March 1989 A.E. Res. 89-5

FARMER INVESTMENT BEHAVIOR: A REVIEW OF LITERATURE

Brian T. Brase and Eddy L. LaDue

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

FARMER INVESTMENT BEHAVIOR: A REVIEW OF LITERATURE[1]

by

Brian T. Brase and Eddy L. LaDue[2]

---

[1] Funds for this research were provided by the Niagara Mohawk Power Corporation under a contract with the Cornell University Departments of Agricultural Economics and Agricultural Engineering for studying the future of the New York agricultural sector and implications for electrical energy use. Any opinions expressed or conclusions drawn are entirely the responsibility of the authors.

[2] Brian Brase is an Economist with the Farm Credit Banks of St. Louis and was a Research Support Specialist in the Department of Agricultural Economics at Cornell University at the time this manuscript was prepared. Eddy LaDue is a Professor in the Department of Agricultural Economics at Cornell University. The authors would like to thank Loren Tauer and Jon Conrad for helpful reviews of an earlier draft of this manuscript and Joe Kwiatkowski for his assistance in preparing the summary and getting the manuscript in final form.

ABSTRACT

The literature on investment behavior is reviewed. The theoretical base and the results of empirical studies are summarized under each of the three perspectives generally used: (1) macro-economic, (2) micro-economic, and (3) socio-economic. Twenty-three factors were identified as influencing investment behavior, at least in some situations. The relationship between each of these factors and investment behavior is discussed.

TABLE OF CONTENTS

Introduction

The investment decisions of farmers determine the capital stock of individual farms and of agriculture in total. The capital stock in conjunction with other investment or buying decisions determine the quantity of operating inputs used in agriculture. Thus, farmer investment behavior determines the levels of use of such items as electrical energy, fertilizer and petroleum, as well as tractors, milking parlors, trees, cows, land and other capital items.

In order to influence the level of use of either capital or operating inputs, an understanding of farmer investment behavior is needed. Such an understanding allows identification of those changes in economic and/or environmental conditions that can be used to efficiently modify behavior.

"In formulating marketing strategy, the decision maker must rely extensively on an understanding of the purchasing decision process of present and potential customers. Because the objective of the market planner is to influence this decision process, the success of such efforts depends on a thorough understanding of how the buying decision is made." [24, p.26].

This publication presents a review of the literature on farmer investment behavior.

To identify the literature on farmer investment behavior, a computerized literature search was performed. The literature search used two abstracts: 1) The Bibliography of Agriculture, and 2) The World Agricultural Economics and Rural Sociology Abstract. The literature was searched back to 1971 using the general phrasing "Investment Behavior of Farmers" (and variations and synonyms thereof). Over 70 references were found.

The second stage of the review involved the collection and summarization of the material identified through the search and the additional references cited within the identified literature. The review examines agricultural investment behavior from micro-, macro-, and socio-economic perspectives. The numbers in brackets following the author's name or the direct quotes refers to the references listed at the end of the publication. Appendix A defines the variables used in the investment equations throughout this publication.

A farmer's investments will normally not be the financial assets many individuals envision as an investment. Typically, a farmer's investment(s)/purchase(s) will include machinery, buildings, livestock, land improvements and land. This review is concerned with the farmers' buying behavior of such physical assets, although financial assets may play a role in determining opportunity costs.

The articles found in the literature use different approaches to explain investment behavior. "Farm inputs are normally chosen because of their potential and expected contribution to production and marketing efficiency. At the same time, farmers are known to be susceptible to a

range of social and psychological factors in their purchase decisions." [24, p.300]. Thus, the review examines investment behavior from a normal economic perspective and from a socio-economic perspective. The "normal" economic perspective will be pursued at a macro and a micro level and, like the socio-economic perspective, will be examined by looking first at general theory and then at the empirical results found.

An Economic Perspective

Investment behavior has been assessed from an economic perspective both at a micro or firm level and at a macro or aggregate level. Investment behavior at the micro level determines total farm investment. However, some micro level investments represent a transfer of assets from one farmer to another and, thus, net investment or capital formation at the aggregate level may differ significantly from the sum of all farm level investments. Further, the relative importance of various determinants of investment may be different for the two levels.

A Macro Focus

One reason to examine the macro-investment perspective is that "the agricultural sector is far more closely related to, and integrated with, the total economy than is currently recognized. Farm policy, therefore, might be more effective if it were more closely coordinated with overall monetary and fiscal policy." [30, p.719]. Brake [7, p.1057] noted about then recent studies, "They ... illustrate the tendency to rely on micro-economics and neglect macro-economics in the search for explanations of capital formation."

Theory

"Increased agricultural investment expands food and fiber production capacity, it adds to Gross National Product (GNP), and it induces productivity growth since new capital tends to be more efficient in its use of inputs. Further, increased agricultural investment ultimately stimulates the competitive efficiency of domestic agriculture in world markets as prices are pushed down from investment induced technology change. ... In addition, agricultural investment serves as a measure of the current health of the farm sector and as an indicator of future farm output. Thus, it is important to understand the basic determinants of domestic agricultural investment if the implications of change in the farm sector, or changes in farm sector policies, are to be fully understood." [48, p.16].

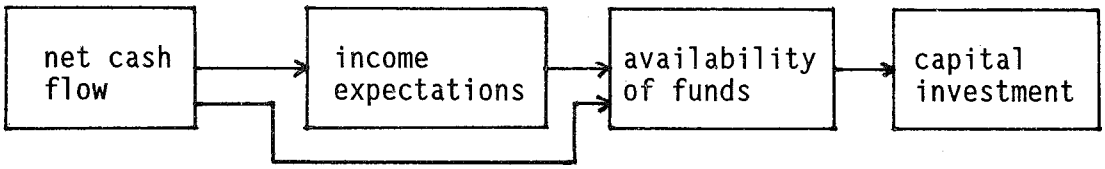
According to the *Economic Indicators of the Farm Sector - Farm Sector Review, 1984* [69], gross capital expenditures have been decreasing since 1979 (Table 1). "The recent financial crunch in the farm sector has caused many farm operators to forego or postpone buying farm machinery, relying instead on used equipment which has become more readily available." (p.47). "High real interest rates and strong machinery prices relative to net income were key reasons for the sharp decline in capital expenditures

since the 1979 peak." (p.17). The levels of aggregate farm net cash flow and gross capital expenditures are shown in Table 1.

Table 1. **Gross Capital Expenditures and Net Cash Flow**

Item	1979	1980	1981	1982	1983	1984
	----------Billions of Dollars----------					
Gross Capital Expenditures	19.9	18.0	16.8	13.7	13.0	12.5
Net Cash Flow	46.5	40.2	40.4	37.6	33.3	30.7

The positive relationship exhibited by the data in Table 1 between the farmers' net cash flows and gross capital expenditures would be expected (as is expected in the nonfarm sector) under the following chain of influences:



However, this is not a conclusive occurrence as Lamm [48] found real farm investment increasing but real net farm income declining when trended over the years 1946-79. Lamm offers two explanations of why he found farm sector investment to depart from the expectation of a positive relationship with income. First, the definition of income excludes capital gain income generated by asset ownership. Second, other factors influence investment besides income.

Both these explanations may be relevant but what Lamm fails to note is that over this time period there has been major structural change in agriculture that may offer better explanations. For example, the decrease in the number of farms and the labor/capital ratio over the 1946-79 time period are structural changes. Examining aggregated net farm income, one would expect a decline when in 1946, 5,926,000 farms were aggregated and in 1979 only 2,430,000 farms were aggregated [68, p.110]. If net farm income is examined on a per farm basis, then an increase is noted (as opposed to Lamm's decline) in real terms from $4,347 in 1946 to $6,189 in 1979 [68, p.111]. When examining aggregated capital investment one would expect an increase due to the substitution of capital for labor that occurred. Using the value of machinery and equipment as a proxy for this substitution, then examining this value as a percent of total assets indicates a structural change. In 1946, the value of machinery was 5.5 percent of total assets [68, p.120]. In 1979, the value of machinery had increased to 10.1 percent of total assets [68, p.120].

The point of this discussion is that on an aggregate or macro level, structure of the sector will influence investment without necessarily

changing the investment behavior of the farmers. With these things in mind, the following paragraphs examine models used to explain investment behavior.

Four "basic macro-economic models" (and their modifications) are only briefly presented here because more detailed explanations of similar models appear later in the micro focus section. For more details of these macro investment models, refer to Bischoff [3], Clark [13], Jorgenson [44], or Lamm [48]. The four "basic macro-economic models" described in these references and further discussed in this section are as follows:

1. Neoclassical model
2. Generalized accelerator model
3. Cash flow model
4. Securities value model

The neoclassical model suggests that net investment occurs when the existing level of capital is less than optimal (i.e., the desired level of capital). The amount of investment in any one year is a function of the difference between actual and desired capital. The desired level of capital is theoretically determined by equating the marginal value product of capital to its marginal factor cost.

"Under the assumption of competition and a Cobb-Douglas production function, desired capital (K^D) can be determined directly from the first-order profit maximizing condition requiring the value of capital's marginal product to equal its price." [48, p.18]. Thus,

$$(1)\quad K^D = gpQ/c$$

where K^D = desired level of capital
g = capital output elasticity
p = product price
Q = output
c = price of capital (user cost of capital)

The level of net investment in any one year is assumed to be the difference between the desired level of capital for that year and the desired level of capital for the previous year ($I^n_t = K^D_t - K^D_{t-1}$). The level of gross investment is the sum of net investment and replacement investment ($I_t = I^n_t + dK_{t-1}$). Using these relationships, equation (1), and the assumption that desired capital use is reached only after a delay (or lag), then the neoclassical model can be expressed as:

$$(2)\quad I_t = G(L)\ \Delta\ (p_tQ_t/c_t) + dK_{t-1}$$

where I_t = gross investment in year t
$G(L)$ = a polynomial lag operator
d = the rate at which the capital stock depletes
K_{t-1} = capital stock in year t-1

Thus, gross investment is a function of: 1) the change in the ratio of the total value of output to the cost of capital where the cost of

Thus, gross investment is a function of: 1) the change in the ratio of the total value of output to the cost of capital where the cost of capital includes interest, depreciation, and capital gains or losses from owning the asset, and 2) the depreciation of the existing capital stock.

The basic neoclassical model may be modified and still use output, output price, and the cost of capital. Rather than having these factors enter the equation as a *change* in the ratio, the modified neoclassical model has investment as a function of the *level* of the ratio. The form of the modified neoclassical model is presented in equation (3).

$$(3)\quad I_t = J(L)[p_{t-1}\, Q_t/c_{t-1}] + R(L)[p_{t-1}\, Q_{t-1}/c_{t-1}] + dK_{t-1}$$

where J(L) and R(L) are polynomial lag operators and other variables are as previously indicated.

The modified neoclassical model assumes that investment is a function of prior year product price and cost of capital and both current and prior year output as well as depreciation of the current capital stock. This differs from the neoclassical model in that current product price and capital costs are not included. The model also differs from the neoclassical in that the modified equation allows for a difference in the distributed lag structures of investment on changes in the relative price of capital services and on changes in output.

"The generalized accelerator model is based on the premise that desired capital stock is related (usually linearly) to output (Q)." Since "desired and actual capital stock are unlikely to ever correspond exactly, and a reasonable assumption is that actual capital stock responds after delay to changes in output... distributed lags on output change are normally included in the general accelerator model to explain delayed reaction. Hence,

$$(4)\quad I^n{}_t = B(L)\ \Delta\ Q_t,\ t = 1, \ldots, T$$

where B(L) is the polynomial lag operator on output change." Assuming "that depreciation is exponential and a function of B(L) Q_t... allows gross investment (I) to be written as:

$$(5)\quad I_t = B(L)\ \Delta\ Q_t + dK_{t-1} \quad t = 1, \ldots, T$$

where K is capital stock and d is a parameter representing the rate at which capital stock depreciates." [48, p.18]. Thus, investment in the generalized accelerator model is a function of lagged output and depreciation of the existing capital stock.

