Agricultural Economics, Vol. 2, No. 2, December 1958, pp. 93-103.

[12] Parenthetically, it can be observed that with internal financing becoming of more importance to the industrial economy, the differences between agriculture and industry with respect to investment decisions may be lessening. Traditional investment models may not only be of little use in agriculture, but have less relevance to the total economy. On the other hand, broader understanding of the investment process in agriculture may provide insight to the economy as a whole.

[13] J. R. Hicks, A Contribution to the Theory of the Trade Cycle, the Clarendon Press, Oxford, 1950.

of J. M. Clark,[14] R. F. Harrod,[15] and Paul Samuelson[16] contain the classic references to the accelerator principle.

The "multiplier" refers to the observation that in such models, since investment creates income, a part of which is devoted to consumption, income appears to be a multiple of investment. The "accelerator" is the mechanism through which additional increments of demand accelerate the rate at which new capital is added to the investment flow. It is the influence of additional increments of demand which will be examined in this study. Every Keynesian model is an aggregative model, where aggregate income and aggregate output are synonymous. This kind of system says that aggregate income in the current period depends on some multiple of the last period's level of income plus a multiple of the incremental change in income which brought last period's income to its level from a previous level. These quantities are added algebraically to a constant represting the growth path of aggregate income or output. The new level of income thus pictured can be greater or less than the trend of growth. Over time the variance from the trend can, depending on the nature of the coefficients ("multiples and/or coefficients"), trace a path showing deviations of increasing or decreasing magnitude and stable or unstable in nature. This characteristic is demonstrated with difference equations in mathematical models.[17] The Hicks

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[14]J. M. Clark, Business Acceleration and the Law of Demand: A Technical Factor in Business Cycles, Journal of Political Economy, Vol. 25, March 1917; reprinted in American Economic Association, Readings in Business Cycle Theories, Richard D. Irwin, Inc., Homewood, Illinois, 1944.

[15]R. F. Harrod, The Trade Cycle, The Clarendon Press, Oxford, 1936. Also Toward a Dynamic Economics, Macmillan & Co., London, 1948.

[16]Paul Samuelson, Interaction Between the Multiplier Analysis and the Principle of Acceleration, Review of Economics and Statistics, Vol. 21, May 1939, pp. 75-78. Reprinted in Readings in Business Cycle Theory, Richard D. Irwin, Inc., Homewood, Illinois, 1944.

[17]Samuelson, op. cit.

theory goes on to show how a "ceiling" could curb or contain a fluctuating mechanism in spite of its basic tendencies. His theory is of much broader nature than the scope of this study; however, this study will be a partial test of the Hicks theory for the agricultural sector.

Most of the Hicks volume is concerned with the so-called "elementary" case, in which the induced investment in period t depends upon the change in income from period t-2 to period t-1. Consumption in period t depends solely upon income in period t-1. The Hicks elementary case can be expressed:

$$Y_t = cY_{t-1} + v(Y_{t-1} - Y_{t-2}),$$

where Y represents the deviation of income from the "equilibrium" or growth path level, c represents a marginal propensity to consume, and v represents the investment coefficient--that is, the ratio of induced investment to the change in income which caused it.

In the elementary case, Hicks demonstrates that an investment coefficient equal to 1 will cause cycles of constant amplitude, and an investment coefficient less than 1 will cause cycles of decreasing suplitude. If v is substantially less than 1, the cycles will die out quite rapidly, so Hicks believes that this does not provide an adeuqate explanation of the existence of business cycles. Hicks further believes it highly unlikely that the value of v has remained at 1 over the years, and so rejects the likelihood of cycles of constant amplitude. Consequently, Hicks believes that expanding cycles caused by a v greater than 1, offer the most promising explanation of business cycles. Hicks, of course, does not believe that the economy will eventually "explode." Rather, he believes that the expanding cycles are restrained or contained by contact

with the "ceiling" or the "floor". The "ceiling" is a roughly defined area in which expansion of the economy is slowed by shortages of a few key factors of production and/or slower delivery of orders. Once the expansion of the economy has been sufficiently slowed, induced investment (which depends upon the rate of expansion) will be reduced, and a recession must take place, even though this event may be postponed by the making of delayed deliveries caused by catching up with shortages. The "floor" is an even more roughly defined area, below which the economy cannot fall, as long as the autonomous investment does not also fall.[17] During the recession phase, induced investment becomes negative. Thus, it represents a subtraction from, rather than an addition to, autonomous investment. However, the amount of negative induced investment is limited by the slow rate of depreciation of most types of fixed capital. Consequently, if autonomous investment, which depends on something other than recent changes in the level of income, does not decline, there is a lower limit to the level of economic activity. When the economy approaches a lower limit, the rate of decrease declines, negative induced investment becomes smaller and the stage is set for an upturn, although that may be delayed by the "working off" of excess capacity.

All multiplier-accelerator theories including the Hicks type are associated with some critical assumptions. One purpose of setting up expository models is to help observers to grasp the implications of changes in the structure of a dynamic system. But it is important to understand the extent to which the analytical results depend on the particular, restricted form used. Eckaus has pointed out the nature of some important

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[17]Autonomous investment is that investment associated with population growth, new products, and new processes.

qualifications which should be recognized as models are employed which represent special cases.[19] He says that the stability range of the parameters of Hick's model is small. The marginal propensity to consume and the accelerator must both be less than one.

Lagged relationships can be examined in a "receipts-expenditure" model which includes the Hicks formulation. Other models make use of an assumed relationship between lagged variables based on the "sales-output" period where the lags may well be of a different nature. Eckaus associates this latter type with what he describes as the Lundberg-Metzler formulation. Models of these two types are combined by Eckaus. He shows that combinations provide more latitude with respect to stability conditions than either type by itself. Thus in one combined model, as the marginal propensity to consume ranges from zero to one, the accelerator can range from one to two without upsetting the stability conditions. The analysis by Eckaus emphasizes the necessity of being cautious and avoiding unwarranted conclusions. Consequently, in this study of agricultural investment, the coefficients which appear in that part of the Hicks model which we will be using will be incomplete indicators of the coefficient's ability to generate departure from stability. This study does not suggest anything about the nature of the marginal propensity to consume in either the agricultural sector or the total economy. The whole investigation is only for the purpose of gaining insight into the character of the investment process in agriculture. As will be shown later, the nature of the appropriate lags and the level of precision generally associated with the bulk of aggregative agricultural

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[19]R. S. Eckaus, The Stability of Dynamic Models, The Review of Economics and Statistics, Cambridge, Mass., Vol. XLII (1957), pp. 172-182.

statistical data allows the decision to be made that more sophisticated models are not necessarily more appropriate in this case.

The elementary case of Mr. Hicks can be broadened to add more realism to the assumptions by examining the influence on investment of changes in income from more than one recent period. The summation of the significant investment coefficients associated with the change in investment for each period would give the total investment coefficient for the time series as the regression equations are set up in this study.

Actually this study involves a further modification of the Hicks theory, in that changes in value of inventories will be examined here as well as the changes in fixed capital. It is really only changes in fixed capital which are important to Hicks' theory.

This study concerns the relation between incremental changes in income created in agriculture and subsequent agricultural investment. The results cannot be expected to lend themselves to generalization beyond agriculture and may not be typical of subsectors within agriculture; the study deals with aggregate agricultural data only. Such implications as may be derived will relate to broad policy for the whole agricultural sector, but the purpose is primarily to gain further insight into the investment process.

A First Approximation for Identifying Relevant Variables

A change in real output which overtaxes the existing facilities for production is reason enough to cause a farmer to expand his plant in order to satisfy the new level of demand. Since the traditional accelerator principle assumes no excess capacity, it is suggested that livestock inventories are particularly sensitive because "plant" capacity and "plant"

output have a relationship shaped more by biology than by mechanics. Crop inventories, too, are flexible. This is somewhat more involved than an "inventory cycle" in that the means of production are so interrelated with the inventory stocks. Although expenditures on buildings, machinery, and equipment can be deferred, thus precluding the assumption of a smooth replacement schedule, such expenditures may also show sensitivity to acceleration. Farmers should be expected to try to adjust their business organization to accomodate forces affecting their well-being. An observed increasing profitability in certain enterprises may reopen investment plans tentatively tied to decisions arrived at in terms of lower rates of profit.

In this study agricultural investment will include additions to fixed capital in farm buildings, motor vehicles and other machinery and equipment, and in breeding stock and seed stock for livestock and crops. Additions to livestock and crop inventories will be considered as investment and, because of difficulty in segregating breeding herds or seed stock, these will be included in the inventory groups.

The concept of the accelerator assumes that there is no excess capacity with respect to capital. Farm management resource allocation models often conclude that excess capacity does exist with respect to capital in portions of agriculture. In this study we are assuming rational behavior to underlie our raw data. Thus, the fact that many farmers keep on purchasing more capital equipment so that the available labor may be more fully or more conventiently employed indicates that excess capacity with respect to capital is not present in an economic sense--even though the simple optimization criteria of many resource allocation models would suggest otherwise in the same cases.

Changes in income created in agriculture have been selected as the dominant independent variable. In this study these data were obtained from

a series maintained by the U. S. Department of Commerce and referred to as Gross National Farm Product.[19] This is a value added concept. It is gross only in that it includes depreciation. Otherwise it is devised by deflating agricultural products sold by prices received and deflating agricultural inputs purchased by prices paid and taking the difference. The Department of Commerce series was selected because it extends back to 1910 and because a detailed explanation of its development was available.[20] A similar series could also have been assembled from such a source as The Farm Income Situation.[21] The same basic U. S. Department of Agriculture figures are drawn on in either case. With the appropriate assembly already accomplished by the Department of Commerce, much effort was saved by using its series.

Depreciation is another problem. Depreciation has been included in all series used in this study. It was believed best to leave it in because data from which depreciation has been extracted do not reflect the real conditions. Depreciation in certain cases in USDA as well as in other data has been estimated on a declining balance basis, for example. This may be satisfactory for income tax purposes but it does not account for the fact that much capital equipment remains productive long after it has been "depreciated" but not yet replaced. The matter of replacement is an interesting subject itself and may be positively correlated with such things as income level, liquidity position, and capital rationing, rather

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[19]John Kedrick, Survey of Current Business, Department of Business Statistics, U. S. Department of Commerce, September 1951, pp. 13-19.

[20]Op. cit.

[21]Farm Income Situation (FIS), published four times a year by Agricultural Marketing Service, United States Department of Agriculture.

than guided by any "schedule" or programmed ideal. On the other hand, depreciation is by definition a part of the gross saving of entrepreneurs and this concept may be useful if this study should at some future date be blended into a more elegant model of investment (and income determination) in agriculture.

The matter of new technology has been mentioned briefly. It will be assumed constant in this study because the observations here are extremely short-run.

It is proposed to test the statement that changes in the value added to national product by agriculture shape farmers' decisions to invest. That is, farmers will adjust their inventories and capital stock to meet the demands of trade. This test will be accomplished by noting relations or associations between changes in new agricultural investment and an independent variable, past changes in value added or what will be referred to hereafter as Gross National Farm Product (GNFP). The value added concept was selected rather than some direct measure of income. This was because multiplier-accelerator models are associated with income-output concepts of an economy. The value of all output in the economy is the summation of all value added by each subsidiary element. For this reason "value added" is an appropriate measure to select for an independent variable. It can be granted that income and consumption patterns in the total economy will affect agriculture. It can also be granted that such induced investment as there may be in agriculture can be induced in part by some characteristic activity in the total economy. Yet this study seeks only to examine the nature of that investment in agriculture which is induced by the changing scene within the sector. Within the limits of the proposed formulation a total investment coefficient of about two would

suggest the presence of an interesting condition. Even though destabilizing forces generated in the agricultural sector itself could be counterbalanced or overwhelmed by exogenous activity the extent to which agriculture itself is not equilibrium seeking would be of interest to students of policy. The size of a statistically significant R^2 will also allow something to be said about the presence of induced investment.