A variation of the generalized accelerator model is the accelerator cash flow model. "The accelerator cash flow model is identical to the generalized accelerator model except that either profits or a cash flow variable is added as a determinant of investment. The rationale for adding a profits or cash flow variable is simply that greater current profitability produces expectations of increased future profitability. This stimulates current investment. Another argument for the inclusion of

Under the assumption of delay before increased cash flow influences investment, the accelerator cash flow model is:

$$(6)\quad I_t = B(L)\Delta Q_t + C(L)F_t + dK_{t-1},\ t = 1, \ldots, T$$

where C(L) is a polynomial lag operator on cash flow F." [48, p.18].

The cash flow model (without the accelerator), though presented here as a basic model, is considered a secondary model because "no serious investigator of U.S. investment behavior has proposed a model that is based on cash flow alone." [13, p.77]. A cash flow model would be similar to the previous model but without the output variable (Q). Such as,

$$(7)\quad I_t = C(L)F_t + dK_{t-1}$$

Thus, gross investment is a function of cash flow, an explanatory variable for net investment, and of depreciation of the capital stock, an explanatory variable for replacement investment.

The securities value model is also considered secondary because; 1) it reacts to the same state of long-run expectations as the previous models, and 2) there are difficulties in obtaining and using the data. It is considered basic because of its different approach; the "securities value model attempts to explain investment on a financial basis in terms of portfolio balance. Roughly speaking, if the market value of a firm exceeds the replacement cost of its assets, it can increase its market value by investing in more fixed capital. Conversely, if the market value of a firm is less than the replacement cost of its assets, it can increase the value of shareholders' equity by reducing its stock of fixed assets." [13, p.84]. The securities-value model as described by Clark is:

$$(8)\quad \frac{I_t}{K_{t-1}} = C(L)\frac{MV_t}{RC_t}$$

where I_t = gross investment in year t
K_{t-1} = the capital stock in year t-1
MV_t = market value of the firm in year t
RC_t = replacement cost of the firm's assets
C(L) = the lag distribution between the ratio and investment

"... Both investment and the ratio of market value to replacement cost react to the same state of long-run expectations about future output and prices. When real capital is expected to be profitable in the future, both investment and Q rise. Conversely, pessimistic expectations about profitability in the near future should depress both variables." [13, p.84].

Empirical Studies

Five studies compared some combination and variations of these models in explaining investment using empirical data. The five studies by Bischoff, Fisher, Clark, Penson, et. al., and Lamm, are each briefly presented below.

The study by Bischoff [3] compared five investment models for quarterly data on investment in equipment and investment in non-residential structures. The five models and their equations are presented below.

1. generalized accelerator model

$$(9) \quad I_{E,t} = b_o + \sum_{i=1}^{n} b_i \, Q_{t-1} + b_{n+1} \, K_{E,t-1} + U_t$$

2. cash flow model

$$(10) \quad I_{E,t} = b_o + \sum_{i=1}^{n} b_i \, (F/q_E)_{t-1} + b_{n+1} \, K_{E,t-1} + U_t$$

3. securities value model

$$(11) \quad I_{E,t} = b_o + \sum_{i=1}^{n} b_i \, (V/q_K)_{t-1} \, K_{E,t-1} + U_t$$

4. standard neoclassical model

$$(12) \quad I_{E,t} = b_o + \sum_{i=1}^{n} (pQ/c_E)_{t-1} + b_{n+1} \, K_{E,t-1} + U_t$$

5. modified neoclassical model

$$(13) \quad I_{E,t} = b_o + \sum_{i=1}^{n} b_{1,i} \, (P/C_E)_{t-i-1} \, Q_{t-1} + \sum_{i=1}^{n} b_{2,i} \, (P/C_E)_{t-i-1} \, Q_{t-i-1} + b_{n+1} \, K_{E,t-1} + U_t$$

where E = a subscript for equipment and was replaced with S's for the structure equations,
U_t = error or other omitted factors influencing investment, and all other terms are as previously defined.

Bischoff compared these alternative investment behavior models in three ways: 1) how well the models fit the sample period data, 2) how the equations (thus, investment) reacted to limited changes, and 3) how well the models extrapolate or project future investment.

All five models, for equipment and construction, fit the data relatively well ($R^2 > .95$). The two models with the highest R^2's were the modified neoclassical and cash flow models.

In the partial response analysis, Bischoff states that the standard neoclassical "equation is basically misspecified, in so far as it assumes that the response of investment spending to a change in relative prices ... is the same as the response to a change in output. ... Thus, when the response pattern is statistically estimated for a period in which there is substantial variation in both output and relative prices, the pattern is really a mixture, or average, of two distinct responses." [3, p.27-28].

modified neoclassical models showed a stronger and faster response from the changes in output.

The comparison of the models, via their ability to predict, differed by whether it was equipment investment or construction investment. The investment models for equipment were ranked as: modified neoclassical (best), generalized accelerator, standard neoclassical, and cash flow (worst). The models were ranked for construction as: standard neoclassical (best), generalized accelerator, modified neoclassical and cash flow (worst). The securities value model was not included in this comparison because it was not simulated in the same way (used first-differences). In general, the securities value model over-predicted and was one-quarter late in estimating peak investment. From the above rankings, the cash flow models performed second best to the output equations. In addition to these models, alternate models were developed to include expectations of capital gains, "these equations also produce results inferior to those from their counterpart equations." [3, p.34].

"The general conclusion from these tests is that the three output-based models... perform the best, through no one of these is clearly superior to the other two." [3, p.33].

The second, a study by Fisher [23], modeled investment as a function of output and the ratio of prices received to implicit rental price of capital. Due to the latter's insignificance or wrong sign, investment was remodeled as a function of output and the implicit rental price of capital. The implicit rental price of capital reflected the after tax interest and depreciation costs. The weights for lagged variables were estimated using the Almon variable technique, a polynomial lag distribution. Models with output lagged up to four quarters and the implicit rental price lagged up to five quarters were found to give significant results. Other implications were given (p.28) and are as follows:

1. "The neoclassical theory provides a useful framework on which to base empirical studies of aggregate investment and the effects of taxation incentives. The theory is useful in that it provides a set of variables that can be tested in a regression equation and suggests ways in which these variables may be combined."

2. "The role of the output variable appears to be limited to one of causing seasonal shifts in investment. Lags longer than four quarters and lag distributions following polynomial of degree 3 and 4 resulted in unreliable estimates of the lag weights."

3. The significance of the implicit rental price variable is the capability to include the effects of tax concessions.

The third study by Clark [13], examines five models of business investment behavior. The models examined were: generalized accelerator model, accelerator cash flow model, neoclassical model, modified neoclassical model and securities value model. These models were described earlier.

Clark states that the first four models ("output based" equations) fit the data fairly well. "The securities value equation does not fit as well, reflecting divergences between the behavior of investment and the stock market." (p.85). Clark preferred the fit of the accelerator models to the neoclassical models because, "... My analysis indicates merely that prices have evolved slowly enough over the past 30 years that they do not help to explain the cyclical variation of business fixed investment." (p.121). Additionally, in regards to the neoclassical models, "For short-term forecasting (two years or less), the effect of moderate variations in taxes and interest rates is likely to be negligible, over longer periods it may be substantial, but cannot be estimated with any degree of accuracy from equations relating the quarterly aggregates." (p.104).

The focus of the fourth article, a study by Penson, Romain and Hughes [58], was the appropriate depreciation method to use when engineering data were not available. The study modeled net investment (gross investment less replacement investment) under the assumption that depreciation equaled replacement investment. Net investment was modeled as a function of; 1) basic neoclassical variables - prices received, output, and implicit rental cost, 2) the existing capital stock, and 3) the previous year's level of net investment. The data primarily came from annual observations appearing in USDA publications.

The following results were mentioned:

1. The engineering data pattern of capacity depreciation most closely influences actual capital spending decisions.

2. The straight-line pattern out-performed the one-hoss-shay pattern which out-performed the geometric decay pattern according to the R^2's.

3. "The elasticity associated with the geometric decay pattern substantially overestimates farmers' investment responses to changes in prices, interest rates, taxes and other relevant variables." (p. 634).

4. "If an estimate of the engineering pattern data is not available for a particular durable input, the results from this study and Coen's show that the one-hoss-shay and straight-line patterns do a better job of approximating capital deterioration in aggregate investment analysis than the frequently used geometric decay pattern." (p.635).

The fifth, and last, article to be presented was done by Lamm [48]. This article is the most recent article found on macro-economic investment models but takes much of the theory from Clark's work [13] examined earlier. Lamm compared four models; 1) generalized accelerator model, 2) accelerator cash flow model, 3) basic neoclassical model, and 4) modified neoclassical model. (This modified neoclassical model was derived by Bischoff as previously described, and Lamm refers to it as the Bischoff model.)

Lamm states, "Clearly, the Bischoff model with a one-year lag fits the data better than any of the other models." (p.19).

Also, "The Bischoff model indicates that agricultural investment is as sensitive to changes in prices farmers receive and capital cost as it is to changes in output." (p.22).

These five studies had a general consensus that the output based equations performed better than the cash flow or securities value models. Fisher and Penson, et. al., used the neoclassical model for the analysis in their studies. Bischoff and Lamm in their comparisons indicated that the modified neoclassical models were better. And Clark preferred the fit of the accelerator models in his comparisons of models. The consensus of these studies is more surprising when considering that the data used in each study differs.

The determinants used (which have been broadly classified in the models presented) differ slightly in definition for each of the studies. For example, some of the data for Bischoff's study came from "*The National Income and Product Accounts of the United States, 1929-65*" where the data for Lamm came from various publications by the ERS of the USDA under the general title "*Economic Indicators of the Farm Sector.*" Also, the studies differ in that some used quarterly data and some used annual. The Bischoff, Fisher, and Clark models all appear to be strongly influenced by the industrial sector in that they use quarterly models for analysis. These models may not be appropriate for the agriculture sector which operates on an annual system and for which only annual values for some variables are available.

Researchers using macro models have generally tried to explain aggregate farm investment with relatively few economic variables. Hughes and Adair [40] used an economic model, called GEM (General Equilibrium Model), which was much more comprehensive. They incorporated tax policy changes of ERTA and TEFRA into the GEM by modifying the marginal value product (MVP) and the marginal factor cost (MFC) of capital (a neoclassical approach). The relationships they point out are useful and important before examining the investment behavior literature from a micro-economic perspective. The relationships are as follows:

1. Due to the increased investment tax credit and shorter depreciable lives of many assets, the marginal factor cost of capital is reduced. The tax-induced investment will be less than the initial expectation because all businesses will try to expand, bidding up the price of goods and the interest rates. This partially offsets the tax-induced decline of marginal factor cost.

2. Due to the tax cuts, the government deficits may be increased. This provides incentives to reduce government expenditures. Reduced government spending may diminish government support of farm incomes. Additionally, agriculture's dependence on general economic conditions causes an effect on farmers through slow growth in domestic incomes. Lower incomes will lower the MVP of capital and, thus, reduce investment.

3. "Large governmental deficits will probably keep real interest rates high." "Any stimulus to investment that might be expected from cutting tax rates will, therefore, likely be offset to some extent by higher

interest rates. Higher real interest rates increase the costs of ction and lower prices received by farmers over the short- to mediate-term. With farm debt at about $200 billion, a one entage point increase in interest rates adds about $2 billion to uction expenses." [36, p.3-4]. Higher real rates of interest may decrease farm revenues via suppliers reducing prices offered and an increase in the foreign exchange value of the dollar reducing demand and the prices of farm products.

LeBlanc and Hurboucak [49] modified the simple accelerator model to orporate a cost of adjustment variable for investment in quasi fixed puts (equipment, structures and land). The inclusion of a cost of adjustment variable was motivated by indicating that "... The relative fixity of inputs causes adjustment to a new equilibrium position to take time. Immediate adjustment is prevented because certain inputs cannot be changed until some time has elapsed after the original decision to alter inputs is made. If uncertainty is excluded, then the reason for slow adjustment is that it costs the firm more to adjust production rapidly." (p. 768). Although this logic would imply that the adjustment cost rate would increase with the level of investment, they assumed that the rate was constant. Further, this model's estimates frequently had high standard errors and low t statistics.