Method of Study

Hicks' "elementary case" can be modified to accommodate the suggestion that induced investment during period t will be created not only by the change in income $(Y_{t-1} - Y_{t-2})$ but may also be influenced by changes in other earlier periods. For this reason the "general" case of Hicks is examined:

$$Y_t = C_1 Y_{t-1} + C_2 Y_{t-2} + \cdots + C_r Y_r + V_1 (Y_{t-1} - Y_{t-2}) + V_2 (Y_{t-2} - Y_{t-3}) + \cdots + V_p (Y_{t-p} - Y_{t-p-1})$$

But the properties of this case are not as precise as in the elementary case. If significant amounts of consumption are lagged more than one period, the meaning of the total investment coefficient is less distinct. It will still be possible to say that a total investment coefficient of less than one will be associated with dampened cycles, but it will not be possible to say that a total investment coefficient of more than one will generate cycles of increasing amplitude. To be able to state what kind of cycles will be generated would require knowledge of the "c" values in the "general" equation. This is why this study is only a partial test of this type of theory. A total investment coefficient of, say, two or three would still tend to support the thought that self-generating cyclical influences exist in the agricultural sector and that they may be destabilizing in their effect on agricultural income.

The accelerator approach emphasizes the technical need for greater capacity to meet an increase in demand for final product. Theories using this approach are set apart from the so-called monetary theories of investment. The emphasis of the monetary theories is on the cost and availability of capital funds. It has been strongly suggested in this study that such things as internal financing are of great importance in agriculture and that this importance thus belittles or at least obscures the importance of cost of funds and also availability of funds. On the other hand, capital-output relationships can be examined by sectors. In the case of agriculture, considerable data have been assembled relating to capital-output aspects.

The equations which will be used to find the necessary coefficients will have the following form:

$$I_t - I_{t-1} = a + b\,(O_{t-1} - O_{t-2}) + c\,(O_{t-2} - O_{t-3}) + \ldots + (O_{t-n} - O_{t-n-1}),$$

where I = capital stock including inventories in Agriculture,

O = income created in agriculture,

t = a time period,

n = a number of periods,

b, c = regression coefficients,

a = a constant.

The components of total agricultural investment that are used in this study may be tested separately or in various combinations as well.

The intent of this chapter has been to outline or point out the problem. The purpose of this thesis will be to contribute to the development of more satisfactory explanations of investment in agriculture and to

gain insight into possible sources of instability in the agricultural sector.

Chapter II will deal with the theoretical background and statistical techniques. Chapter III will be a report on the results of the calculations revealing any new facts. It will lead into the analysis of the findings. Chapter IV will embrace the analysis leading to the economic conclusions. Chapter V will summarize the entire study.

CHAPTER II

THEORETICAL BACKGROUND AND STATISTICAL TREATMENT

Theoretical Background

Expanding on the observation that the well-being of agriculture fluctuates, it will be assumed that the pattern of investment in agriculture plays a key role in contributing to and responding to the fluctuations. The place of investment as a creator of income will not be examined in detail. This is because of the difficulty in making meaningful statements about subsequent uses of that income which farmers receive. But the other side of the question will be pursued--that is, the effect of income on investment.

Several definitions need to be expanded from the manner in which subjects were introduced in Chapter I. Many accelerator theorems deal with changes in consumption, but this study deals with changes in value added. Changes in consumption of agricultural produce mean changes in demand for that output. Translated to the farmer's point of view, the element of output of significance to him is the value of what was added in his sector. It can be granted that the size of that demand is gauged by the total value of agriculture's products. Yet, the investment studied here is change in investment and it is desired to examine the conditioners of investment decisions, not the extent of capital needed to take care of productive activities formerly undertaken elsewhere. Because income created in the agricultural sector affects expectations with respect to agriculture, a value added concept was used.[1] This is the side of the theory of

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[1]John Kedrick, Survey of Current Business, Department of Business Statistics, U. S. Department of Commerce, September 1951, pp. 13-19.

fluctuations which Hicks associates with the accelerator.[2] Output (or income) is taken for granted in order to study the consequential effects on investment. Where investment is taken for granted in order to study the consequential level or movement of output the multiplier, involving the other half of this theory, is involved.

The items considered as investment are (1) capital expenditures on buildings, (2) capital expenditures on machinery and equipment, (3) changes in livestock inventories, and (4) changes in stored crops. The latter two categories do not include all inventories. Some supplies cannot be considered because the information is insufficient. Land has not been included because, first, the acreage cannot be changed and, second, economic theory considers land a gift of nature which does not respond to decisions regarding investment as readily as do other forms of capital. Value of land can be changed as can its productivity; nevertheless, it will be excluded from this study.

Theory

If income from agriculture is constant and the capital stock is well adjusted to fulfilling the demand for products so that the output and income remain constant, then only replacement is a consideration. Net investment balances out to zero. If the conditions of demand change so that farmers see the value added by agriculture increase (output constant with prices received increasing, for example), their expectations of further sharing in such increases are supported. Their reaction is to increase output by adding to capital stock more than a replacement increment. This will be so that the new level of output can be produced without taxing the

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[2]Hicks, Op. Cit., p. 38.

productive mechanisms at anything different than under the initial conditions. If the new level of production is stable, net investment will rise to the same level from its previous neutral balance. Following this, however, gross investment will work down to its level held prior to the adjustment but there will be an obligation to account for extra depreciation on the new investment stock. Net investment can even be envisioned to become negative by the amount of the new net depreciation until the recently added capital needs to be replaced. If this replacement is all to come in one lump, net investment will rise again but not quite to the same level as caused by the initial new investment because the extra depreciation will continue to be deducted. The fluctuating schedule for replacement will be dampened but fluctuating, nevertheless, with decreasing amplitude. This is a simple picture of induced investment involving only one change in value added. Actually, investment induced in this manner must be envisioned as being added to an existing pattern of investment rather than tracing a fluctuating pattern centered on a stable level. Nevertheless, increasing output will have a tendency to introduce a lump of investment, succeeded at the appropriate replacement time by a dampened lump, and so on.

A decrease in output must next be examined. When capital stock is seen to be larger than necessary to produce the output demanded, a downward adjustment is necessary. This means, in effect, that depreciation exceeds gross investment. Even though gross investment might be zero, the depreciation schedule would favor a tempered fluctuation, probably never a mirror image of the positive inducement discussed previously, but a lump of disinvestment can nevertheless be envisioned. However, the depreciation rate, whatever it is, must be taken into account in another way. Looking

at induced investment, succeeding inducements could be cumulative. On the other hand, succeeding disinvestments cannot be cumulative but must be scheduled over time. But again, to remove the assumption of proceeding from a stable state, these induced disinvestments may come when normal replacement schedules have increased or decreased the range of influence an otherwise unmodified induced disinvestment may have had.

Hicks sums up the characteristic effect of investment of a rise in the demand for output in terms of three phases.[3] He says that in the first phase there is a tendency for disinvestment to be apparent. This is because the additional output is not yet forthcoming and the additional demand is satisfied out of stocks. A gradual transition to the second phase takes place and the period arrives when the main part of induced investment takes place. This includes investment in stocks to make up for the depletion in phase one. Also included is investment in fixed capital to adjust the plant to the level of productivity needed for the larger output. The third phase is characterized by oscillations in investment due to the effect of replacement schedules on depreciation reserves.

There are characteristic effects of a fall in the demand for output which can be classified in a similar manner, according to Hicks.[4] The first phase is that period of time when surplus stocks build up because of the fall in demand. This phase is followed by the disinvestment phase. In this phase surplus stocks are worked off and fixed equipment is not replaced as it becomes depreciated. The amount of disinvestment which

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[3]Hicks, Op. Cit., p. 51.

[4]Ibid., p. 51.

must occur in this phase will of necessity be spread over a longer period of time than would be involved in adjusting to an equal change in demand in the opposite direction. This is because depreciation schedules take time. The spreading out of the second phase dominates any third phase which may be present to the extent that if it emerges at all it is of negligible importance.

Agricultural investment will be subdivided into four categories in this study. They are: (1) Expenditures on buildings and farm construction, (2) Expenditures on farm machinery and equipment, (3) Changes in value of crop inventories, and (4) changes in value of livestock inventories. Each will now be examined separately with respect to the theory just advanced. It is possible that investment decisions peculiar to each category may be sorted out. If this is so, counteracting investment decisions could easily distort the observed connection between changes in the well-being of agriculture and subsequent agricultural investment.

In farm management work it is very difficult to estimate the useful life of farm buildings. A very slight recombination of enterprises on farms may be all that is necessary to show them to be grossly oversupplied with buildings. Capacity of buildings used for cattle feeding operations may be very elastic whereas in the case of poultry the range of optimum use is very narrow. For these reasons, the manner in which farmers respond to suggestions to build may vary considerably with the region and type of farming area. Changes in technology may make the desirability of investment in buildings apparent without inducement from endogenous forces. The bulk tank and pipeline milking systems need rather elaborate shelter. Such investment decisions may be weighted more significantly by institutional

requirement than by acceleration and be seemingly uncoordinated with either economic cyclical influences or agricultural well-being. If such is the case, the correlation between changes in value added by agriculture and changes in investment in buildings and farm construction would not be expected to be consistent with theory or demonstrate similarity between various time periods. This would be because technological inputs have probably been introduced in random lumps, with or without being in combination with some institutional device, which caused a discontinuity in the investment function. This would, of course, distort the fit of a linear regression equation.

Farmers may experience years of relative well-being combined with buoyant expectations. An appropriate condition to encourage the latter state would be an increase in the rate of output valued in real terms. That the level of investment in buildings could be associated with the change in rate at which output from agriculture is being added to the economy is a reasonable suggestion. But if there is a decrease in the rate at which income created in agriculture is being added to the economy farmers may recombine their resources to make different uses of buildings. Farmers may revalue the buildings and set up new replacement schedules which shape a disinvestment schedule which may vastly reduce the correlation between the level of investment and the change in rate of income being created in agriculture. The coefficient expressing the relationship of these two magnitudes could be much smaller when rate of change decreases than when rate of change increases.

The case of investment in machinery and equipment may be more clear-cut. In the first place, one way to make labor more productive is to place bigger

capacity machines in the hands of a given amount of labor. If, in accordance with the accelerator principle, more output is called for, the response will include investment in larger, more complex machines. Investment in machinery and equipment does involve some of the deferrable features brought out in the discussion of buildings and construction. Replacement of machinery does not involve a precise schedule. It is quite probable that there is a considerable volume of totally depreciated farm machinery (with respect to farm accounting) contributing to agricultural productivity. Here, as in buildings, it would seem that investment decisions may be conditioned by the buoyancy of expectations as well as by acceleration. Expectations of farmers could certainly be influenced by the waves of optimism and pessimism fostered by general economic conditions. General economic conditions may introduce an influence peculiar to farm machinery in that as prosperity advances it may be easier for farmers to obtain credit for the purchase of machinery. On the other hand when forces favoring contraction dominate the economy it may be difficult to finance desired new machinery. With the introduction of more specialized and expensive equipment for agriculture in recent years, this observation may be particularly relevant.

Although this study tests the presumed presence of accelerator action between changes in value added and associated investment, the preceding discussion suggests why the relationship may not be too clear, especially when dealing with fixed capital items. Investment decisions in buildings, other construction, machinery and equipment may depend on the level of general economic activity as well as the rate of change of value added by this sector. The internal capital accumulation of farmers affects their

rationing of capital and priority ratings. Assuming that new investment creates or expands productivity, it follows that investment in fixed capital can be shaped by what takes place in at least three classifications:

a. accumulation of capital

b. past changes in capital stocks

c. changes in value added

The interdependence of these categories may make it difficult to examine the latter classification with precision. However, the real purpose of this study, dictated primarily by our present state of knowledge, is to examine the plausibility of relationships and not to develop a tight system of equations to offer a complete explanation of the determinants of agricultural investment.

A rise in value added by the agricultural sector that has a particular association with livestock may not create an immediate need for an increase in livestock inventories because a part of the existing inventory is actually a reserve for such a case. But, with respect to the phases suggested by Hicks,[5] sooner or later livestock inventories will be adjusted to a higher level of output so that inventory turnover will approximate the customary velocity. This takes time with livestock, but in the case of poultry or even hogs, the lags may be comparable to construction and inventory lags in the business world.

In the previous discussion about stocks of fixed capital, the relevance of the availability of capital was introduced. This was discussed both with respect to internal capital accumulated as a result of past profitability and with respect to external capital. It was implied that availability of external capital would be connected in some sense to the level of general

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[5]Hicks, Ibid., p. 51.

economic activity. Investment in livestock inventories may not be so involved. Livestock inventories are more liquid assets than buildings, for example, and short term credit would probably be available to finance livestock expansion even when buildings and equipment could not be financed. It would seem that with an appropriate lag, the change in livestock inventories conforms more obviously to the acceleration generated by changes in value added.

Crop inventories and the way they change will be affected by the weather as well as the natural annual production turnover. Crop inventories are held for sale as cash, for livestock feed on the premises, or for seed. Decisions to adjust livestock inventories probably are associated with parallel decisions with respect to crops held for feed, assuming weather constant. There may also be independent decisions about adjusting crop inventories for cash sales. These decisions would be associated primarily with shifts in demand and extreme weather or other random distortions of the supply situation. However, it seems most appropriate to suggest that adjustment of crop inventories would be sympathetic to those in livestock because of the feed relation and also because the changing demand conditions would be more or less common to both categories.

Statistical Treatment

Data used in this study have been extracted from publications of the Agricultural Marketing Service, the Agricultural Research Service and other agencies of the U. S. Department of Agriculture. In addition, data have been used as found in the Survey of Current Business and its supplements, a publication of the U. S. Department of Commerce, and from R. Goldsmith's

"A Study of Savings."[6] Much of the background material from which these figures were assembled deals with estimates and index numbers. The range of error is quite large. Nevertheless, these data are believed to be the best available.

Unless specifically stated otherwise, data used in this study have been deflated in order to obtain a real value. Deflators are without doubt a source of error. Farmers who are making investment decisions may be conditioned more by dollar volume than by value measures or physical volume. The mechanical construction of a deflator involves some prior subjective treatment. Such error as may be present in method could very well compound or balance off existing error in the material to be deflated. However, because accelerator theories refer to real terms rather than to dollar terms, the decision was made to use deflated data. It seemed more appropriate in view of the concept behind the study. If an increase in effective demand results in an increase in prices, the part of the increase in demand that was absorbed by higher prices of former quantities would be eliminated through the deflation process. Perhaps even more important than the previous argument is the fact that general price level changes could work on both sides of any equations developed. Such price level changes could tend to favor a higher correlation and give an upward bias to the very thing from which bias is desired to be removed. This false sense of relation associated with the fluctuating general price level could favor a demonstration of a non-existent correlation between measurements which may be, in fact, totally unrelated.

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[6]Raymond W. Goldsmith, A Study of Saving in the United States, Princeton University Press, 1955.

The deflated capital stock and inventory figures are not used directly in multiple correlations but, instead, the differences between the values of consecutive periods are used. This means that change in capital stock, that is, the level of investment, is correlated with change in the rate at which income is created in the agricultural sector. Differences are used because, where using material that is subject to estimating error, a compounding of that error is avoided by their use. The error involved in misrepresenting a change in rate is in all probability less than the error involved in misrepresenting the absolute figure. That is, figures on annual changes probably give a more accurate measure than would estimates of the absolute level. This argument applies to the data on gross expenditures for capital equipment. Secondly, accelerator theories are framed in terms of changes. Third, differences are probably more independent of each other than are absolutes from previous absolutes, thus favoring a reduction of bias by using differences. Fourth, absolutes appearing to be correlated with each other may in fact be correlated to a trend. Because it is the short period relations with which this study deals, differences seem to serve better (granting that size of difference may be related to trend).

Time lags are difficult to handle when annual data alone are used. The opportunities for refinement are too few. Inspection of a graphical representations of each of several plots with "the nearest" independent and a dependent variable shows some coinciding years and some years where the dependent variable lags by one year. This suggests an average lag of less than one year.

Actually, there are at least two ways in which lagged relationships may be examined more closely by refining the data. The first is to make

estimates of less than annual periods by interpolation as just suggested. Values in periods of length less than $t-t_{-1}$ may be estimated by using $.25t + .75t_{-1}$ or $.50t + .50t_{-1}$, for example. The difficulty with interpolating in this manner is that averages modify or temper the basic figures from which they are derived. The manufactured averages may not reveal the sensitivity that is expected from the base figures. Then, too, tempering the fluctuations by introducing levels in between the annual figures gives a possible false sense of rhythm to the series which could be a mechanical source of bias. There is a way that a correction factor could be applied to the interpolated figures and compensate for such error. This method would involve identifying a series already reported on a monthly or quarterly basis and which is closely correlated with the annual series under study. Then, assuming a highly correlated proportional relation between the annual quotations for the two series, an adjusted interpolation could be computed for less than annual time spans. This method was experimented with in this study and seems to have merit. It was not used, because an alternative system seemed to have more value in the particular case of the figures employed.

Basically the chosen method was a fortuitous combination of variables to be studied. Gross National Farm Product is a flow reported at an annual rate. It can be visualized as an average rate centered in the middle of the year. The difference between two periods is really an average difference and would be centered at the end (or beginning) of a year. Beginning-of-year inventories are stock figures but the change from year to year is an average of a flow as stocks are built up or depleted. The change figure then should be centered at midyear. Gross additions to fixed

capital are a flow reported at an annual rate. If it is taken to be an average annual rate, the change again would be centered at midyear. Careful treatment and understanding of the data allow inspection of changes in investment and changes in Gross National Farm Product to be accomplished with an initial six month lag. This was judged more appropriate because even though annual accounting is typical for agriculture, farmers could very well adjust to changes or trends as they become apparent.

The Influence of Weather

If farmers attempt to adjust their investment to trade in a consistent manner, it means that they will decide or plan on a certain pattern. Weather can certainly distort plans, and it seems particularly appropriate to assume that deviations from planned crop inventories could very well result from the influence of weather. The shock of weather surprises can easily necessitate adjustment in every facet of the farm business. The major question dealt with by this study carries along with it an assumption that output changes and inventory changes have some proportional relation. This would suggest that if weather affects output, it must also affect inventory investment. If this is so,it would seem to be in the following manner. Farmers may decide on a certain change in crop inventory to accommodate their analysis of the adjustment needed for trade. Taking crops as the major absorbers of weather influence, abnormal changes can be reflected in two ways: first, the physical output will be modified, and second, because price and quantity movements are not necessarily proportional, value of output will change in a manner other than will quantity. If crop inventories can be deflated to account for such influence, it would allow

a more accurate estimate of the relation between what farmers plan to do as a result of deciding to adjust to the trade.

An index is available to use in attempting an adjustment for weather.[7] Stallings' index relates to crop output, so a method was devised for transferring the effects of weather on output to value of output. Changes in the price index of crops have exhibited a reasonably uniform relationship to changes in output. This is apparent when averaged over periods as short as five years and also when averaged for the forty nine observations used in this study (less the war years). On the average, it appears that an increase in output of ten percent has been associated with a decrease in price of six and three tenths percent. This is, of course, a very crude observation and the relationship incorporates such things as the effect of decreases in the cost of production as well as other things which are not being held constant. Yet, for estimates aimed at insights rather than detailed precision it seems that the effect of weather can be assumed to be associated in this same way. Therefore, in order to try and estimate how farmers may have "planned" to adjust their crop inventories, weather was assumed to have modified inventories in the same way that it modified output. Assuming that the elasticity estimate would allow an adjustment at least "in the right direction" a value of planned inventories can be computed. Planned changes in inventories are then merely the differences between observed inventories and succeeding planned inventories. There are more detailed methods of deflating a time series to avoid certain distortions. For example, crop inventory value can be computed as a regression

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[7]James L. Stallings, Indexes of the Influences of Weather on Agricultural Output, unpublished Ph. D. thesis, Michigan State University, 1958.

on the weather index to get an estimating equation, $Y = A + bX$, where Y is the estimated value of inventory index and X is the weather index. Then value of crop inventories index (Y) could be deflated by the procedure $\overset{*}{Y} = \frac{Y}{bX} + A$ to get an estimated value of crop inventories deflated by weather ($\overset{*}{Y}$).

This method of deflating the series, though appearing technically appropriate, yields some estimates that appear grossly distorted on inspection. This means that some other influential forces which desynchronize the relation between value of output and value of inventory have not been taken into account. This may mean that the sequence, phases of plans for adjusting crop inventories to changes in demand, has not been adequately pictured by using annual data. Until such forces or reasons are understood, it is believed that, for the purposes of this study, the estimated "direction of movement" factor is more appropriate, and so it will be used.

In summary, changes in variables are observed. Although reasons are advanced to show that a six month lag can be tested with the data as a result of the manner in which they are presented, lags of more than one annual period will be introduced as well. An attempt will be made to recognize the effect of weather on planned investment. The mechanics of preparing material to be handled on the electronic computer makes it easy to study simple correlations between all variables. This will aid in the ease of obtaining partial correlation coefficients.

CHAPTER III

PRESENTATION OF THE RESULTS

In this chapter, the summary of the results will be presented in tabular form. Several points will be brought up which need to be considered when the results are being interpreted.

The principle purpose of this study is to estimate the amount of agricultural investment induced by or associated with changes in the rate at which income is created in the agricultural sector. The full play of a multiplier-accelerator system takes in the resulting change on output from a change of investment and also the resulting changing level of investment associated with changes in the rate of output. Because the interaction of these forces suggests a tendency for output and investment to oscillate in some manner this study seeks to test the strength of one of these forces using the agricultural sector as a testing ground. If it is an inherently destabilizing force within its own sector it should be more completely understood. It may be that other, exogenous, forces do overpower or hide the potential strength of destabilizing powers within the agricultural sector itself. But, if this is so, the dominance of such exogenous forces may wax and wan or in some manner change in character over time.

In the statistical analysis, the regression of investment change on several periods of change in the income flow being created in agriculture is accomplished. Where sample size is adequate and coefficients are statistically significant at the levels chosen, the regression coefficients will be one measure of the nature of changes in the independent variables associated with changes in investment.

The regression coefficients, multiple and simple correlations were tested for statistical significance. By referring to a standard table showing "percentile value of 'student's' distribution"[1] the significance of the "t" for regression coefficients as computed by the electronic computer can be determined.