They conclude that changes in tax policy since 1954 have caused nearly 20 percent of the net investment in agricultural equipment that occurred during 1956 through 1978. "... Investment tax credit has probably been the most effective tool in stimulating investment" (p. 776) and has biased investment in favor of equipment rather than structures.

A Micro Focus

Much of the micro level investment behavior research has used the macro-economic models described above. Thus, the macro theoretical models will be presented again, modified to the micro focus.

Theory

"The theory of investment behavior has received its most thorough theoretical examination and empirical testing in the context of industrial sector investment." [71, p.134].

"Much of the work done in the agricultural sector has been based on the industrial sector theory. Since the late 1970's, the generally accepted model specification has been

$$(14) \text{ "... } I_t = w(D)(K^D_t - K^D_{t-1}) + I^r_t$$

That is, investment is explained in terms of lagged changes in the desired capital stock and replacement investment." [19, p.137].

By specifying; 1) a function for the change in desired capital $(K^D_t - K^D_{t-1})$, 2) an appropriate lag (w(D)), and 3) a function for

replacement investment (I^r_t), "a complete model of investment beha obtained." [71, p.134]. Alternative models, and theories of inve behavior found in the literature, differed mainly with respect to determinants of desired capital but also with respect to their specifications of the adjustment response and to their handling of replacement investment.

Each of these aspects are discussed below.

Desired Capital

Dawson and Dawson [19] divide the theory that has been proposed to explain desired capital stock into two types; 1) "ad hoc" theories, and 2) Jorgenson's neoclassical theory. Waugh [71] categorized the theories into three groups, desired capital is determined by; 1) output variables, 2) internal finance variables, or 3) external finance variables. In the macro section earlier, the theories were classified as; 1) general accelerator, 2) neoclassical, 3) cash flow, and (4) securities value. The micro section will examine investment behavior theories categorized as follows:

1. The accelerator theory of investment
2. The neoclassical theory of investment
3. The Keynesian theory of investment
4. The "ad hoc" theories of investment

The accelerator theory of investment is based on capacity utilization theory originated by Clark [13]. The basic accelerator model assumes "that there is a cost-minimizing level of capital which is required to produce a certain output, Q, so that:

$$(15)\quad K^D_t = BQ_t$$

where B = (the accelerator constant) is the desired capital output ratio." [13, p.139]. Therefore:

$$(16)\quad I_t = w(D)\ B\ \Delta\ Q_t + I^r_t$$

where I_t = gross investment
$w(D)$ = a power series in the delay operator D
B = as above
$\Delta Q_t = Q_t - Q_{t-1}$ = change in output
I^r_t = replacement investment

Due to the symmetry of the crude accelerator, a five percent increase in output would have an equal but opposite effect on investment as a five percent decrease in output. Thus, to overcome this criticism, a threshold variable is introduced. Net investment is assumed to depend on the difference between current output and the previous maximum level of sales. The investment function becomes:

$$(17)\quad I_t = w(D)B(\Delta' Q_t) + I^r{}_t$$

where $\Delta' Q_t = Q_t - Q^{max}$, if $Q_t > Q^{max}$ *or*
$= 0$, if $Q_t < Q^{max}$,
Q^{max} = maximum of Q_{t-1}, Q_{t-2}, Q_{t-3}, or Q_{t-4}, and
Q_t = current output

Thus, if current output is less than the previous maximum, then the desired change in the capital stock is zero. If current output is greater than the previous maximum, then there is an expected increase in the level of desired capital stock.

The neoclassical theory of investment is most commonly associated with the work of Jorgenson and is derived from "neoclassical theory of optimal capital accumulation."

Jorgenson said [44, p.135] "Reduced to its barest essentials, the theory requires only that capital accumulation be based on the objective of maximizing the utility of a stream of consumption. This basic assumption may be combined with any number of technological possibilities for production and economic possibilities for transformation of the results of production into a stream of consumption."

Assuming; 1) a specific production function (Cobb-Douglas), 2) fixed prices for output, labor services, investment goods, and consumption goods, and 3) maximization of net worth in conditions of perfect competition, Jorgenson shows that the "optimal (desired) level of capital is given by the familiar marginal condition: $K^D{}_t = Bp_tQ_t/c_t$ where p_t is output price in period t and c_t is the price of a unit of capital services or the user cost of capital in period t." [44, p.135]. The neoclassical investment function becomes:

$$(18)\quad I_t = w(D)\ B\ [\Delta(p_tQ_t/c_t)] + I^r{}_t$$

A similar equation was derived by Fisher [23]. Again, assuming "profit maximization and a Cobb-Douglas production function, the gross investment (I_t) equation becomes:

$$(19)\quad I_t = dk_{t-1} + \sum_{i=0}^{n_1-1} f_i\ \ Q_{t-1} + \sum_{i=0}^{n_2-1} g_i\ \ (p/c)_{t-1}$$

where Q = output
p/c = ratio of prices received to implicit rental price of capital services." [23, p.25].

The two equations (18) and (19) contain the same variables but differ by how these determinants are perceived to interact and how they are perceived to influence investment over time (the lag function).

"Traditional production economics suggest that net investment is undertaken whenever the existing level of capital assets is less than

optimal - the level required to equate the marginal value product of capital to its marginal factor cost. The driving forces behind investment are, therefore, the determinants of the marginal value product and marginal factor cost of capital." [40, p.2].

The marginal value product of capital (MVP) is determined by "the amount of capital used, the price of output, the desired quantity of output, and the amounts of other inputs used in production." [40, p.2]. "The marginal factor cost of capital (MFC) usually includes the price of a unit of capital, the level of interest rates, the level of tax rates applicable to purchasing or using capital, the time pattern for depreciating the capital for tax purposes, and the time pattern of physical deterioration of the services the capital asset provides." [40, p.3]. Table 2 helps explain the impacts that changes in these determinants have on MVP and MFC of capital, and ultimately investment.

Table 2. **Impacts to Marginal Value Product and Marginal Factor Cost of Capital from Changes in Their Determinants**

Determinant	Change	Impact
Amount of capital used	increases	MVP declines
Price of output	increases	MVP rises via shift
Desired quantity of output	increases	MVP rises via shift
Levels of other inputs	(depends on whether or not the other inputs are complements or substitutes of capital)	
Price of a unit of capital	increases	MFC rises
Level of interest rates	increases	MFC rises
Level of income tax rates	increases	MFC rises
Level of ITC	increases	MFC declines
Time pattern for depreciation	shortened	MFC declines
Time pattern for deterioration	increases	MFC rises

The inclusion of c, the price of capital, also called the user cost of capital or the implicit rental price of capital, is a useful tool and concept for these models. The measure includes (or can include) both debt and owner equity financing, and the tax consequences of depreciation, interest, and credits. The determinants shown in Table 2 are implicit in c, the price of capital.

"For the firm which maximizes the present value of its after tax flow of profits, the user cost of capital is:

$$(20)\quad C_t = \{P^c_t\,[r_t(1-T_t) + \delta]\,(1-Z_t)\}/(1-T_t)."\quad [19,\ p.142].$$

where P^c_t = the cost of capital equipment
r_t = the opportunity cost of money in period t
T_t = the rate of tax in period t
δ = the true depreciation rate (constant)
Z_t = the present value of allowances on a unit of capital expenditure (or investment tax credit), in period t

"The implicit rental price of tractors will increase if their purchase price, the cost of debt and equity capital, capacity depreciation, or income tax rates increase. These effects will be offset to some extent by an increase in the investment tax credit rate and the deductibility of tax depreciation allowances and interest payments." [58, p.631]. These impacts can be expanded to most investments not just tractors. More details on the user cost of capital and how its affected by taxes is presented in Appendix B.

The third classification of investment theories, Keynes' "theory of investment demand for the firm," was classified by Giaro [30 and 31] along with Jorgenson's neoclassical theory as a theory of utility maximization. That is, the optimal level of capital exists where the marginal conditions are satisfied. "According to Keynesian thought, the demand for investment, or marginal efficiency of investment (MEI) schedule is a concave function of the rate of interest. Two additional sets of variables, one related to expectations and the other to rate of return on investment under static conditions jointly determine the position and shape of the MEI function." [31, p.7]. If the marginal cost of funds schedule is assumed to be elastic, then investment is the level associated with the rate of interest and the MEI function. Figure 1 helps visualize this theory.

The first ad hoc theory is an adaption of the Keynesian theory. Since empirical findings have not shown the interest rate as the most important determinant of investment, Duesenberry developed a "unified theory". "Duesenberry recognizes that the funds available to a firm for investment come from several sources, and that the cost and risks associated are not the same. Therefore, the supply of funds to the firm, or marginal cost of funds (MCF) schedule, can not be assumed to be perfectly elastic but instead has an S-shape, rising as the firm moves from depreciation allowances to equity financing." [31, p.7]. "This being so, clearly implies that the rate of investment can not be determined by the rate of interest and the MEI, but instead by the interaction of the marginal cost of funds schedule with the MEI, or better, by the factors in determining them." [30, p.54]. Again, Figure 1 is helpful in visualizing this theory.

The second and third ad hoc theories result from the criticism to the general accelerator theory that other variables, besides output, are important in determining the desired capital stock. Two such variables include expected profits and supply of funds.

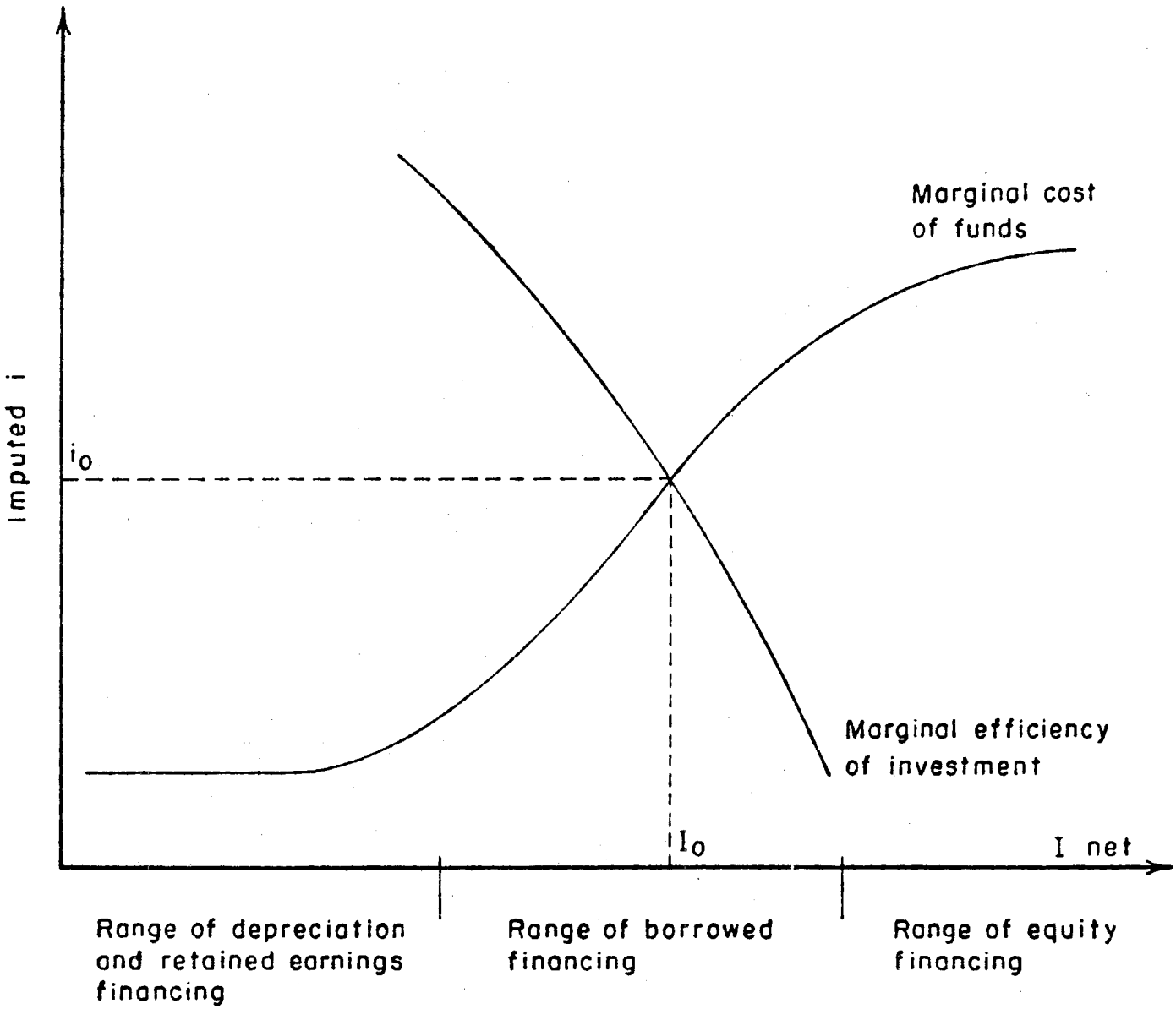


Figure 1. *Determination of the rate of investment.* [31, p.9].