The simple correlations can be evaluated for significance by direct referral to a table.[2]

For the multiple correlations, the selected test was:

$$F = \frac{R^2}{1 - R^2} \times \frac{N - k - 1}{k}$$

This is an F distribution[3] with $n_1 = k$ and $n_2 = N-k-1$ where

R = the multiple correlation coefficient
N = the number of observations
k = the number of predictor variables

From the manner in which the material was prepared to fit into a multiple regression equation, it can be said that in equations meeting specified levels of significance, a regression coefficient of .80 for changes in GNFP during period t-2 indicates that an increase of $1 in GNFP during period t-2 would be associated with, on the average, $.80 in investment during the investment period t. In an introductory formulation, set up for the purpose of checking on the appropriateness of certain variables and lags, some tentative conclusions were reached. In order to avoid detail in some observations that could be very shallow

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[1]Dixon and Massey, Introduction to Statistical Analysis, McGraw-Hill, New York, 1957, p. 384.

[2]Dixon and Massey, op. cit., p. 468.

[3]Helen M. Walker and Joseph Lev, Statistical Inference, Henry Holt and Company, New York, 1953, p. 324

only a few of a considerable number of regression equations were selected for detailed examination. Those selected showed the higher values of the multiple correlation coefficient. See Table I. This technique focused attention on some problems. Using three periods of GNFP, it was obvious from the signs of the b values that a cyclical influence remained present in the time series. Examinations of the residuals of each equation suggested that the business cycle itself was a possible dominant influence.

The suggestion invited refined statistical treatment. A measure of economic activity introduced as an independent variable would allow the remaining independent variables to shed the influence of that cycle measure. As a result, the new total correlations may be improved. This was done, with results shown in Table II. In addition, it became possible to check the influence of the value added variables while holding the business cycle variable static. This can be done by deriving a partial correlation coefficient, testing the importance of all the "value added" variables together.[4]

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[4]The Partial R^2, (Ry123.4) = the Total R^2, (Ry1234) minus the simple R^2 between investment change and the business cycle level of activity measure, (r^2y4) divided by one minus the aforementioned simple r^2. This result has an F distribution subject to the test $F = \frac{(Ry123.4)\ (1-4^2y4)}{1-R^2y1234} \cdot \frac{N-5}{3}$
This procedure was suggested in a personal conference with Professor Robert Gustafson, Agricultural Economics Department, Michigan State University.

TABLE I. ESTIMATES OF AGGREGATE RELATIONS

Total Agricultural Investments and Sub-Categories

(First Run of Tentative Formulations)

Equation number (1910-58 less 1941, 42,43,44)	Coefficients of GNFP			Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Significant Levels			R^2
	t X_1	t-1 X_2	t-2 X_3	*	**	***	
45-8-a[a]	-.2659***[b] (2.4770)	-.1634 (1.2777)	.1025 (.9717)	-.2659			.1567
(1939-58 less 1941, 42,43,44) 16-2-a	.4742** (1.9489)	.2435 (.9519)	-.1960 (1.1766)		.4742		.2796
16-4-a	.3020** (1.9900)	.2017 (1.2644)	-.1255 (1.2083)		.3020		.3073
16-5-a	-.4136*** (2.9030)	-.1958 (1.3072)	.1735** (1.7784)		-.2402	-.4236	.4608
16-7-a	-.8679** (1.7715)	-.6503 (1.2627)	.4674* (1.3886)	-.4004	-.8679		.3093
16-8-a	-.4811** (2.2573)	-.1121 (.50025)	.1752 (1.2011)		-.4811		.3271
16-9-a	-.9251** (1.9729)	-.5556 (1.1273)	.4715* (1.4689)	-.4536	-.9251		.3230
(1939-48) 10_2-1-a	.8248** (2.0782	.4566 (.9345)	-.4268 (.0131)		.8248		.4993
10_2-2-a	.0995 (.5910)	-.4057** (1.9573)	-.2272* (1.6472)	-.6330	-.4057		.5831

(continued on next page)

Equation Number (1910-58 less 1941, 42,43,44)	Coefficients of GNFP			Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Significant Levels			R^2
	t X_1	t-1 X_2	t-2 X_3	*	**	***	
10_2-4-a	.1142 (1.1480)	-.2013* (1.6443)	-.1252* (1.5355)	-.3265			.5941
10_2-6-a	.7417*** (3.4548)	.4655** (1.7615)	-.2771** (1.5748)		.9301	.7417	.7061
10_2-7-a	.7253 (1.9280)	.8623** (1.8621)	-.1995 (.6470)		1.5875		.4789

(a) The equation number has three elements separated by dashes. The first element indicates the number of observations. The second element identified the dependent variable. The third element tells which general formulation was used. Only two formulations were used in this study, the first of which is "a". The dependent variables are numbered as follows:

1. Changes in gross agricultural investment.
2. Changes in investment in all capital equipment. (3+4)
3. Changes in gross investment in farm buildings and construction.
4. Changes in gross investment in farm machinery and equipment.
5. Changes in crop inventory value.
6. Changes in livestock inventory value.
7. Changes in crop and livestock inventory value. (5+6)
8. Planned inventories in crop inventory value (crop inventories adjusted for weather).
9. Changes in planned crop inventory value plus changes in livestock inventory value. (6+8)
10. (9+2)

See Appendix A -- Table I, for basic data from which these figures were developed.

(b) The figure in parenthesis is the "t" value in each case and is appropriate to use in a test of significance of the coefficients of GNFP (b value) assuming a "t" distribution.

* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

TABLE II. ESTIMATES OF AGGREGATE RELATIONS

Total Agricultural Investment and Sub-categories

Final Formulation

Equation Number (1910-58)	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *8	**	***	All	R^2	$R^2_{y123.4}$ (c)	r_{yr} (d)
49-1[a]	.3086*	.0106	.0653	9.8633***							
	(1.3727)[b]	(.0417)	(.3013)	(4.0798)	.3086			.3845	.3185**	.074	.516**
49-2	.0935	.0513	-.0142	8.8928							
	(1.3796)	(.6687)	(.2174)	(12.0752)	.0935			.1306	.7720***	.043	.893***
49-3	.0184	.0114	.0066	3.2314				.0364	.6430**	.008	.800**
	(.5442)	(.2992)	(.2028)	(8.8586)							
49-4	.0682*	.0270	-.0289	5.6324							
	(1.5783)	(.5523)	(.6939)	(12.1127)	.0683			.0663	.7745***	.064	.871***
49-5	-.0007	.0001	.1062	.2533)							
	(.0079)	(.0011)	(1.1831)	(.2533)				.1056	.0453	.044	.039
49-6	.2255	-.0232	-.0163	.7714							
	(1.3120)	(.1195)	(.0983)	(.4176)	.2255			.1860	.0663	,059	.070
49-7	.2228	-.0257	.0883	.9891							
	(1.0011)	(.1021)	(.4114)	(.4130)				.2854	.0593	.055	
49-8	-.1987**	-.1043	.1019	-.4220							
	(1.9409)	(.8998)	(1.0317)	(.3833)		-.1987		-.2011	.1078	.104	-.062
49-9	.0266	-.1277	.0855	.3501							
	(.1211)	(.5118)	(.4022	(.1477)				-.0156	.0311	.030	.026
49-10	.1124	-.0912	.0627	9.2227							
	(.4983)	(.3568)	(.2878)	(3.8002)				.0839	.2697**	.033	.495

1910-58 ess 1941, 2,43,44) quation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels *	**	***	All	R^2	$R^2_{y123.4}$	r_{y4}
45-1	.1081	-.1074	.1448	10.2739				.1455	.3529**	.066	.554**
	(.4680)	(.4134)	(.6676)	(4.3238)							
45-2	.0934*	.1062*	.0359	9.2203	.1996			.2355	.8200***	.062	.899***
	(1.3937)	(1.4076)	(.5702)	(13.3657)							
45-3	.0223	.0311	.0300	3.5159				.0834	.7582**	.041	.865**
	(.7262)	(.9006)	(1.0415)	(11.1216)							
45-4	.0633*	.0605	.0028	5.7598	.0633			.1256	.8008***	.058	.888***
	(1.4166)	(1.2029)	(.0679)	(12.5200)							
45-5	-.0541	-.0709	.0888	.0150				-.0362	.0639	.064	-.003
	(.5630)	(.6548)	(.9831)	(.0151)							
45-6	.0798	-.1227	.0312	1.0108				-.0117	.0584	.051	.091
	(.4459)	(.6093)	(.1856)	(.5488)							
45-7	.0235	-.1968	.1182	.9866				-.0551	.0717	.068	.067
	(.1034)	(.7689)	(.5536)	(.4216)							
45-8	-.2576	-.1720	.0934	.5848				-.3362	.1498	.143	-.092
	(.7487)	(.4442)	(.2892)	(.1652)							
45-9	-.1778	-.2949	.1245	.4267				-.3472	.0743	.074	.026
	(.7922	(1.1676)	(.5909)	(.1847)							
45-10	-.0932	-.2054	.1512	9.7123				-.1474	.3231**	.057	.531**
	(.4037)	(.7904)	(.6975)	(4.0874)							

(1910-1938) Equation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *	**	***	All	R^2	$R^2_{y123.42}$	r_{y4}
29-1	.2588	-.0194	.0663	-2.5992				.3057	.1211	.119	-.039
	(1.1844)	(.0731)	(.2680)	(.2491)							
29-2	.0721*	.1085**	.0722*	4.8975	.2528	.1085		.2528	.2734	.174	.347**
	(1.645)	(2.0380)	(1.4560)	(2.3394)							
29-3	.0130	.0396	.0481*	1.2789	.0481			.1013	.1036	.093	.107
	(.4627)	(1.1547)	(1.5074)	(.9483)							
29-4	.0469**	.0456	.0090	4.0592	.9025	.0469		.1015	.3723**	.129	.529***
	(1.7861)	(1.4295)	(.3040)	(3.2374)							
29-5	.0238	-.0247	.0863	-1.6511				.0854	.0691	.063	-.080
	(.2070)	(.1766)	(.6612)	(.2999)							
29-6	.1749	-.0799	-.0772	-6.2862				.0178	.1240	.111	-.123
	(1.1388)	(.4281)	(.4442)	(.8570)							
29-7	.1988	-.1047	.0090	-7.9374				.1031	.1240	.109	-.130
	(.9261)	(.4012)	(.0373)	(.7743)							
29-8	-.2197**	-.2011	.0581	-4.2779		-.2197		-.3627	.1675	.150	-.145
	(1.7237)	(1.2977)	(.4028	(.7030)							
29-9	-.0448	-.2813	-.0192	-10.5593				-.3453	.1060	.079	-.171
	(.2004)	(1.0333)	(.0761)	(.9877)							
29-10	.0152	-.1957	.0381	-5.2260				-.1424	.0749	.069	-.083
	(.0665)	(.7032)	(.1470)	(.4780)							

920-1940 quation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *	**	***	All	R^2	$R^2_{y123.4}$	r_{y4}
21-1	.1877	-.0747	.0089	11.6474				.1219	.1388	.091	.229
	(.7057)	(.2379)	(.0343)	(.8115)							
21-2	.0168	.0111	-.0092	14.5322				.0187	.9388***	.081	.967***
	(.9449)	(.5269)	(.5289)	(15.0931)							
21-3	.0015	.0055	.0039	5.0817				.0109	.6714***	.005	.818**
	(.0902)	(.2724)	(.2344)	(5.4553)							
21-4	.0153	.0055	-.0132	9.4504				.0760	.7320***	.035	.850***
	(.5499)	(.1689)	(.4845)	(6.2930)							
21-5	.0359	.1050	.1318	-1.6719				.2727	.0667	.067	-.006
	(.2748)	(.6803)	(1.0262)	(.2371)							
21-6	.1349	-.1909	-.1135	-1.2127				-.1695	.1683	.168	-.018
	(.7369)	(.8826)	(.6310)	(.1227)							
21-7	.1709	-.0859	.0182	-2.8847				.1032	.0931	.093	-.017
	(.6523)	(.2775)	(.0709)	(.2041)							
21-8	-.1609	-.0919	.0956	-1.9699				-.1572	.0978	.091	-.090
	(1.0228)	(.4946)	(.6184)	(.2321)							
21-9	-.0259	-.2829	-.0179	-3.1827				-.3267	.0962	.093	-.065
	(.0955)	(.8809)	(.0672)	(.2170)							
21-10	-.0091	-.2718	-.0272	11.3494				-.3081	.1141	.086	.176
	(.0329)	(.8325)	(.1003)	(.7613)							

1939-1958) Equation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *	**	***	All	R^2	$R^2_{y123.4}$	r_{y4}
20-1	.4657	-.0290	-.1065	4.5249				.3302	.0952	.063	.184
	(.8820)	(.0512)	(.2493)	(.6519)							
20-2	.1686	-.4746	-.1587	7.6215				-.4647	.5023**	.131	.654***
	(.9667)	(.2529)	(1.1240)	(3.3236)							
20-3	.0360	-.0356	-.0484	3.8735				-.0480	.4991**	.055	.685***
	(.4377)	(.4028)	(.7271)	(3.5806)							
20-4	.1349	-.0052	-.1086	3.7898				.0211	.4300	.162	.565***
	(1.2204)	(.0438)	(1.2131)	(2.6074)							
20-5	-.0544	.0466	.0750	-2.2178				.0672	.0953	.028	-.263
	(.3126)	(.2489)	(.5319)	(.9680)							
20-6	.3570	-.0218	-.0197	-.8252				.3155	.0574	.057	-.023
	(.8216)	(.0467)	(.0561)	(.1441)							
20-7	.2969	.0183	.0522	-3.0977				.3674	.0385	.027	-.108
	(.5505)	(.0315)	(.1197)	(.4368)							
20-8	-.1676	.0632	.0726	-2.8116				-.0318	.1701	.088	-.300
	(.8969)	(.3146)	(.4797)	(1.1442)							
20-9	.1893	.4138	.5284	-3.6368				1.1315	.0308	.012	-.138
	(.3697)	(.0751)	(.1274)	(.5402)							
20-10	.3579	-.0060	-.1059	3.9847				.2460	.0680	.042	.170
	(.7016)	(.0110)	(.2564)	(.5941)							

939-58 ess 1941, 42,43,44) Equation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *	**	***	All	R^2	$R^2_{y123.4}$	r_{y4}
16-1	-.3715 (.5242)	-.6054 (.8463)	.1916 (.4062)	9.6702 (1.2364)				-.7853	.1674	.092	.287
16-2	.3120* (1.4343)	.1655 (.7536)	-.1214 (.8383)	5.7041 (2.3755)	.3120			.3561	.5238	.179	.648***
16-3	.0944 (1.0463)	.0122 (.1347)	-.0315 (.5255)	7.8771 (2.8894)				.0751	.5462**	.105	.702***
16-4	.2202* 1.4955)	.1624 (1.0924)	-.0879 (.8968)	2.8779 (1.7706)	.2202			.2952	.4609	.217	.559***
16-5	-.3382* (1.5684)	-.2210 (1.0156)	.1183 (.8242)	.4176 (.1754)	-.3382			-.4409	.2219	.211	-.118
16-6	-.3362 (.5700)	-.5393 (.9056)	.1976 (.5033)	3.5720 (.5486)				-.6778	.1177	.112	.078
16-7	-.6838 (1.9892)	-.7710 (1.1050)	.3132 (.6806)	3.9658 (.5198)				-1.1416	.1651	.165	.024
16-8	-.3978* (1.5024)	-.1162 (.4348)	.1222 (.6936)	-.7255 (.2482)	-.3978			-.3918	.2183	.180	-.215
16-9	-.7341 (1.1059)	.6555 (.9783)	.3199 (.7240)	2.8245 (.3885)				.2413	.1563	.156	-.002
16-10	-.4220 (.6123)	-.4900 (.7043)	.1985 (.4376)	8.5506 (1.1240)				-.7135	.1338	.073	.255

(1939-1948) Equation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *	**	***	All	R^2	$R^2_{y123.4}$	r_{y4}
10_2-1	.8077* (1.8800)	.4034 (.7443)	-.4982 (1.2728)	-4.7574 (.4097)		.8077		.7129	.5156	.515	-.007
10_2-2	.1185 (.7261)	-.3465* (1.6826)	-.1477 (.9933)	2.1360 (1.2024)	-.3465			-.3757	.6766	.549*	.532*
10_2-3	-.0040 (.0350)	-.1717*** (2.9908)	-.0713 (.6692)	2.0121 (.6365)			-.1717	-.2470	.4014	.270	.424
10_2-4	.1260 (1.3301)	-.1643 (1.3742)	-.0754 (.8740)	2.1360 (1.2932)				-.1137	.6958	.588*	.512*
10_2-5	-.0234 (.1012)	.3748 (1.2824)	.0461 (.2280)	-1.9637 (.3136)				.3975	.3550	.315	-.241
10_2-6	.7127*** (3.6622)	.3751* (1.5278)	-.3986** (2.2485)	-8.0977 (1.5397)	.6892	.3141	.7127	.6892	.8006**	.792**	-.200
10_2-7	.6892* (1.8182)	.7500* (1.5681)	-.3505 (1.0149)	-10.0614 (.9821)	1.4392			1.0887	.5632	.528	-.273
10_2-8	-.2441 (.8988)	.2715 (.7923)	.0273 (.1105)	-5.6287 (.7668)				.0547	.4330	.355	-.348
10_2-9	.4685 (1.1620)	.6467 (1.2711)	-.3712 (1.0107)	-13.7265 (1.2597)				.7440	.5001	.420	-.373
10_2-10	.5870 (1.3097)	.3001 (.5307)	-.5190 (1.2709)	-8.4224 (.6953)				.3681	.4161	.031	-.1029

1949-1958) Equation Number	Coefficients of GNFP t X_1	GNFP t-1 X_2	GNFP t-2 X_3	Business Cycle Variable X_4	Total Investment Coefficients (Summation of "b" Values of GNFP Variables at Several Levels) *	**	***	All	R^2	$R^2_{y123.4}$	r_{y4}
10-1	-.5016 (.3492)	-.6445 (.4443)	.2749 (.2371)	.2915 (1.1600)				-.8712	.1049	.095	.101
10-2	-.0211 (.2425)	-.1284* (1.4557)	-.0959 (1.3610)	-7.8637 (5.1447)	-.1284			-.2451	.8544**	.341	-.883***
10-3	.0059 (.1006)	-.0242 (.4082)	.0010 (.0229)	-1.4870 (1.4463)				-.0173	.3045	.084	-.491
10-4	-.0271 (.3648)	-.1042 (1.3887)	-.0970* (1.6183)	-6.3766 (4.9051)	-.2012			-.2283	.8506**	.378	-.872***
10-5	.0032 (.0099)	-.3417 (1.0532)	-.0967 (.3736)	-1.2866 (.2288)				-.4352	.2412	.239	.056
10-6	-.4672 (.3868)	-.1570 (.1287)	.4774 (.4896)	9.4281 (.4462)				-.1468	.1460	.086	.256
10-7	-.4808 (.3332)	-.5160 (.3541)	.3714 (.3188)	8.1531 (.3230)				-.6254	.1390	.091	.229
10-8	.0653 (.2277)	-.3401 (1.1736)	-.1692 (.7306)	-5.0255 (1.0010)				-.4440	.3324	.287	-.251
10-9	-.4018 (.2937)	-.4971 (.3598)	.3081 (.2790)	4.4025 (.1839)				-.5858	.1103	.084	.170
10-10	-.4230 (.3106)	-.6256 (.4549)	.2121 (.1930)	-3.4611 (.1452)				-.8365	.0904	.089	.031

(a) The equation number has two elements separated by a dash. The first element indicates the number of observations. The second element identified the dependent variable. The dependent variables are the same as in Table I.

(b) The figure in parenthesis is the "t" value in each case and is appropriate to use in a test of significance of the coefficients of GNFP (b value) assuming a "t" distribution.

(c) Partial correlation coefficient, investment with X_1, X_2, X_3 holding influence of X_4 constant.

(d) Simple correlation between investment and X_4.

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

CHAPTER IV

ECONOMIC CONCLUSIONS

This study sought to determine (a) the presence of induced investment in agriculture and (b) the character of such induced investment as may be present. Induced investment was to be examined with respect to its strength as a destabilizing influence on the well-being of agriculture. This influence would become apparent as a result of investment generated by changes in the value added to national product by the agricultural sector. In Chapter II it was proposed that the investment coefficients, that is, the "b" values of the "value added" variables would reveal their ability to destabilize by their size. If, at the level of significance chosen, the summation of statistically significant "b" values is greater than two (as discussed in Chapter I), this fact would add encouragement to the suggestion that forces which persistently destabilize the well-being of agriculture can very well be generated within the agricultural sector itself. Such does not seem to be the case as the results are reviewed in Table II. True enough, in a number of regression equations which were statistically significant at either the 1 per cent or 5 per cent level when R^2 was examined, the "b" values of one or more of the "value added" variables were also statistically significant. This indicated the presence of induced investment associated with these variables. Nevertheless, the magnitude of that induced investment was such that in the terms of Hicks' theory any distortions given to existing patterns or equilibrium seeking trends would soon dampen out. Furthermore, the presence in many of the equations of both positive and negative signs for the "b" values of the "value added" variables is not easy to interpret. Following

the observation that the introduction of a business cycle variable removed some of the diverse influence which must have caused this appearance of opposite signs, it can only be suggested that the existence of livestock cycles themselves could be another distorting factor.

The presence of a business cycle variable in these equations gives results which are very interesting with respect to the influence of that variable. In simple correlations between agricultural investment and the business cycle variable, investment in buildings and machinery, and in machinery alone, the association is significant for all time periods chosen and at the 1 per cent level in most cases. Furthermore, over the two longest time runs--that is, from 1910 through 1958 and during the same period excluding World Was II--this high level of significance is also shown between the business cycle variable and total agricultural investment. The relationships between the business cycle variable and crop inventory changes or livestock inventory changes are not very highly correlated and do not exhibit any consistent pattern between the different time periods. The examination of a partial correlation coefficient which holds the business cycle variable static in order to observe the influence of the other three independent variables on the investment variable clearly demonstrates the importance of the level of economic activity in relation to investment in agriculture and, particularly, capital equipment. Acknowledging the dominant nature of the business cycle as revealed in the regression equations, the following can be said about the sub-categories of investment.