In discussing the second theory, Dawson and Dawson state that "Many studies of investment have recognized the importance of expected profits though opinion diverges on how best to measure it." [19, p.140]. Proxies for expected profits have included realized profits, market value of the firm, and the price of land. Thus, $K^D = B(EP)$ and

$$(21)\quad I_t = w(D)\ B\ (\Delta EP) + I^r_t$$

where EP = the expected profit proxy (i.e., the price of land)

A supply of funds, the third and final ad hoc theory, variable is important in that a shortage may prevent the attainment of desired capital levels. "According to modern financial theory, there is no rational distinction between internally and externally generated funds in a perfect capital market (Modigliani and Miller, 1958)." [19, p.141]. However, agency transactions, imperfect markets, or capital rationing may cause internal funds to be relatively less expensive. Again, defining a proxy may be controversial due to the data available. "... Desired capital is hypothesized to be a constant proportion of available funds, L, that is $K^D_t = BL_t$ giving an investment function of:

$$(22)\quad I_t = w(D)\ B(\Delta L_t) + I^r_t."\quad [19, p.141].$$

Thus, the proxy may consider net income (NI), taxes (T), and depreciation (Depr.), (i.e., $L_t = NI_t - T_t + Depr$).

Adjustment Response

Another aspect to consider concerning investment functions is the time adjustment required for investment to respond to changes in its determinants. There are basically two classifications of reasons why a time delay, or lag, occurs.

The first classification is objective reasons; these may be technological or institutional in nature. The technological reasons relate to the fact that changes in production require time as well as does installing or building new investment. The institutional reasons relate to the fact that decisions take time to implement and that custom or laws may cause delayed reactions in this implementation.

The second classification is subjective reasons. "Subjective reasons for lagged reactions are imperfect knowledge of the market and psychological inertia of economic subjects." [47, p.8]. For example: 1) it may take some time for a farmer to believe that higher product prices will stay at a level to make investment profitable, or 2) a fall in price of a capital good may not be known to every potential buyer immediately, or 3) habits may lead to lagged reactions.

Whatever the reasons, "some individuals will react nearly immediately or after a short lag, some will be very slow for one reason or another and will react after a long period, others may be grouped between these extremes. Generally the lag in the reactions of a number of subjects will be distributed over a period of time, it will be a 'distributed lag'."

[47, p.9]. Thus, consideration needs to be given to which variables to lag and how to do so econometrically.

The same lag structure may not be appropriate for alternative variables included in the investment model. For example, in "the long run, income must provide the ultimate source of all investment and consumption outlays, other factors, for example, changes in liquid assets and outside funds, may have important effects in the short run." [71, p.137]. The point here is not that income is the "ultimate source" but that the determinants of investment may have long-run or short-run effects.

"A distributed lag arises when the values from several previous periods as well as the current value of one variable influence the current value of another. In notational form this may be represented as:

(23) $I_t = \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + Z_t$

(24) $I_t = \beta_i X_{t-i} + Z_t$

where I_t and X_t are observable variables of interest to economists (in the present context, investment and say output, respectively) and Z_t represents remaining influences. Conceptually, such a formulation has greater applicability than one of instantaneous response, but does, however, present quite serious problems of estimation." [71, p.140]. Several methods have been used to incorporate lags into investment analysis. They are discussed below.

1. OLS (Ordinary Least Squares)

"As long as the length of the lag, n, is finite and less than the number of observations, the regression coefficients ... can be estimated by the simple application of least squares. Indeed as long as the disturbances ... are 'well-behaved,' the resulting least squares estimates have the usual 'optimal' properties specifically, they are unbiased, consistent and efficient, and they lead to valid tests of hypotheses concerning the weights... ." [61, p.11].

"By a wide margin, OLS out-performs the other estimators tested (Almon-Hannan methods), regardless of whether the criterion is efficiency, small bias, or robustness under departures from the assumptions of the classical linear model. ...Even when the independent series and residual process are highly autocorrelated, OLS continues to be a clear best choice. [11, p.1038]. ("Distributed lag regression models are often, but not always, estimated with a GLS procedure to remove auto correlated error." [16, p.327]). "Besides checking for the presence of a lag, the least squares results may also be useful for obtaining information on what values of n (the length of lag) and p (the degree of polynomial) may be reasonable." [61, p.13]. The primary problem with OLS is that "... Least squares estimates may not be sufficiently precise due to multicollinearity among the regressors." [71, p.140].

"To overcome such problems, a priori information is often utilized in order to adopt certain restrictive assumptions about the profile of the lag coefficients. Such restrictions, if true, will provide unbiased, consistent and more efficient estimates then those found through the application of least squares methods and would lead to valid tests of hypotheses concerning the true weights. If, however, the restrictions imposed are not true measures of the underlying (unconstrained) lag relationship, biased and inconsistent estimates and invalid tests result. Careful consideration should thus be given to the choice of a priori restrictions." [71, p.140].

As indicated by Fisher, "the possible difficulties of estimating the weights by simple application of least squares, are well documented (Schmidt and Waud). The problem caused by the likely existence of a high degree of multicollinearity between the regressors may be overcome if some a priori information about the true weights can be incorporated in the estimation procedure. This usually involves the imposition of some restriction on the distribution of the true weights. A variety of these lag distributions has been formulated." [23, p.26].

2. Almon Lag Technique

The Almon lag technique is a polynomial lag technique. This technique is identical to ordinary least squares if there is no constraint (the polynomial of degree p = the length of the lag n).

"The Almon lag technique has been widely used in empirical work. The main reason for its popularity is probably the ease with which it can be used -- simply pick a length of lag, n, and a degree of polynomial, p, and results are quickly forthcoming." [61, p.13]. However, "The Almon lag technique should never be applied unless there is good a priori reason to believe that a lag is present. ... When reliable a priori information on the length of lag is not available, the use of the Almon lag technique should be avoided; alternatively, a number of different lag lengths should be tried... ." [61, p.13].

In a simulation study, Cargill and Meyer [11, p.1039] concluded that "The Almon procedure is much less efficient than OLS and is more sensitive to misspecification of the lag length."

The Almon lag technique, as a polynomial lag, is capable of representing a "humped distribution." "Other classes of lag such as the Pascal and the Jorgenson rational lag distributions can exhibit a humped type of distribution but they are much more difficult to estimate than the polynomial lag." [23, p.26]. These "humped" distributions are an alternative to geometric lag forms when using monthly or quarterly data. "Whilst the use of annual data makes the use of a geometric lag form plausible, it must be remembered that such an assumption would be highly restrictive if applied to monthly or quarterly data." [71, p.142].

3. Jorgenson's Rational Distributed Lag

As described above, Jorgenson's rational distributed lag exhibits a "humped" distribution appropriate for monthly or quarterly data.

"Jorgenson's rational lag procedure requires the choice of the degree of two polynomials and introduces lagged dependent variables as regressors which will yield inconsistent parameter estimates if the residual process is serially correlated." [11, p.1031]. "Caution should be used when estimating the distributed lag function for farm firm investment by the rational distributed lag technique. Although this method allows the data to determine the form of the lag distribution, the researcher should not expect a clear-cut answer about its exact form." [67, p.115]. For more details about rational distributed lag functions, refer to Trevena and Keller [67].

4. Koyck's Distributed Lag

"A Pascal distribution constraint and its special case, the Koyck lag, present a nonlinear optimization problem which has a discrete parameter and yields an objective function which is not, in general, strictly concave so that direct application of nonlinear programming techniques for the maximum likelihood method will not guarantee that the resulting estimates correspond to a global maximum for the likelihood function." [11, p.1031].

"One approach to the problem of distributed lag estimation, which has received considerable empirical support in the literature and which appears consistent with the a priori reasoning ... is to specify the lag weights as declining systematically through time according to the Koyck geometric distribution. Although theoretical development of this geometric lag formulation has been well documented, problems still surrounded its use, particularly in the case where the error structure is not 'well behaved' but is subject to an auto regressive process." [71, p.141].

5. Dhrymes' Search

"Dhrymes' search represents a numerical approximation to the maximum likelihood solution. The usefulness of this approach however will be restricted if a large number of parameters are to be included in the estimated equation." [71, p.141].

Of these five methods, the distribution lag methods (2, 3 and 4) are quite common. However, "while widely and variously used, most distributed lag models have almost no or only a very weak theoretical underpinning. Usually the form of the lag is assumed a priori rather than derived as an implication of a particular behavioral hypothesis." [33, p.42]. If distributed lags are to be used, here are some "commandments" Griliches says to follow. "First, if one is working with strongly trending data one should investigate whether the independent variables (the x's) provide an adequate explanation for these trends. Do not throw the problem into the residual category without doing something about trend removal. The standard statistical theory applies only to the case of stationary disturbances. In practice, with estimated roots close to unity, it is difficult to discover whether these high estimates are due to a slowly growing component of the series or to long lags in adjustment. Second, test for the possibility of misspecification of the model by including additional lagged terms of the independent variables. Third, if non-linear regression routines are available, use them to test simultaneously for the

presence of serial correlation. If not, have some written. Fourth, forget about the Durbin-Watson statistic in this context as a test for serial correlation in the original disturbances. It is very badly biased. Fifth, do not expect the data to give a clear-cut answer about the exact form of the lag. The world is not that benevolent. One should try to get more implications from theory about the correct form of the lag and impose it on the data. Sixth, interpret the coefficients of a distributed lag model with great care, since the same reduced form can arise from very different structures. Moreover, different reduced forms may not differ much in the fit that they provide to the data, but have widely different implications as to the underlying structure that generated the data. Finally, not all is hopeless, but to get better answers to such complicated questions we shall need better data and much larger samples." [33, p.46].

Ordinary least squares is also commonly used as a comparison tool to other distributed lag methods. OLS performs quite well versus other methods as noted earlier but requires the length of the lag to be less than the number of observations. Generalized least squares may be a more appropriate estimation method due to correlation between the residuals.

More details on the structure of these adjustment response methods can be found in the papers referenced. Further detail is beyond the scope of this publication. Some insight into the adjustment response, as well as the other two aspects of investment theory, will be obtained when the results and conclusions of the empirical results are presented later.

Replacement Investment

"The theory of investment attempts to explain the change in net new fixed investment, but it is gross investment that is normally observed (which includes net new and replacement investment). American evidence suggests that total investment is generally dominated by replacement investment and hence careful consideration should be given to the choice of a replacement model." [71, p.138].

"Replacement investment... is the actual purchase of equipment necessary to maintain output capacity that has been lost through output decay and scrapping and as such, does not equal deterioration or depreciation." [71, p.139].

Since "capital assets have different lifespans, they will be scrapped (and replaced at different times in the future). The replacements will then generate further replacements, and so on. Thus, the level of replacement investment can be approximated by a simple model whereby replacement investment is a constant proportion of the actual capital stock, that is:

$$(25)\quad I^r_t = dK_{t-1}$$

where d = the rate of replacement
$1/d$ = the average life of capital goods measured in time periods. [19, p.139].

Such a model "implies that the underlying measure of a capital stock series should be the declining balance formula" (a declining balance depreciation model). [71, p.138].

The problem with such a model of replacement investment is that "little direct evidence is available concerning validation" [71, p.138] and defined this way it does not meet the previous definition given in light of output decay. However, such a model is commonly used in the belief "that little serious error is committed in using a geometric deterioration function to calculate capital stock that a replacement model based on a proportionality relationship to capital stock is probably a reasonable approximation for many purposes." [71, p.139].

A study done by Penson, Romain and Hughes, discussed in the macro section, found "that both the straight-line (SL) and one-hoss-shay (OHS) patterns are better proxies for capital deterioration suggested by engineering considerations than the frequently used geometric decay (GD) pattern." [58, p.634].

"While the GD pattern is easiest to implement because time-series data for R_j (real level of replacement investment), and K_j (real stock of farm tractors) are readily available and the specification of C_j (implicit rental price of tractors) is relatively simple, it represents the poorest proxy for the capacity depreciation pattern suggested by engineering considerations. If an estimate of the engineering data (ED) pattern is not available for a particular durable input, the results from this study and Coen's study show that the OHS and SL patterns do a better job of approximating capital deterioration in aggregate investment analysis than the frequently used GD pattern." [58, p.635].

Empirical Studies

Seven studies are presented below that have a micro-economic orientation to investment modeling. The first four presented, discuss studies conducted on investment modeling as developed in the micro or macro sections. The other studies presented may be considered as tangents off these general models.

The first of the four general investment modeling studies is a study conducted by Giaro [30 or 31]. Giaro's study had next year's capital stock as a function of this year's total sales, last year's total sales, last year's capital stock, and some measure of last year's financial standing. The following comments from Giaro's article [31, p.25-26] indicate his results:

1. "The internal availability of funds is not the sole variable influencing gross fixed investment."

2. "At least two other factors play an important role in the decision to invest, namely, the existing capital stock and changes in the level of output."

3. "In addition, debt and possibly the extent to which output prices are favorable in relation to input prices also appear to help determine the rate of overall investment in some equations."

The second study to be presented was done by Waugh [72]. Investment was modeled as a function of current and lagged output, current and lagged prices received, transitory income, and the change in debt. Waugh's results are as follows:

1. "In times of adverse market conditions, farmers are likely to invest more slowly or postpone investment if they expect that the benefits of conserving internal funds outweigh the costs of not having required capacity. According to Campbell, replacement investment is seemingly placed in the same category as new additions and is consequently also postponable."

2. "... disinvestment by debt properties in periods of adverse prices and seasonal conditions became relevant. Such a phenomenon is expected since debt farms tend to rely on credit institutions for supplementary investment funds, who, in time of financial hardship, seek repayment of existing debts. This placed further strain on an already tight liquidity situation resulting in disinvestment by debt properties."

3. "The purchase of new types of machinery and replacement of obsolete equipment is evident during expansionist periods associated with marked improvements in agricultural prices (and hence transitory incomes)."

4. "With respect to desired capital, *'expected'* output appears to play a determining role."

5. "The level of funds internally generated by the farm, exert an impact on the time path chosen for investment response (to a given change in the level of desired investment) rather than determining the actual level of desired investment."

6. The "transitory income variable is positively related to investment expenditure."

7. "Investment motivation will differ between individuals, time periods and industries; by ignoring these differences we may not be adequately dealing with the problem."

8. "While depreciation is a cost, representing annual wear, tear and obsolescence, and reflects the loss in productivity of an asset as it ages, by equating it with annual replacement investment is to ignore the ability of farmers to postpone replacement of assets beyond their economic life." [72, p.156-160].

The third study is quite unique. Trevena [67] in 1974 said, "This study grew out of the need for a more realistic notion concerning the investment behavior of the individual farm firm. ... Considerable effort has been devoted to estimating the appropriate investment behavior function for industrial corporations; however, a search of the literature revealed no estimates of such a function for individual farm firms."

Trevena used two models, accelerator theory (with gross farm income as a proxy for output) and expected profits theory (with net farm income as a proxy for expected profit), as a basis. Other variables believed to have significant effect on the farmers' willingness to invest include nonfarm income, size of the farm, age of the farmer, number of dependents, and equity in the farm business. The following are brief comments of the results:

1. The results substantiated a two-period lag distribution.

2. "Nonfarm income had a negative effect on net investment possibly because nonfarm work was competitive with farm work."

3. The larger farms tended to be more growth oriented.

4. Age and number of dependents had a negative effect on investment.

The last of the four general investment modeling studies was conducted by Dawson and Dawson [19]. This study examined five models:

1. General accelerator
2. Accelerator with threshold variable
3. Expected profits
4. Supply of funds (financial considerations)
5. Neoclassical

The results showed little difference between the models; all the models fit the data well. However, the neoclassical model was stated to have performed the worst (marginally) and the expected profits model (proxied by agricultural land prices) to have best explained net investment.

Hill and Kau [38] examined investment as a threshold level. If conditions were such that this threshold level was attained or exceeded, then the farmer invests. The aggregated index of all the explanatory variables (A) and the threshold level (A*) varies among farmers.

"To explain and predict the decision for individual farmers or groups of farmers, it is necessary to identify and quantify relationships between the variables that comprise A and the purchasing decision Y." [38, p.22].

$$(26)\quad Y_i = \begin{cases} 0 \text{ if } Ai < Ai^* \\ 1 \text{ if } Ai > Ai^* \end{cases}$$

Hill employed three basic models; model I was to explain present ownership of a grain dryer, model II was to explain actual purchase of a grain dryer, and model III was to explain intentions to purchase a grain dryer. Table 3 shows the variables used in these models and if they were significant.

Helmers [36] examined the impacts of livestock price changes on farmers' investment analysis using a polyperiod linear programming model with discounted net returns as the objective function. The result was that "investment strategy is only slight to moderately affected by the presence of cyclical livestock prices." [36, p.47].

Table 3. **Variables Used by Hill and Kau to Help Explain Ownership or Purchase of Grain Dryers**

	Model I Present Ownership	Model II Actual Purchase	Model III Intentions to Purchase
Farm Size	*	*	*
Farm Type	*	X	X
Percent Field Shelled	*	*	X
Tenancy	X	*	X
Shelled Corn Storage	-	-	X
Percent Sold at Harvest	*	X	X
Operators Age	*	X	*
Elevator Drying Charges	-	-	-
Adequacy of Elevator Services	-	-	-
Dryer Ownership in 1967	-	*	X
Change in Percent Field Shelled	-	*	-
1967 Intent to Purchase	-	*	-

X = Variable used in model
* = Significant Variable
- = Variable considered but not included

Dixon, Hill and Saffell [20] used "data from two surveys at different points in time ... to construct a model for determining the reliability of farmers' intentions about future purchases and for the prediction of metal bin grain storage." (p.67). "The results show that the size of farm has a significant influence on both the probability of purchase and the amount purchased. The data show that the farmers did not accurately anticipate making purchases, but that, when viewed in the aggregate, their purchasing patterns showed significant relationships with reported plans. Thus, farmer purchases of an intermediately priced capital item such as bin storage cannot be precisely forecasted for an individual farmer, but group purchases are fairly predictable." [20, p.68].

The Socio-Economic Perspective

"There is often speculation about the factors which influence individual farmers in the purchase of farm durables. This is especially so when there is a possibility that such decision-making depends less on economic rationality than on social and psychological influences. There is wide agreement that noneconomic factors... may influence farmers' buying decisions; but there does not appear to be any consensus of opinion as to how much importance should be placed on these factors compared with such economic influences as price and the availability of credit." [24, p.299].

The economic (or rational) purchase decision and the psychological (or irrational) purchase choice represents the two extremes of a continuum. In most cases, a decision to invest (or purchase) will be based on a range

of economic, social, and psychological influences (a position in between the two extremes). [24, p.300].

Understanding investment behavior requires understanding both the decision-making process and these economic, social, and psychological influences used in or affecting that process. This publication first examines the literature on the decision-making process and then proceeds to discussion of the socio-economic investment studies.

Decision Making Process

Johnson, et. al., [43], McClymont [51], and Norvell [56] all describe the decision process of farmers but each a bit differently. The decision processes described in each of these articles are presented below.

Johnson, et. al., [43, p.296] describes decision analysis as a component of the management process. The decision analysis itself has three steps:

1. "The manager begins decision analysis by stating as concisely as possible the decision that is to be made."
2. "Next, the manager makes a list of the criteria upon which the decision will be based. ... Some of the criteria are mandatory; others are desirable. Mandatory criteria must be objective, realistic and measurable whereas desirable criteria can simply be statements of the manager's preferred results. Desirable criteria are personal and do not have to be objective, realistic or measurable, but they do have a potential influence on the decision choice." "Which criteria are included, and the weighting of each is itself a decision variable. Managers, as circumstances change and as they acquire experience, will add and delete criteria and change the relative weighting."
3. "Before making the final decision, the manager analyzes the risk involved."

McClymont [51] examined the decision making process of commercial farmers in Zimbabwe. The decision process was found to be cyclical and included five phases:

1. Initiation phase
2. Review phase
3. Active information seeking phase
4. Reasoned experimental phase
5. Implementation phase

Norvell [56] in defining the decision process developed a farmer buying behavior model (Figure 2). "The model depends upon the first decision, the need -- defined as a lack of something, a feeling or state of inadequacy, a dissatisfaction with things as they are, or a desire to obtain something more or better." (p.11).

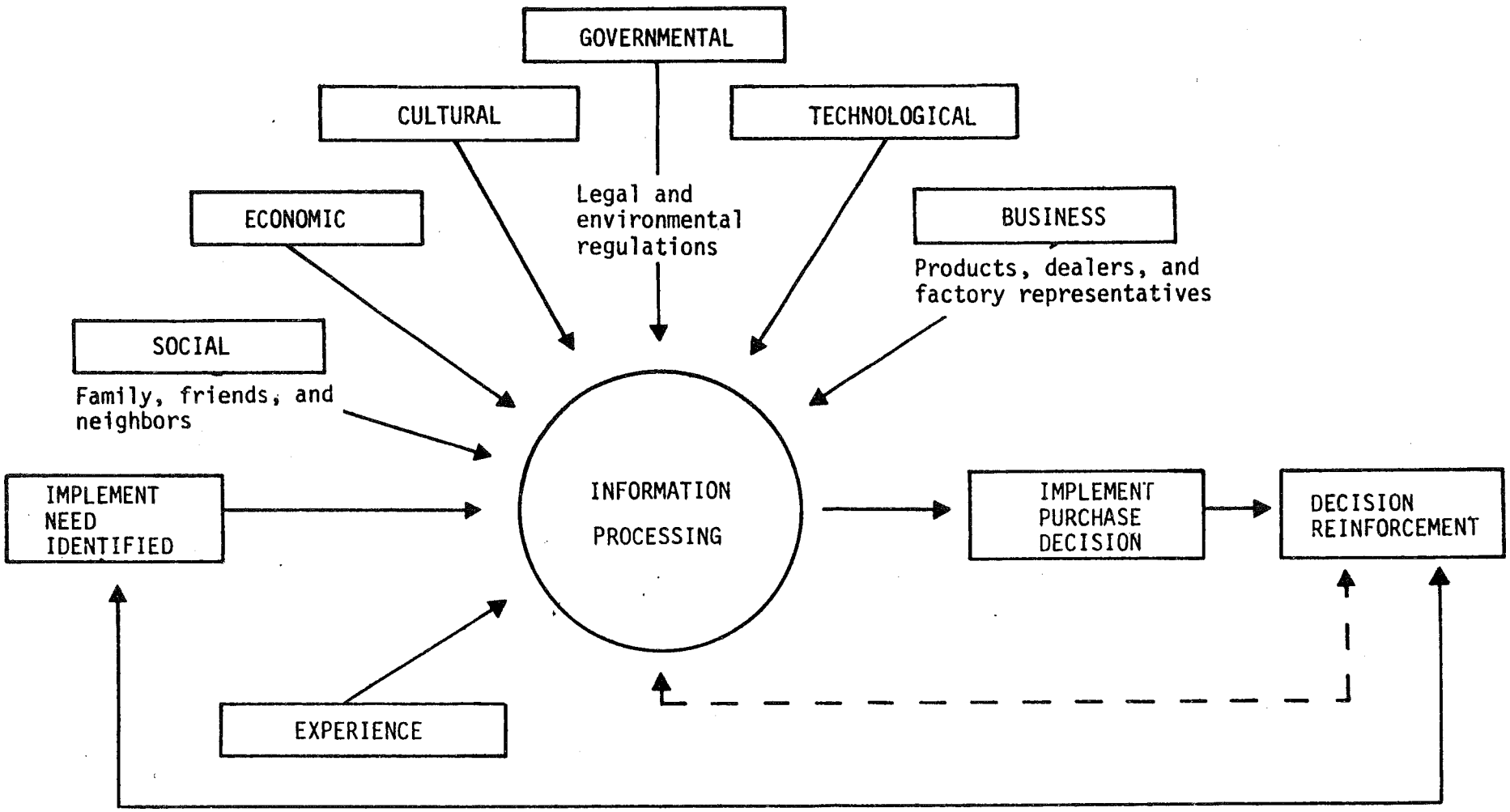


Figure 2. Model used for conducting interviews with farmers and implement dealers on farmers' buying behavior with regard to purchase of farm implements. [56, p:14].