Livestock inventory changes appeared significantly sensitive to changes in real value added during the period 1910 through 1958, (but the part of the inventory change explained by the total regression equation was not

statistically significant at the selected level) and for the period 1939 through 1948. In the latter period the equation was statistically significant at the 10 per cent level of significance. It is interesting to note that during 1939 through 1948, the induced investment as revealed by the "b" values in the livestock inventory equation was significant with respect to each independent variable. This significance at the 10 per cent level, and really in most cases the 5 per cent level, was also apparent in a test of the partial correlation coefficient referred to in the previous paragraph. Because the 1939-1948 period encompassed years of booming economic activity and the most optimistic kind of expectations on the part of farmers, a study of it would be expected to show special relationships probably not apparent in other time periods. This equation is but one of eight with similar variables.

Crop inventory changes are significantly sensitive to changes in the way value is added only in the 16-year span between 1939 and 1958, excluding World War II. However, planned crop inventory changes[1] were significantly sensitive in time periods from 1910 through 1958, and 1910 through 1939, as well as the aforementioned time span. Although in no case was the R^2 significant at the 10 per cent level or higher, the R^2 of equations using planned crop investment changes was higher than was the R^2 in equations using actual crop inventory changes in seven out of eight cases. In the eighth case, the R^2's were about the same. Although this suggests that the attempt to acknowledge the influence of weather was "in the right direction," the percentage of the change in crop inventory as explained by these variables was too low to encourage a great deal of speculation about the meaning of the results.

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[1]Crop inventory change adjusted for weather.

The references to "significance" introduce more important observations than the limited cases just discussed. In the series of eighty equations, twenty five had R^2's significant at the five per cent level or higher. This indicates that more substance had been advanced to explain the relationships than would have occurred by mere chance and that analysis will have a greater depth of meaning as a result. The "b" values of the GNFP variables show the relationship between the flow of value added to the economy from the agricultural sector and the level of agricultural investment. It was said in Chapter II that the total investment coefficient would be found by summing the "b" values of coefficients of GNFP variables in a regression equation. The ability of a changing rate of output to initiate a destabilizing force was to be indicated by the size of the total investment coefficient.

The problem of determining the meaning of "b" values having different signs and occurring in the same equation has arisen. This could mean that livestock cycles or some other cyclical influences were not adequately recognized. Furthermore, when "b" values are summed, the total investment coefficients sometimes show different signs for different investment categories. See Table II. There are cases where some of the total investment coefficients for one investment category have different signs for different time periods.

There is more that can be said about the coefficients than superficial discussions about levels of significance and signs. In the multiplier-accelerator framework and the underlying difference equations, the ability of total investment coefficients to foster an initial displacement does not depend on the sign of the coefficient. Either a positive or a negative

investment coefficient can initiate an oscillation. A graphical plot of a path traced by a wave initiated with the aforementioned oscillation may well have its character as to amplitude and wave length determined by the sign as well as the size of the investment coefficient. But the initial ability to foster displacement is a function of the absolute nature of the coefficient and not of it sign. To expand on this observation, the investment coefficients for each category in the eight time periods were averaged without regard to sign. The results appear in Table III.

TABLE III. AVERAGES OF ABSOLUTE INVESTMENT COEFFICIENTS, ALL TIME PERIODS.

Category	Size
Crop inventory changes plus Livestock inventory changes	.4712
Planned crop inventory changes plus livestock inventory changes	.4672
Change in level of Total Agricultural Investment. (Gross)	.4571
Change in the level of total gross agricultural investment adjusted for weather	.3781
Livestock inventory changes	.2768
Gross investment in buildings and construction plus gross investment in machinery and equipment	.2599
Planned changes in crop inventories	.2477
Changes in crop inventories	.2301
Gross investment in machinery and equipment	.1074
Gross investment in buildings and construction	.0773

Table III shows that the size of the total investment coefficient is positively associated with changes in the value of livestock inventories and also with these inventory changes in combination with the changes in crop inventories. This observation is consistent with the argument developed in Chapter II . In that chapter a number of factors were discussed which could counteract or delay investment in fixed capital items but it was suggested that livestock inventories might be most sensitive to induced changes.

In addition to observing the difference in size of total absolute investment coefficients for the several categories of agricultural investment, there is a way to see how these coefficients have changed over time. The average absolute coefficients for periods studied prior to 1940 have been compared to those for periods 1939 through 1958 and 1949 through 1958. The resulting relationships are shown in Table IV.

TABLE IV. RELATIONSHIPS BETWEEN INVESTMENT COEFFICIENTS FOR YEARS 1910-1940 AND TWO POST 1940 PERIODS

	49-58/10-40	39-58/10-40
Value of inventory changes, crops and livestock	6.0600	7.8157
Value of inventory changes, livestock	1.5667	4.8856
Total Gross agricultural investment	4.0740	3.1556
Gross expenditures on machinery and equipment	2.5709	3.0200
All gross capital equipment expenditures	2.8070	2.6565
Total gross agricultural investment with Value of crop inventories adjusted for weather	1.7434	2.0107
Value of inventory changes, crops	2.4783	1.8726
Gross expenditures on buildings and construction	.3084	1.7165
Value of planned inventory changes, crops	1.7083	.8872

Table IV shows that there have been some distinct shifts in emphasis over time. Post 1940 years have seen total inventory levels become from six to eight times more sensitive to changes in value added than in pre 1940 years. Other categories of recent investment range down to a unitary relation or an inverse relationship with earlier years. Some explanation can be suggested for these relationships appearing as they do, but the reasoning must be evaluated in the light of the quality of the statistics as has been mentioned previously.

In the early years of this study, planned crop inventories were subject to induced pressures, to a greater extent than were the actual inventories of crops. (Table II) In recent years, however, the evidence shows that planned inventories and actual inventories of crops have been more nearly the same. The character of the induced part of crop inventory changes was nearly the same for planned and actual when measured either by the magnitude of the total investment coefficients or by the value of R^2. Also in recent years technology has advanced to help overcome the perils of weather. The reasons for holding crop inventories have not changed a great deal over time. Induced changes in this category, therefore, can be envisioned to be stable over time. Livestock inventories, on the other hand, have changed in reason for existence over time to the extent that horses and mules have been a stable part of the category. Such induced pressures as could have been directed at the horse and mule element would have been met with the resistance associated with delays in reproduction.

This brief examination of the extremes noted in Table IV show the speculative nature of explanations. A category where the ratio is more moderate includes gross expenditures on machinery and equipment. In recent

years farmers were no doubt much more sensitive to the part played by machinery in the productive farm plant. Mechanized operations are being supplemented with further mechanization. The opportunities for substitutions between machinery and labor seem to favor going from labor to machinery with what might be termed a ratchet effect. There appears to be little incentive to reverse the shift. Thirty years ago this condition was not so apparent. The matter of machinery obsolescence was probably not as great a concern to a farmer making investment plans thirty years ago as it is today. Now, commercial farming requires the use of specialized, complicated, expensive machinery and equipment. In modern agriculture this may have forced the farmer to make greater use of external financing with respect to this category. The relative availability of such finance through the different phases of the business cycle could have a decided influence on the investment actions of farmers.

Capital expenditures on buildings and farm construction show a low level of influence by acceleration and not much change in this level over time. Gross expenditures in this category are not highly correlated with economic activity, either. Two observations seem appropriate. Anticipated returns from construction inputs must be calculated on a long run basis and, therefore, may be influenced in only a minor way by short run changes in the rate of value added. The relative liquidity of assets in buildings and construction is so low that at best, external financing would again be subject to an availability effect in sympathy with the business cycle. The tendency to use internal financing for building and construction investment is probably stronger for this category rather than for any other category of investment in agriculture. Very little is known about what prompts

internal financing in agriculture. The gross effect of internal financing for building and construction purposes would not necessarily show sympathy with the business cycle or with short run changes in the rate of value being added to the economy by agriculture, at least in the framework being discussed in this study.

To combine and array this data as done in Tables III and IV may be taking liberties uncalled for in either the Hicks type multiplier-accelerator theories or the modified versions suggested by Eckaus.[2] In view of the low levels of significance further abuses of the data may deserve less than detailed attention. Nevertheless if the value of an "initial disturbance" is not wholly consistent with a traditional accelerator model, reference can be made to some business cycle models which depend on random or erratic shocks to keep a fluctuating system in motion.[3] Analysis based on points associated with such models will not be pursued in this study other than to observe that suggestions have been made about other theoretical connections with which oscillations may be linked.

The presentation in the previous two tables and the discussion of the information in them was prompted by the striking difference between the size of the accelerator for inventory changes which included livestock and for the most unresponsive category of investment, buildings and construction. There are a few things that can be said about these other categories, however.

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[2] Op. cit.

[3] R. Frisch, "Propogation Problems and Impulse Problems in Dynamic Economics", in Economic Essays in Honor of Gustav Cassel, (London, 1933) referred to by Alexander David Knox, author of "On a Theory of the Trade Cycle" in Readings in Business Cycles and National Income by Alvin Hansen and Richard Clemence, Norton and Company, New York, 1953. See also M. Kalecki, Theory of Economics Dynamics, Allen and Unwin, Ltd. London, 1954.

In only two cases did investment in buildings show a significant sensitivity to inducement by changes in value added: during the period from 1910 through 1939, where the only significant variable had a 2½-year lag, and in the 1939 through 1948 10-year period, where the only significant variable had a 1½-year lag. These are the only two equations which include only buildings and construction where the business cycle variable showed no significant influence, but the total R^2 is not significant either.

Investment in machinery and equipment showed a significant sensitivity to inducement from changes in value added in equations over five different time periods. Here the appropriate level of significance for the appropriate variables was just short of the 10 per cent level in a sixth time period. The 20-year span from 1939 through 1958 and the 21-year period from 1920 through 1940 revealed a very low sensitivity of investment in machinery and equipment to changes in the value added variables.

Equations 10_2-7-a and 10_2-7 suggest that when income created in agriculture advanced over previous rates by $1.00, crop and livestock inventories were changed in the same direction by about $1.50. This is not too unrealistic for the World War II period characteristic of most of the ten years included in this series. During the World War II period, there was great pressure on farmers to increase production. The capacity of the crop and livestock-producing mechanism was deliberately expanded. Expectations were buoyant. On the other hand, the negative sign of the total investment coefficient for equation 16-7-a seems to indicate that just the opposite atmosphere prevailed on the average during the 20-year period from 1939 through 1958 (excepting the four World War II years of 1941, 1942, 1943, and 1944). Following World War II farmers were looking for a downward

readjustment in commodity and land prices. Therefore, it would seem that when GNFP showed a positive change, inventories would be reduced to take immediate advantage of the new level. Farmers were very undecided about the future. Possibly the dampening of such traditional signals of the level of demand as broad swings in prices received by farmers reduced their ability to forecast. Subtracting from the data four World War II years which favored accurate forecasting and adding ten years which at least did not favor the World War II kind of forecasting may have changed the average lag relationship in the time series so that the signs in the regression equation appear the way they do. At any rate, these two examples of investment coefficients suggest that there could have been influences generated in the handling of inventories that at least contributed to cyclical pressuring of farm income away from an equilibrium level. At the levels chosen, the only statistically significant equations for total agricultural investment, as defined in this study, was number 10_2-1-a. This equation supplied a total investment coefficient of .8248.[4] Although according to accelerator theory, cyclical pressures generated by this relation would be dampened, an initial destabilizing force is present. The R^2 is such that even after being adjusted for degrees of freedom in this relatively short period, 25 per cent of the variation in total investment can be ascribed to inducement by changes in GNFP. To describe these investment coefficients in another way, the theory stated in an earlier section may be paraphrased. During most of the years 1939 to 1948, expectations were buoyant enough so that induced disinvestment in stocks, the "early" reaction to the accelerator, was quickly overcome and the induced readjustment had taken place by the time annual data was recorded. During most of the 16 years studied between 1939 and 1958, however, expectations were dominated by pessimism and the "early" disinvest-

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[4]Equation 10_2-1, though not having an R^2 significant at the 10% level, shows a "b" value of .8077, significant at the 5% level.

ment in stocks precipitated by an increase in GNFP was not adjusted by the end of the recording period, either because of poor forecasting or gross pessimism.