"Once the need has been identified, the farmer moves into the next stage, information processing, and is influenced by a great many external factors as well as by personal characteristics and attitudes." (p.13).

"After evaluating all available information and weighing all possible alternatives, the farmer proceeds to the implement-purchase-decision stage, then to the decision-reinforcement stage, associated with the farmer's rationalizing the implement-purchase-decision. ...The decision reinforcement process continues until reinforcement becomes negative, then the farmer proceeds to re-identify the need and proceed through the steps in the model again." (p.13).

All of these descriptions may simply be summed up with Funk and Blackburn's [28, p.19] four basic stages of the decision process; 1) problem recognition, 2) evaluation of alternatives, 3) purchase, and 4) post purchase evaluation.

"A purchasing decision process begins when the farmer recognizes some problem or opportunity. This involves: 1) a dissatisfaction with an existing product or service, and/or 2) a realization that there are new products or services which are available, but are not currently being used."

"Following the recognition of a problem, the farmer evaluates alternative solutions to this problem. For an existing product the evaluation procedure involves the formation of attitudes or preferences for brands, and the selection of the preferred brand for purchase, while for a new product the farmer must evaluate the consequences of trying and adopting it for use on his farm."

"In post purchase evaluation, the farmer evaluates the results of his purchase decision, based on the results achieved in actual usage. If results are satisfactory, favorable attitudes are formed toward the product and the farmer's preferences strengthened, whereas if results are unsatisfactory, unfavorable attitudes may develop with a strong possibility of a future brand change or discontinued use of the product.

In an "Integrated Review of Literature", Funk [27], examined decision-making influences of farmer buying behavior. All of the studies referenced in his working paper were conducted prior to 1970. However, the influences of decision making then may still apply today. The following is a list of topics (listed as a.) and results (listed as b.) found in Funk's review concerning the decision-making process of farmers.

1.a. Investigation of the extent of rationality in farmer's decision making.

b. The degree of rationality was found to have positive relationships with extension service contacts, mechanization of the farm, farm size, level of living, social participation, and the amount of education.

2.a. Determine the factors which motivate farmers to purchase new tractors.

b. Common factors were related to economic considerations; the most frequent reason was for the added convenience.

3.a. Determine the factors which trigger the decision-making process.

b. A replacement need was usually the beginning of the process. Other less important factors included change in operations, desirable qualities in newer models, and labor saving.

4.a. Determine how farmers decide how much, when, and where to buy machinery.

b. A very large percentage of farmers do not have a specific criterion for making the decision on how much to invest. Purchases were usually caused by the desire to own larger equipment and the need to replace worn out items. Personal characteristics and quality of repair and service were the most important factors in choosing where to purchase.

5.a. Studied farmers machinery purchasing behavior.

b. Sixty percent of the farmers indicated they had no specific method for determining how much to invest. Of the remaining 40 percent, 27 percent said income set the limit, 24 percent indicated return on investment was the criteria, 20 percent said need was what determined the level of investment, 13 percent based the decision on available cash, and less than 10 percent considered investment in terms of the whole farm.

6.a. Determine whether decisions to purchase various items are studied or routine.

b. Over two-thirds of the farmers indicated that studied decisions were made when purchasing cattle, land and fertilizer. Only 10 percent made studied decisions for replacing tractors or barns. Neither the size of the investment nor the length of time for which the investment was to be made were found to be dominant factors in determining whether or not the investment decision was studied.

7.a. How are risks incorporated into the decision process of the farmer?

b. Most farmers had adopted some method for taking care of risks - maintaining a high equity position, diversifying, and buying on a *need* basis.

8.a. Evaluation of farmers risk attitudes.

b. Sixteen percent indicated they were risk takers, 22 percent were in-betweeners, and 62 percent were risk averters. Land ownership and high gross incomes were found to be associated with conservative attitudes and high net worth with great venturesomeness.

9.a. Importance of farmers deliberateness (those decisions based on choice processes in which alternatives are consciously identified and evaluated).

b. Fertilizer buying was more habitual. Prices paid by deliberate farmers were lower than those paid by habitual purchases.

10.a. Importance of buyer knowledge (concerning fertilizer purchases).

b. It could be quite difficult for the average farmer to understand enough to be effective buyers.

The preceding list of studies give a good idea of some of the factors influencing the decision process. Some peculiar features of farmers' purchase decision process were pointed out by Foxall [24, p.301] and are as follows:

"(i) The lag between movements in farm income and the purchase of farm durables which may be up to 16 months;

(ii) The decision to buy machinery is a very personal one and farmers like to deal with someone they know, especially when credit is involved;

(iii) The purchase of farm machinery represents a capital investment whose success will be judged mainly according to its contribution to farm output;

(iv) Farmers are highly suspicious of advertisers' claims and of *extrovert marketing* which is believed to hide deficiencies in the product, and finally

(v) Farmers demand a particularly high standard of after-sales service."

Socio-Economic Studies - General

In his review of farmer buying behavior, Funk also examined shopping area, dealer and brand selection, dealer and brand loyalty, shopping behavior, adoption behavior, sources of information, impact of demonstrations, and opinion leadership. The following is a section from Funk's summary and conclusions. [27, p.29-30].

"The generalizations about farmer buying behavior which seem to be substantiated either individually or collectively by the research reported include the following:

1. Farmers tend to have a propensity for nearness in purchasing all farm supplies. Most farm supplies are purchased from the nearest source.

2. A majority of farmers are not able to detect much difference among alternative dealers or brands of farm supplies; however, his ability to detect differences varies according to the product considered.

3. The reasons farmers select particular dealers or brands are many and varied. No reason appears to be predominant for all products, but rather some reasons are important in the case on one product and other reasons for another product.

4. For most farms supplies the level of brand and dealer loyalty is quite high. Farmers seem to be reluctant to change brands very often.

5. Even though the degree of brand loyalty to specific inputs is high, only a small group of farmers can be identified as having a general tendency to be brand loyal. The same is true for farmers exhibiting a general tendency toward brand switching. Most farmers do not exhibit a consistent pattern of overall brand loyalty.

6. Most farmers do not spend much time actively comparing alternatives before making a purchasing decision. In many instances, farmers are not even aware of many of the available alternatives.

7. There is a substantial degree of variation among farmers in the extent of their shopping activities. Increased shopping tends to be associated with higher gross incomes, higher levels of education, larger farm size, and more expensive purchases.

8. Most farmers do not have a well-established method of evaluating purchasing decisions. Many of their purchasing decisions are routine and do not take future expectations into account.

9. A very large percentage of all farmers can be classified as risk-averters. These farmers have found a level of risk appropriate for given situations and will avoid unnecessary or undesirable risks which may jeopardize their present level of income.

10. The process by which farmers adopt new products and/or innovations is not a unit act, but rather a series of complex unit acts which includes the following stages - awareness, interest, evaluation, trial and adoption.

11. There is a great deal of variation among farmers in the time required to move from the awareness stage to the adoption stage. Some farmers adopt new products when they are first introduced, others wait a long time, and some never adopt.

12. The length of the adoption period varies substantially among new products. Those products or practices which are relatively simple in nature, divisible for trial, compatible with the farmers past experiences, and have visible or measurable results will be adopted faster than products with the opposite characteristics.

13. Innovators can be classified as having higher adoption leadership, more education, higher social status, and younger age. Furthermore, they are more likely to own their own farms, have larger farms, higher gross farm incomes, greater farm efficiency, and a more specialized farm operation. They have more direct contact with agricultural

scientists, are more likely to read research literature, and read more farm magazines than other farmers.

14. The usefulness of various sources of product information varies from product to product. In general, farm magazines, dealers, and neighbors and friends tend to be rated higher than radio and TV, manufacturers, demonstrations, and the extension service.

15. The importance of different information sources varies as the farmer moves through the adoption process. The mass media are the most important source at the awareness stage, other farmers play a predominant role in the decision making stage, while agricultural agencies and commercial sources are the most influential in the action stage.

16. Every farming community has a small group of farmers who can be called opinion leaders. These farmers are widely used as sources of information by other farmers in the community. Opinion leaders in general tend to operate large farms, have a high community status, are active in all types of formal social organizations, have a broad social orientation, and are extremely competent on a technical level.

17. Both formal and informal social groups in rural communities facilitate the exchange of farm information."

In addition to these generalizations, Funk listed areas of farmer buying behavior requiring further research [27, p.31]. They are as follows:

"1. Not much is really known about the decision making process of farmers in purchasing production inputs. None of the studies reviewed paid much attention to this basic process. Additional research in this area will not only provide a deeper understanding of the basic determinants of farmer buying behavior, but it will also provide a more logical framework to evaluate existing research results and guide future efforts.

2. Several studies have looked at the issue of dealer and brand selection, yet the results seem inconclusive. Further work in this area is necessary to identify and measure factors involved in the dealer and brand selection process.

3. The issues of dealer and brand loyalty have not been adequately explored in the studies reviewed. More attention needs to be given to developing typologies for loyal and non-loyal farmers across a wide range of production inputs as well as for specific products. In addition, research is needed which identifies the determinants of brand and dealer loyalty among farmers.

4. Very little is known about the shopping behavior of farmers. Some of the studies reviewed have looked at this issue from the point of view of the length of time devoted to shopping and the number of alternatives considered, but many other elements of shopping remain unexplored.

5. A totally unexplored area of farmer buying behavior deals with farmers' responses to various marketing programs of input firms. How do farmers respond to price changes, various advertising appeals, and different kinds of promotional programs? These, and other similar questions, despite the fact that they are of great importance to farm supply firms, have not been investigated in previous research."

Since Funk's 1972 working paper, he has published at least four journal articles concerning the farmers' buying behavior or decision process. As in his working paper, these studies examined fertilizer and herbicide purchase decisions. The results and conclusions of these four studies differ little from the working paper and, thus, are not discussed here (but are referenced). Though Funk does not examine investment/purchase decisions of durable goods (the focus of this publication); many of the factors influencing the purchase of nondurables are appropriate in the discussion of investment in durable goods.

Norvell examined farmers' buying behavior as it related to the purchasing of farm implements [56]. The variables included in his analysis are representative of socio-economic models and are presented in Table 4. The results of this study were summarized in a study related to the purchase of fertilizers and feeds; the basic results are presented below [55, p.57-58].

1. "Relevant factors influencing the behavior of farming as they proceed through the decision process of purchasing farm implements were identified.

2. Spouse, other family members, product quality, past experience, and service were recognized by farmers as important influences, regardless of a farmer's age, years in operation, type of ownership, or education level. Service was considered the most important factor when choosing an implement dealer.

3. As a source of information for new or improved products, farmers considered other farmers as the number one source. Magazines were identified as second.

4. The research findings indicated that dealers, as did farmers, perceived many of the same factors (i.e., product quality, product availability, spouse, information from others, past experience) as influential to the farmers when purchasing implements. However, dealers did perceive themselves as highly influential in the implement purchase process, as opposed to the not-so-strong response by farmers. Reputation and service were perceived by dealers as being the most important factors to farmers when choosing their dealer. Farmers did not rate reputation as highly as did the dealers.

5. Dealers believed that farmers gained most of the product information from other farmers, as did farmers. Information from television and newspapers was relied on very little.

6. Both farmers and dealers perceived various government requirements and regulations as having little or no influence on the implement-purchasing decision made by farmers."

Table 4. **Factors Perceived by Norvell [56] as Influencing the Purchase Decision of Farm Implements**

Sociological and Business Factors

Neighbors
Friends
Spouse
Other Family Members
Dealers
Factory Representative

Cultural and Governmental Factors and Product Characteristics*

Family Tradition
Government Regulations & Requirements
Product Quality
Product Availability

Experience and Information Sources*

Past Experience
Information from Others
Magazines and Brochures

Repair Service, Trade-in's & Warranties*

Warranty
Service
Emergency Repair
Trade-in's

Dealer Characteristics

Service
Dealer Atmosphere
Trade-in's
Product Information
Reputation
Reliability
Product Quality & Availability
Honesty

Media and Other Information Services

Magazine
Newspaper
Radio
Television
Other Farmers
Factory Representative

Demographic Factors

Farmer's Age
Years of Farming Experience
Type of Ownership
Size of Farm
Farmer's Education

* Norvell does not examine any factors classified as economic even though he indicates in his decision-making model that they play a role.

Johnson, et. al., [43] in a study which included 20 variables (Table 5), found in their machinery-purchase-decision study that soil zone, value of machinery inventory, operator's age and education, but not farm size or type, are significant elements in the farm management process. This "suggests that farm manager decisions are influenced by variables

which are treated only indirectly in neoclassical theory. The existence of a management process which allows for the inclusion of noneconomic factors or criteria in decision making appears to be validated." [p.305]. Johnson, et. al., also found that agricultural representatives and farm machinery dealers do not "perceive the management process accurately. These groups, in fact, underestimate the importance of machinery wearing out and overestimate the importance of improved features on new models, and income tax considerations." [p.305-6].

Brown, one of the authors for the previously mentioned study, and Strayer [8], using the same dataset but 27 variables (Table 5), conducted a study "to document the importance farmers, agricultural representative and farm machinery dealers, attribute to a number of factors a farmer may consider when purchasing a major piece of equipment such as a tractor and/or combine." The following factors were listed in the summary and conclusions section as being:

1. "consistently rated as more important than the average by all three respondent categories:

   old machine wearing out

   change in the size of the farming operation

   time available due to weather

   time available due to labor supply

   credit available

   more income tax deductions through capital cost allowance, business investment tax credit, etc.

   new model had improvements not on old model." (p.36)

2. "less important than the average by all three respondent categories:

   soil texture

   custom hiring the machine work done no longer available

   custom hiring machine work for others

   advertisements." (p.38).

3. "significantly more important than the average by either or both the machinery dealers and agricultural representatives:

   farm records indicated the benefits outweighed the costs

   written calculation indicated by benefits outweighed the costs money available to pay cash, and renting too expensive." (p.39).

Table 5. **Socio-Economic Factors Viewed as Important to Tractor/Combine Purchases**

Factors considered in Brown and Strayer [8] analysis	Factors included (X) in Johnson, Brown, O'Grady study [43]
I. Factors Dealing with Size and Power	
a. Change in size of the farming operation	X
b. Time available due to weather	X
c. Time available due to labor supply	X
d. Time available due to desire for leisure	X
e. Soil texture	X
f. Topography	X
g. Size of other machinery already being used	X
II. Factors Dealing with Age and Brand	
a. Old machine wearing out	X
b. New model had improvements not on old model	X
c. Dissatisfied with presently owned brand	0
III. Economic Factors	
a. More income tax deductions through capital cost allowance, business investment tax credit, etc.	X
b. Money available to pay cash	X
c. Credit available	X
d. Custom hiring the machine work done too expensive	0
e. Custom hiring of machine work done for others	X
f. Machinery price rises	0
g. Renting too expensive	0
IV. Factors Dealing with Decision-Making Method	
a. Past experience indicated the benefits outweighed the costs	X
b. Mental calculation indicated the benefits outweighed the costs	X
c. Written calculation indicated the benefits outweighed the costs	X
d. Farm records indicated the benefits outweighed the costs	X
V. Miscellaneous Factors	
a. Dealer persuasion	0
b. Family persuasion	X
c. Friend's and neighbor's persuasion	X
d. Advertisements	0
e. Custom hiring the machine work done no longer available	0
f. Fuel efficiency	X
VI. Demographic Factors	
a. Soil zone location	X
b. Farm type	X
c. Farm size	X
d. Farmer age	X
e. Farmer education	X

In a study by Foxall [24], particular attention was devoted to the design of the questionnaire. The reason for this was due to concern about "the willingness of farmers to admit the relevance of non-economic factors to their business decisions: no businessman wishes to draw attention to his susceptibility to influences which might not be considered entirely rational." (p.302). The following list includes some of the results found.

1. Previous experience was the primary response given as the source of initial information.

2. The most influential factors in the farmers' decision-making were technical performance, price, and past experience. The only other factor farmers indicated as being most important was after sales service.

3. "... The farmers surveyed acted in a similar fashion to industrial purchasers (of the manufacturing industry) generally in demonstrating brand loyalty and very limited search behavior." (p.306).

4. "... Opinion leadership could exert an influence in markets for agricultural machinery... ." (p.307).

The articles discussed in this general socio-economic section did not model the determinants of the desired level of capital but rather surveyed the farmers' manner in which purchasing decisions are made. Most of these articles stress the importance of such information as a useful aid to stimulate improvements in the farmers buying activity and to help firms in designing marketing programs which serve the farm market efficiently.

Socio-Economic Studies - Specific

Some additional factors usually considered to influence investment behavior, that have not been discussed in the previous sections, include risk, credit, taxes and costs and analysis. Each of these areas have had studies conducted as they pertain to farmer's investment decisions. Each of these areas will briefly be examined.

Risk

"A farmer's response to risk may be in production, marketing, or the financial organization of the farm business." [63, p.115]. An article by Johnson and Boehlje [42] addressed this aspect of risk management. Their "results suggest that the use of various strategies for managing market risks (i.e., hedging or diversification) allow the entrepreneur to accept more risk in investing and producing, and that an integrated analysis of production, marketing and investment-financing alternatives is essential to make accurate recommendations about risk management strategies." (p.155).

An article by Just [46] examined the importance of risk in farmers' decisions. Specifically they examined how risk played a role in

determining what field crops California farmers decided to plant (in association with government programs). "Well over 90 percent of the acreage variation in the San Joaquin Valley, the most important district, is explained when risk variables are included in the analysis. ... In general, the only equations in which risk did not appear significant pertained to crops strongly regulated by government programs." (p.22).

Risk, in Just's study, was measured by the variance and covariance of yield and price output. Farmers perceive other factors contributing to risk also, such as; 1) the degree of familiarity with a crop, 2) illnesses, family affairs, etc. may delay needed operations, and 3) constraints may prevent timely application of fertilizer or pesticides.

How these factors-contributing-to-risk influence investment was not directly examined. They may effect the decision (i.e., the family goals do not warrant the investment) or modify the decision process (i.e., the new crop requires more analysis of profitability as opposed to just past experience).

Credit

"A better understanding of what motivates farmers to make decisions as they do would enhance economic analysis in general and in particular cases involving credit decisions." [73, p.49]. One such case involving credit decision occurs when the farmer invests in capital. Three studies regarding credit are briefly presented below.

The objective of Singh Bagi's study [62] "was to predict the odds of a farmer using short-term and long-term credit, conditional upon information about personal characteristics of the farm operator and economic aspects of the farm firm household." (p.13) "The results show that the probability of a farmer using short-term as well as long-term credit is directly related to the size of the farm, farm experience, level of formal education, frequency of contact with extension agents, perception that credit can increase farm profits, and the number of children below 14 years of age. But, as expected, the probability of borrowing is inversely related to the prevailing interest rate." (p.18).

In Wise's and Brannen's study [73], "(it) was hypothesized that the amount of credit used per farm was a function of a number of endogenous as well as exogenous factors. Endogenous factors include capital investment, land investment, labor used, type of enterprises produced, alternative methods of acquiring control of resources, equity position, personal goals, and other personal characteristics of the operator. Exogenous factors include the cost of extending credit, the interest rate, the lender's perception of the risk involved, the characteristics of the credit institution, and so forth." (p.49). The major focus of this study was the relationship of the farmers' goals to credit use. "Overall, goals were not significantly related to credit use. ... Such a result suggests that other factors tend to offset the importance of goals in credit decisions." (p.53).

The third study concerning the use of credit was authored by Stover, Teas, and Gardner [64]. This article differs from the first two in that the credit decision process is examined from a perspective of the loan officer. The effects on management quality, collateral, and repayment expectation on a given loan request were used to explain the decision process of the individual loan officer. As for results, "the signs of the regression coefficients are as expected. In particular, they suggest risk aversion on the part of the lender: that is, the participating lending officers tended to weigh more heavily the negative influence of all the decision variables. ...The farm management variable is the most important attribute although it is not dominant. Repayment ability and collateral are next in influencing the preference of the loan officers for specific credit situations. Both loan policy and yield are considerably less important." (p.518).

It was surprising not to find studies that directly examined the influence of credit on investment. It is surprising because an increase in the need for capital is usually accompanied with an increase in the use of credit. The direct relationship between credit and investment may be seen by the common factors used to explain each. Size of the farm, farm experience, level of education, profit expectation, interest rate, and equity position were significant in explaining credit and were used in the micro-economic models presented earlier.

Taxes

"Taxes and tax management appear to play a significant role in the choice among various production, marketing, and financial strategies by farmers. ...Furthermore, policy makers clearly perceive that changes in tax rules will significantly alter savings and investment behavior as evidenced by the major changes in the U.S. tax code with passage of the Economic Recovery Tax Act of 1981." [4, p.1030].

The following tax-related factors have often been studied and considered as relevant to investment decisions:

1. The use of cash accounting
2. The deductibility of interest and depreciation
3. Capital gains treatment
4. Investment tax credits
5. Income tax rates (now and in the future)

Studies conducted by Burrell, et. al., [9], Hall and Jorgenson [35], Crabtree [17], Lybecker [50], and Traill [66] examine some of these characteristics.

Burrell, et. al., examines income taxes, inflation, and investment credits effect on profitability (net present value of investment adjusted for tax) and feasibility (feasible if the net-of-tax cash income generated by the investment is sufficient to cover interest payments). In general, increased profitability and feasibility occurred with the use of investment credits, increased inflation, and increased marginal tax rate.

Crabtree examines post-tax machine costs using a present value model and varying the tax rate. Increased income tax rates reduces the machines present cost because of depreciation allowances and partly because of a lower post-tax interest rate.

Traill examines how the "user cost of capital" (a single variable including the price of investment goods, investment credits, income tax rates, and interest rates) changes will effect investment. In the model used, a five percent increase in investment credits, a .07 percent decrease in interest rate, or a 6.1 percent increase in interest rate would reduce the user cost of capital by 4.8 percent causing an increase in net investment.

Hall and Jorgenson studied the relationship between tax policy and investment expenditures. Their basic conclusion was that tax policy is highly effective in changing the level, the timing, and the composition (structures or equipment) of investment expenditures.

Lybecker analyzed purchase-sale and purchase-exchange decisions when acquiring machinery under different tax legislation (before ERTA of 1981, after ERTA, and after TEFRA of 1982). General results showed that the purchase-sale advantage decreased from 1980 legislation to 1981 to 1982 legislation. Tax changes involved in this legislation included:

1. Eliminating additional first-year depreciation
2. Substituting accelerated cost recovery for rapid depreciation methods
3. Changed investment credit (in 1981 and 1982)
4. Reduced marginal tax rates

Costs and Analysis

This last section is somewhat of a catch-all summary category. Many of the tax-related factors listed above can be considered as costs or benefits affecting farm investment. These factors, as well as other considerations such as:

1. Purchase new or used
2. Alternatives to owning (i.e., sharing or leasing)
3. Appropriate size of equipment
4. Replace or repair
5. Profitability of off-farm investment

should be included in the analysis used to study the investment decision.