Earlier in this study it was mentioned that whereas agricultural income and one of its more volatile determinants, agricultural investment, fluctuated more or less in phase with the business cycle, the relationship had become blurred in the recent post World War II years. Some evidence was supplied as to why the pressures of demand had tended to stabilize and thus may have become overshadowed in influence on agricultural well-being by other forces. In the statement of the problem, it was suggested that the operation of an accelerator phenomenon might, through induced investment and its subsequent effect on income, distort or shift the pattern of aggregate income and output in agriculture so as to obscure or modify its former relation with the business cycle. This analysis has not dealt with a complete study of income determination in agriculture but only with the determinants of investment, and only a partial test of one type of theory at that. Nevertheless, the results at this point show some existence of an induced quantity in the investment "mix," both in total agricultural investment for one series and in special cases for sub-categories of investment. Furthermore, that part of the investment examined and not appearing to the "induced," by changed in GNFP, at any rate, and the fluctuations of the business cycle show considerable affinity. In addition, if "Demand Determination" is no longer a major influence on agriculture--either in profit determination or in shaping major inducements to invest--then one must turn to the factor supply side of agriculture for the major influences of changes in agricultural well-being. With more

and more emphasis being placed on purchased inputs which are either products of or competing with the business and industrial sector, it is no wonder that agriculture should show increased sympathy with the business cycle. But farm produced inputs may rise and fall in importance both as livestock cycles move broad swings, as weather shapes output and as the accelerator works on inventories. This offers some explanation of the blurred relationship between agriculture and the business cycle.

The argument that agricultural investment could show expanding phases and contracting phases in timing with the broad swings in the total economy seems to be sound. Farmers would show more hesitation in the purchasing of factors when the price on those factors of production begins to appear unfavorable in relation to the output which they generate. Typically, factor prices show a disproportionate rise as the expanding cycle of business nears its peak. Of course, the business cycle is an aggregate phenomenon and sums the reactions of each sector in the economy. Nevertheless, most descriptive analyses of the cycle sequence stress the causal relationships inherent in the circumstances apparent at the various stages of the cycle. These causal features may be acknowledged both through the psychological play on expectations as well as through the plain necessity of adjusting inventories, and finance, for example.

The variations in signs of coefficients as well as magnitudes suggests that farmers may demonstrate a forecasting ability that varies in accuracy. If it were impossible to guess the direction of GNFP or to adjust investment to trade when changes occur, then a very high negative correlation would exist between change of GNFP during a given period and investment during the same period. This is because an increase in GNFP would cause an initial

depletion of stocks and a decrease in GNFP would be associated with an initial accumulation of stocks.

There are many reasons why a higher degree of correlation may not be demonstrated or why the correlation coefficients cannot be "improved" in this test of the accelerator in agriculture. Some of these reasons are: (1) unknown problems in financing capital equipment; (2) uncertainty of farmers regarding permanency of indicated changes in demand; (3) delays in building up inventories because of plant and animal production cycles and, notwithstanding the previous analysis, possible delays in obtaining capital equipment because of no excess capacity in industry supplying farmers. In other words, the stage of the business cycle itself may be an important reason here; (4) smooth adjustment may be prevented because of discontinuities of the production functions or indivisibilities; (5) changes in level of well-being may influence a farmer's investment decisions in some way different from the influence of changes in GNFP as described in this study; (6) the unit of time measurement in this study does not allow adjusting to minor changes in lag relationships.

Weather

There is some question whether or not to try and deflate for "weather." Some difficulties arise. First, years of good or bad weather sometimes follow each other for several years in a row. This makes it difficult to say "what might have been." It is important to recognize that in agriculture, because the life cycle of farmers actually involves such a few production turnovers, extended periods of good or bad weather can distort concepts of normal farm business life expectancy and level. Second, other things remaining the same, large crops generally bring less total revenue than small crops, excepting complete failure. But there

is little reason to believe that farmers in the aggregate do recognize and take into account this phenomenon in a characteristic manner. This is because different elasticities are associated with different products. Over time and over cycles, the aggregate shifts in commodity selection are extremely complex. This all means that investment plans conditioned by changes of value added probably are influenced by weather, but it is difficult to predúct what the aggregate effect really is. Yet, it seems probable that the direction of changes caused by weather would come about as described in this study. The weather index used in this study is not quite conceptually complete in that it is not clear what an index of zero could mean, or for that matter, fifty. Again, however, it appears that direction and some sense of magnitude are the best use that can be gained from the weather index as used in this study.

CHAPTER V

SUMMARY OF CONCLUSIONS

In Chapters I and II it was proposed that there could be significant induced investment in agriculture. The particular induced investment investigated was that which was associated with the relation between changes in the rate at which value added flowed to the total economy from the agricultural sector and new investment in agriculture. Furthermore, it was suggested that knowledge of the numerical magnitude of this ratio would be useful. Its size would reveal the character of underlying tendencies and their ability to generate fluctuations in agricultural income which would be destabilizing in character and could range between growing or diminishing kinds, once generated.

The method of study involved fitting multiple regression equations to eight time series between 1910 and 1958. The first approximation of an appropriate selection of variables consisted of a set of three lagged measures of real value added for the independent variable. The dependent variable was either aggregate agricultural investment in real terms or one of four sub-categories or a combination of these categories. The categories were (1) farm buildings and construction, (2) farm machinery and equipment, (3) changes in crop inventories, and (4) changes in livestock inventories. In addition, an attempt was made to remove the influence of weather from changes in crop inventories. This was done by preparing a series called "planned changes in crop inventories" to be compared with "changes in crop inventories."

The first set of equations showed a rather low incidence of R^2's significantly different from zero, as well as values of those significant

R^2 approaching the minimum allowable in most cases. By plotting the residuals, an obvious sympathy with broad swings of the total economy was shown for most equations. This prompted the development of an index of economic activity to be included as an independent variable in another set of equations. This second set of equations was the same as the first in all other respects.

The results of the second set of equations showed the presence of induced investment in crop inventory changes in four out of sixteen equations. In these four the "b" values were statistically significant at the 10 per cent level or higher, but the R^2 of the equation was not statistically significant at any of the selected levels. In the case of livestock inventory changes, the presence of induced investment appeared significant in two out of eight cases with the R^2 in one equation significant at the 5 per cent level and the "b" value, demonstrating the magnitude of the induced investment, significant at the 1 per cent level.

In five out of eight equations where investment in farm machinery and equipment was the independent variable, the "b" values, showing the magnitude of induced investment, were significant at the 10 per cent level or higher. The R^2 of these five equations tested out significant at the 5 per cent level or higher.

With respect to investment in farm buildings and construction, induced investment was observed at significant levels in two of eight cases, but neither of the equations had a significant R^2.

In two of eight equations dealing with total investment, a summation of the four categories just described, induced investment was revealed

at a 10 per cent level of significance or higher in two of sixteen cases. Eight of these sixteen cases involved "planned" crop inventory changes (adjusting for weather) none of which showed significant induced investment.

Where induced investment was identified under the criteria of significance of the "b" values, its character was evaluated. In all cases, it seemed that the induced investment could be destabilizing only in a modest sense and would soon dampen out. In only one case out of twenty-two did the total investment coefficient exceed 1.00. Because the pattern of saving by farmers is not known, at least in the manner alluded to in a Hicks-type cycle model, it is highly doubtful that a total investment coefficient greater than 1.00, but less than 2.00 or even 3.00, could be destabilizing with growing pressure of instability rather than a dampening influence on the distortions of well-being of agriculture. Furthermore, in this particular instance the selected "significant" variables "explain" little better than half of the variation of the dependent variable.

Business Cycle Variable

Observations about the relationship between the level of total economic activity and aggregate investment are an interesting development of this study. Of eighty equations examined, the "b" values of the business cycle variable were statistically significant in twenty-five. Twenty of these eighty equations showed R^2 significantly different from zero at the 5 per cent level or better and each included a significant "b" value for the business cycle variable. This implies that the relationship has some genuine association exceeding what might be credited to chance.

With respect to crop inventory changes, the business cycle variable appeared significant in only one of sixteen examples and then the R^2 was not significant.

In the case of livestock inventory changes, there was apparent sensitivity at the selected levels of significance in only one of eight equations examined. Here, however, the total equation showed an R^2 of .80, significant at the 5 per cent level. In this same equation (10_2-6) all independent variables exhibited "b" values of statistical significance at the 10 per cent level or higher. The fact that it is only one equation among eighty of an associated nature to exhibit this character tempers any general implications which seem to be apparent.

In seven out of eight equations where new investment in farm machinery and equipment was examined, the level of economic activity is a significant variable. The "b" value is significant at the 1 per cent level in six cases, at the 5 per cent level in one case and just under the 10 per cent level in the final case. The R^2 of four of the first mentioned equations is significant at the 1 per cent level, of one at the 5 per cent level, and of two at the 10 per cent level.

With respect to total aggregate agricultural investment the business cycle variable showed significance at the 1 per cent level in four of sixteen equations and each of these same equations had an R^2 significant at the 1 per cent level.

A partial correlation coefficient was computed to estimate the partial correlation between the dependent variable and changes in Gross National Farm Product in t, t_{-1}, and t_{-2} independent of the level of economic activity. This statistic turned out to be significantly different

from zero in only three out of eighty cases. In the case of livestock inventories, equation 10_2-6, 80 per cent of the variance in change in livestock inventories was attributed to the relation of this dependent variable to value added variables and the business cycle variable. In this case, 79.2 of that 80 per cent is due to the net effect of the value added variables. The R^2 was also significantly different from zero at the 5 per cent level in that equation. In equations 10_2-4, farm machinery and equipment, the partial R^2 showed 58.8 of the 69.6 per cent (R^2) being the net effect of changes in value added. However, the R^2 was not significantly different from zero at either the 1 per cent or 5 per cent levels of significance.

These observations indicate that with investment in capital equipment, the level of economic activity is a dominant influence. In the case of changes in crop and livestock inventories, dominant influences have not been adequately identified. Even though the selected independent variables may "induce" changes in crop and livestock inventories, the net effect of this relation on all agricultural investment may be gauged by noting the figures in Table V as well as noting the R^2's in the relevant equations, Table II.

It is concluded that the business cycle has had a dominant influence on major elements of agricultural investment, namely, capital equipment. The accelerator principle has been of lesser influence on the less well understood elements of agricultural investment, changes in crop and livestock inventories. Investment in agriculture is influenced by forces within agriculture and forces from outside agriculture. Such portions of that investment as may be induced include a small proportion, low in

volatility, generated within agriculture and a larger amount, of unknown power, associated with economic activity in the entire economy.

TABLE V. AVERAGE AGGREGATE INVESTMENT IN SUB-CATEGORIES PER $100 TOTAL AGRICULTURAL INVESTMENT[a]

	Farm Buildings and Construction	Farm Machinery and Equipment	Change in Crop Inventories	Change in Livestock Inventory
1910-1919	$38	$46	$ 2	$14
1920-1929	45	73	-20	1.5
1930-1939	22	76	4	-1
1940-1949	27	58	7	8
1950-1958	35	58	2	6
1910-1958 (N=49)	34	62	1	2
1910-1958 less WWII (N=45)	37	64	-2	1
1910-1939 (N=29)	42	72	-6	-7
1920-1940 (N=21)	32	34	11	24
1939-1958 (N=20)	31	58	5	7
1939-1958 less WWII (N=16)	35	60	*	5
1939-1948 ($N=10_2$)	25	52	11	13
1949-1958 ($N=10_1$)	37	62	-1	2

*Less than $ .50

[a]1947-49 dollars

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APPENDICES

TABLE I. APPENDIX A -- BASIC TIME SERIES DATA FEATURING GROSS AGRICULTURAL INVESTMENT

In Millions of 1947-49 Dollars Unless Otherwise specified

Year	(1) GNFP change from previous year	(2) Total gross agricultural investment	(3) Gross investment buildings and construction	(4) Gross investment farm machinery and equipment	(5) Crop inventory change from previous year	(6) Livestock inventory change from previous year	(7) Planned crop inventory change from previous year	(8) Composite index of business cycle 1947-49 = 100
1910	717	1842	609	761	-367	839	-613	173.8
1911	-659	467	575	779	-39	-848	568	169.2
1912	2342	2981	605	783	268	1325	340	183.8
1913	-1917	2348	605	763	-110	1090	803	179.1
1914	944	1594	593	817	124	60	328	172.2
1915	2115	810	546	908	101	-745	-1072	178.0
1916	-2169	178	699	855	-371	-1005	-13	203.6
1917	889	3906	759	788	2417	-58	2332	224.0
1918	-942	-678	692	693	-931	-1132	452	234.2
1919	563	-929	830	793	-674	-1878	-813	237.7
1920	-316	-1128	662	974	-1163	-1601	-1568	261.5
1921	-1035	-1414	360	525	-1866	-433	-1925	201.2
1922	1077	2465	446	602	1046	371	987	216.4
1923	834	794	499	764	236	-705	317	237.4
1924	-784	1244	466	674	307	203	190	230.4
1925	1261	1551	475	812	-300	564	-765	243.6
1926	-432	1024	465	889	-671	341	-563	249.1
1927	1121	2347	559	833	220	735	59	244.9
1928	-1006	2257	512	904	-11	852	-387	246.5
1929	636	1765	480	1031	18	236	92	258.3
1930	-1590	-1510	320	869	-871	-1828	-435	233.6

(Continued on next page)

Year	(1) GNFP change from previous year	(2) Total gross agricultural investment	(3) Gross investment buildings and construction	(4) Gross investment farm machinery and equipment	(5) Crop inventory change from previous year	(6) Livestock inventory change from previous year	(7) Planned crop inventory change from previous year	(8) Composite index of business cycle 1947-49 = 100
1931	2857	-988	187	599	-472	-1302	-521	206.7
1932	-1197	-886	83	351	-722	-598	-812	179.6
1933	-235	1769	113	322	1164	170	1606	185.6
1934	-3148	1227	123	661	234	209	1018	202.5
1935	3319	4214	226	905	-246	3329	-102	216.9
1936	-2680	1382	281	1246	378	-523	1109	238.6
1937	3955	1587	369	1357	-78	-61	-118	255.4
1938	174	2234	349	1036	409	440	-617	233.0
1939	-29	2196	434	1142	537	83	562	250.7
1940	-339	1740	499	1262	10	-31	429	271.0
1941	1476	5504	508	1749	1193	2054	921	315.8
1942	1858	5660	430	1550	1161	2519	664	357.7
1943	-1890	1135	400	944	1000	-1209	913	395.2
1944	523	729	432	2028	-122	-1609	-169	400.3
1945	-1224	1586	493	1527	-559	125	-784	378.3
1946	281	4233	1240	1210	552	1131	528	360.6
1947	-1664	4533	1371	2014	1130	18	1386	392.1
1948	2665	3725	1520	2635	-1388	958	-2324	410.3
1949	-1050	1958	1456	3024	-893	-1629	-582	398.7
1950	1126	8242	1545	2947	542	3208	468	429.2
1951	-1444	5946	1496	2787	367	1296	381	462.3
1952	840	-34	1651	2445	-29	-4101	154	470.0
1953	723	1246	1627	2667	-560	-2491	-179	489.2
1954	999	3046	1501	2268	66	-657	489	475.7
1955	1193	2522	1459	2308	-725	-520	-1004	506.4
1956	-543	3705	1390	2004	168	143	-126	520.3
1957	-359	4948	1338	2018	-539	2131	-927	578.8
1958	1184	8293	1211	2434	1373	3275	1000	515.5

(Continued on next page)

(1) Department of Business Statistics, U.S. Department of Commerce, Survey of Current Business, August 1954, and National Income, Annual Issues 1958, 1959, converted to constant dollar figures with 1947-1949 base.

(2) The sum of Columns (3), (4), (5), and (6).

(3) Farm Income Situation (FIS-179), Agricultural Marketing Service, U.S. Department of Agriculture, July 1960, Table 19 H. Deflated by index of prices paid by farmers, 1947-49 = 100.

(4) Same as (3).

(5) 1910-1949: Raymond W. Goldsmith, "A Study of Saving in the United States", Princeton, New Jersey, Press, 1955, Vol. II, Table A35, Crop inventory value. Deflated by index of prices paid by farmers, 1947-49 = 100. 1950-1958: Balance Sheet of Agriculture, Agricultural Research Service, U.S. Department of Agriculture, issues of 1954-1960. Adjusted to 1947-49 dollars. Changes in annual inventories recorded in Column (5).

(6) Same references as (5). Changes recorded in Column (6).

(7) Crop inventory, (5), adjusted for influence of weather to give "planned value of crop inventory". From this, value of crop inventory last year was subtracted to obtain "planned change in crop inventory". Deflating for weather was done by using Stallings' weather index, "Total Index of Crop Production", James L. Stallings, unpublished Ph.D. thesis, Indexes of the Influence of Weather on Agricultural Output, Michigan State University, 1958. The expected volume, deflated for weather, was further adjusted by an average elasticity coefficient to recognize the change in value associated with the expected change in volume.

(8) Index of Industrial Production 1947-49 = 100 plus index of wholesale prices excluding farm and food products, 1947-49 = 100 plus index of non-agricultural employment, 1947-49 = 100, plus index of Gross National Product, constant dollars with 1947-49 = 100. See National Bureau of Economic Research occasional Paper 31, "Statistical Indicators of Cyclical Revivals and Recessions," G. H. Moore, for selections of indicators of economic activity. See Appendix B .

TABLE 1. APPENDIX B -- DEVELOPMENT OF INDEX INDICATING LEVEL OF ECONOMIC ACTIVITY.

Four measures of economic activity were selected to be combined into an index for use in regression equations as a "business cycle variable". The selected measures were used because (1) Other researchers use them as measures of economic activity[1] and (2) They have been developed for the period 1910-1958 under Consistent Critera.[2]

Year	Index of Industrial Production[3] 1947-49=100	Wholesale Price Index[4] (All Commodities Other Than Farm Products & Foods 1947-49=100	Index of Non-Agricultural Employment[5] 1947-49=100	Index of GNP 1954 Dollars[6] 1947-49=100	Index of Economic Activity Column 1+2+3+4
1910	40	49.5	48.0	36.3	173.8
1911	38	45.9	49.0	37.7	169.2
1912	45	48.6	50.5	39.7	183.8
1913	38	50.0	51.0	40.1	179.1
1914	34	47.5	52.0	38.7	172.2
1915	38	48.6	53.0	38.4	178.0
1916	45	63.1	54.0	41.5	203.6
1917	45	81.7	55.5	41.8	224.0
1918	43	89.1	56.5	45.6	234.2
1919	39	92.1	61.3	45.3	237.7
1920	41	115.3	62.0	43.2	261.5
1921	31	75.0	55.1	40.1	201.2
1922	39	73.2	58.6	45.6	216.4
1923	47	74.6	64.3	51.5	237.4
1924	44	71.3	63.6	51.5	230.4
1925	49	73.4	65.2	56.0	243.6
1926	51	71.5	67.5	59.1	249.1
1927	51	67.2	67.9	58.8	244.9
1928	53	66.4	68.0	59.1	246.5
1929	59	65.5	70.9	62.9	258.3
1930	49	60.9	66.6	57.0	233.5
1931	40	53.6	60.2	52.9	206.7
1932	31	50.2	53.5	44.9	179.6
1933	37	50.9	53.8	43.9	185.6
1934	40	56.0	58.8	47.7	202.5
1935	47	55.7	61.3	52.9	216.9
1936	56	56.9	65.9	59.8	238.6
1937	61	61.0	70.2	63.2	255.4
1938	48	58.4	66.1	60.5	233.0
1939	58	58.1	69.3	65.3	250.7
1940	67	59.4	73.4	71.2	271.0

Year	Index of Industrial Production[3] 1947-49=100	Wholesale Price Index[4] (All Commodities Other Than Farm Products & Foods 1947-49=100	Index of Non-Agricultural Employment[5] 1947-49=100	Index of GNP 1954 Dollars[6] 1947-49=100	Index of Economic Activity Column 1+2+3+4
1941	87	63.7	82.8	82.3	315.8
1942	106	68.3	91.1	92.3	357.7
1943	127	69.3	96.3	102.6	395.2
1944	125	70.4	95.0	109.9	400.3
1945	107	71.3	91.5	108.5	378.3
1946	90	78.3	94.5	97.8	360.6
1947	100	95.3	99.3	97.5	392.1
1948	104	103.4	101.6	101.3	410.3
1949	97	101.3	99.1	101.3	398.7
1950	112	105.0	102.3	109.9	429.2
1951	120	115.9	108.2	118.2	462.3
1952	124	113.2	110.5	122.3	470.0
1953	134	114.0	113.7	127.5	489.2
1954	125	114.5	110.7	125.5	475.7
1955	139	117.0	114.6	135.8	506.4
1956	143	122.2	118.5	138.6	520.3
1957	143	125.6	119.2	141.0	528.8
1958	134	126.0	117.6	137.9	515.5

[1]Moore, Geoffrey H., Statistical Indication of Cyclical Revivals and Recessions, Occasional Paper No. 31. New York: National Bureau of Economic Research, 1950.

[2]The measure of Non-Agricultural Employment begins in 1920 but was computed back to 1910 by assuming a proportional relation to total employment for this short period.

[3]Federal Reserve Bulletin, December 1922, December 1945, December 1953, and December 1959 for 1913-1958. Raymond W. Goldsmith's, A Study of Saving in the United States, Princeton, New Jersey, 1955 for 1910-1912. Indexes for these years estimated on basis of stock and bond issues and converted to 1947-49=100.

[4]U. S. Bureau of the Census, Historical Statistics of the United States, Colonial time to 1957, Washington, D. C., 1960, Series E25-41 1913-1957. Index for all Commodities, Series E13-24 1910, 1911, 1912 Converted to 1947-49=100. 1958 from U. S. Department of Commerce, Survey of Current Business, July 1959.

[5]U. S. Bureau of the Census, Historical Statistics of the United States, Colonial time to 1957, Washington D. C., 1960, Series D48-56, page 73, 1919-57. 1958 from United States Department of Commerce, Survey of Current Business, July 1959.

[6]U. S. Department of Commerce, Office of Business Statistics, U. S. Income and Output, November, 1958. Table I-16 for 1910-1928. Table I-13 for 1929-1957. U. S. Department of Commerce, Survey of Current Business, July 1959 for 1958 figures. All in billions of 1954 dollars converted to an index 1947-49=100.