There are numerous references concerning the analysis of farm investments relative to what actually influences the decision and what process is used to make it. The process or methods of investment analysis described included budgeting techniques, payback period, net present value, and benefit/cost (break-even) analysis. Most of the articles presented a single method and made no comment on whether the process influences the decision. However, Crabtree [17] noted that "discounted cash flow (DCF) methods of capital appraisal are rarely used to evaluate agricultural investments... This reflects not only the empirical limitation of DCF

methods as regards the incorporation of risk and financing constraints but also a lack of comprehension amongst farmers and many advisers about the method themselves." [p.374].

Schaefer-Kehnert [59] examined the methodology of farm investment analysis. In that study, three indicators to use for measuring investment performance were listed:

1. The internal rate of return (IRR)
2. The net present value (NPV or NPW)
3. The benefit/cost ratio (BCR)

"The performance indicators used in farm investment analysis (IRR, NPW and BCR) give the same answer to the simple question of whether the investment pays for the opportunity costs of the additional resources engaged. They give different answers, however, when used to make a choice between alternate investment opportunities. For this purpose, they should be used as follows:

1. The IRR for selecting those (not mutually exclusive) investment alternatives that jointly give the highest return (i.e., using up the available resources)

2. The NPW for making a choice between mutually exclusive investment alternatives (which usually include alternative technologies)

3. The BCR (before financing) for checking the sensitivity of alternative investments with respect to price changes or other uncertainties affecting the benefit and cost stream." [59, p.257].

Summary and Conclusions

"The process of reviewing and organizing research results in a common area is often productive in substantiating or disputing the conclusions of several of the studies reviewed, as well as providing insight into the formation of new conclusions." [27, p.28]. The objective of this paper has been to review the relevant literature concerning farmer investment/buying behavior with a view toward integrating this information in some meaningful way. However, the diversity in; 1) the data, 2) the methods employed, and 3) the results obtained for the many articles found makes it difficult to draw general conclusions. Regardless of this, the following is an attempt at doing so.

Research on farmer investment/buying behavior has approached the issue from three general perspectives; 1) a macro-economic perspective, 2) a micro-economic perspective, and 3) a socio-economic perspective. The distinction between the micro and the macro perspectives is the level of aggregation. The micro-economic perspective focuses on the investment behavior of the individual farmer; the macro-economic perspective focuses on some aggregation of farmers (i.e., state or nation). Despite this distinction, the theoretical treatment has been basically the same.

The distinction between the economic (micro and macro) perspectives and the socio-economic perspective is derived from the level of economic rationale assumed to exist in the farmers decision-making behavior. Traditional economic theory has usually been based on rational decision making -- consideration of economic factors. Sociological and psychological factors (possibly economically irrational) may also play a role in decision making behavior and should also be considered.

Economic Models

In the macro- and micro-economic theory of investment behavior, a small set of models and/or slight variations were commonly used. The two models basic to almost all the literature were; 1) the neoclassical model, and 2) the accelerator model. The form of each model is presented in equations 27 and 28, respectively.

$$(27)\quad I_t = G(L) \Delta [P_t Q_t / C_t] + dK_{t-1}$$

$$(28)\quad I_t = B(L) \Delta Q_t + dK_{t-1}$$

If the price variables (P_t and C_t) are not significant in determining investment (as Clark [13] suggested as being the case for the last 30 years), then the neoclassical model structurally reduces to the accelerator model. Four studies statistically compared variations of these two models as to their explanatory power with regard to empirical data. Table 6 below lists the ranking of models for each of these studies.

The differences in the models presented are due to the different theories of what determines the desired level of capital stock. For example, the accelerator model theoretically says that net investment (the increase in the actual level of capital stock) occurs when there is a desire to increase the capital stock due to output expectations based on past output levels and changes. There are two additional factors important to investment behavior models besides the desired level of capital stock -- replacement investment and the adjustment response.

If the actual level of capital stock does not change ($K_t - K_{t-1} = 0$), then any investment made is replacement investment. Replacement investment is important because added to net investment it equals gross investment which is empirically easy to measure. However, theories for replacement investment are few and the common practice is to assume it equals the proportion of the capital stock that is depreciated annually.

"Meaningful investment functions, whether they emphasize cost and rates of return as determinants or whether they incorporate the 'accelerator', must explicitly take account of expectations. This involves the incorporation of time lags and therefore data for several contiguous time periods." [12, p.44]. There are many adjustment response theories -- Almon lag, Koyck's distributed lag, Jorgenson's rational distributed lag, etc. Ordinary Least Squares estimates are useful for; 1) checking the presence of a lag, and 2) obtaining information on the correct length of the lag (and degree of polynomial).

Table 6. **Ranking of Investment Models for Various Studies (Rankings Based on a Combination of the R^2, Durbin-Watson, and Standard Error of Estimate Statistics)**

Model	Study: Bischoff [3] Equip	Bischoff [3] Const	Clark [13] Equip	Clark [13] Struc
General Accelerator	3	5	1	3
Modified Accelerator:				
Cash Flow	2	2	2	2
Expected Profits				
Supply of Funds				
Change from max sales				
Neoclassical	4	4	4	4
Modified Neoclassical	1	1	3	1
Securities Value	5	3	5	5

	Study: Lamm [48]	Jorgenson Seibert [45]	Trevena Keller [67]	Dawson Dawson [19]
General Accelerator	3	2	1	2
Modified Accelerator:				
Cash Flow	3	-	-	-
Expected Profits		3	2	1
Supply of Funds		4	-	4
Change from max sales	-	-	-	2
Neoclassical	2	1	-	5
Modified Neoclassical	1	-	-	-
Securities Value	-	-	-	-

Two studies delved into the theory of investment behavior modeling; 1) Waugh [71 and 72], and 2) Giaro [30 and 31]. In fact, Waugh [71, p.133] states, "this article surveys the theoretical and empirical evidence provided by researchers to date. While the intention is to be comprehensive, rather than exhaustive, it is hoped that this survey will reduce the need for other researchers of investment, to unnecessarily cover the same ground."

The models used in these articles had explanatory variables of output (sales), cost of capital, level of capital stock, and financial conditions, (i.e., lagged saving, surplus, transitory income, debt, and price-

received/price-paid ratio). Such models amount to a combination of basic models. Giaro [30, p.53] states, "by now, it is clear that all of the theories presented have something to contribute towards the explanation of investment behavior. But since each focuses its attention on one or a few considerations, none of them can be accepted as 'the' theory of investment for the firm. Recognition of this fact has prompted the integration of the most relevant contributions of each approach into a unified theory of investment behavior."

However, both Waugh's and Giaro's studies were conducted in the early 1970s. The specific unified approaches were not snatched and encased in gold as "the investment behavior theory". Studies conducted since then have focused and refocused on the aspects of the basic neoclassical and accelerator models. The following time line (Table 7) presents "the leap frog" effect of the pertinent investment modeling for that time.

Table 7. **Time Frame of Articles and Emphasized Investment Model**

Time Period	Article	Best or Emphasized Model
late 1960s	Jorgenson [44]	Neoclassical
early 1970s	Trevena/Keller [67]	Accelerator
	Giaro [30 and 31]	Unified
	Waugh [71 and 72]	Unified
late 1970s	Clark [13]	Accelerator
early 1980s	Lamm [48]	Neoclassical
	Dawson/Dawson [19]	Modified accelerator

Socio-Economic Models

Socio-economic models were less mathematical in design and were frequently specific as a list of the variables believed to influence investment. Some of the research focused on which item to purchase (which brand, which dealer) rather than whether to purchase. Development of investment models incorporating micro-economic variables is a relatively recent phenomenon.

In their 1974 study, Trevena and Keller [67, p.111] stated, "considerable effort has been devoted to estimating the appropriate investment behavior function for industrial corporations; however, a search of the literature revealed no estimates of such a function for individual farm firms." Thus, Trevena and Keller modeled investment with non-farm income, size of the farm, age of the farmer, number of dependents of the farmer, and equity of the farmer in the farm business in addition to the basic accelerator model. Many of the modeling studies since then have relied even more heavily on such socio-economic factors.

The line of reasoning that leads to these types of models can be illustrated by Johnson, Brown and O'Grady who say: "Neoclassical micro-economic theory proposes to predict the behavior of decision makers under a

variety of circumstances, yet, by itself, it is lacking as a basis for predicting or even understanding routine farm management decision. To understand the purchase of farm machinery and other day to day decisions of farm managers, neoclassical micro-economic theory should be supplemented with a vastly different approach. This approach must consider a number of questions. 'How large a machine should be purchased?' 'Should it be new or used?' 'What special features should it have?' 'When should it be replaced?' And, perhaps most importantly, 'What will my friends and neighbors think of my decision?' [43, p.294-95]. "The list does not include all possible criteria and does not cover the entire machinery purchase decision. Other decisions related to machinery purchases are not addressed: 'Do I need a new machine in the first place?' 'What specific set of characteristics should the machine have?' 'From whom should I purchase the machine?' [43, p.297].

Foxall [24, p.300-01] states that farmers' purchase decisions are "influenced by attitudinal, personality, and behavioral factors as well as purely economic forces. ... Farm inputs are normally chosen because of their potential and expected contribution to production and marketing efficiency. At the same time, farmers are known to be susceptible to a range of social and psychological factors in their purchase decisions; this is well documented in studies of the rate at which farmers adopt innovations... ." "The outcomes of farmers' relatively programmed purchase decisions... may, of course, differ in their susceptibility to noneconomic factors from the comparatively non-programmed decisions involved in the process of innovation. Nevertheless, the expectations that the more routine decisions are still modified in some way by considerations of social status, prestige and interpersonal persuasion is contained in the writings of a number of agricultural economists."

"At the outset it is apparent that many machines are purchased without the improvement of farm income as the prime aim. The intention is rather to make some operation(s) less risky or to ease the stresses on management. Such benefits are almost impossible to value except in terms of the judgment of the individual concerned." [18, p.28].

Many factors have been considered in light of such reasoning. A 1980 study conducted by Brown and Strayer [8], examined 27 factors in six basic categories, that they felt were relevant to the farmers' decision to purchase a tractor and/or combine. Norvell [56] perceived 36 variables to be relevant.

The research indicates that socio-economic factors are important but are quite numerous. The importance of socio-economic factors appear to differ significantly between investments. Thus, it is important to tailor the factors to the investment being considered. Even with such factors built into the model it may not be possible to get an investment function for the individual farmer. In their 1978 study, Dixon, et. al. [20, p.68] stated, "Thus, farmer purchases of an intermediately priced capital item such as bin storage cannot be precisely forecasted for an individual farmer, but group purchases are fairly predictable."

Factors Influencing Investment

In summary, not much agreement exists as to *the* appropriate investment model. Net investment is normally modeled with such factors as output, sales, cash flow, the prices received for output, the user cost of capital, and/or profits. Replacement investment is usually assumed to be the proportion of the capital stock that depreciates. The adjustment response is quite important and difficult to determine for any one farmer.

As a compressed overview of the literature, the following tables were designed to present the factors used to explain investment within each study. There are four tables. Each table accounts for a particular classification of studies and are as follows:

1. Studies modeling investment with time series data (Table 9)
2. Studies modeling investment without time series data (Table 10)
3. Studies examining investment without models (Table 11)
4. Studies examining other topics relevant to investment behavior (Table 12)

The factors are numbered according to the list of factors believed to influence investment presented in Table 8.

In general, research on investment behavior has consistently added to the list of variables that are believed to influence investment and has provided little conclusive evidence that some group of theoretically important variables have in fact only a modest influence. Part of this may result from researchers general tendency to report only the positive results from analyses. It is also possible that type of investment and the time period covered by an analysis may influence the results obtained, resulting in a continually lengthening list of variables influencing investment.

The following discussion explains why and how each factor is expected to be,, or has been found to be, related to investment behavior. The factors are discussed in the order presented in Table 8.

Age

Age affects the attitude of individuals toward investment [38, p.24] and is a reflection of the normal life cycle of a farm business where the younger farmer is attempting to expand the business and the older farmer attempts to maintain size for a while and ultimately disinvests. The young farmers may be less risk averse [62, p.14], tend to be more flexible in their decisions, adopt new ideas and technology more readily and, due to expected life span, will anticipate a longer pay-out period for investments [38, p.24]. Thus, age generally has a negative effect on investment [38, p.65,71]. However, since young farmers frequently have fewer resources and less credit capacity, age may have a curvilinear relationship to investment with a maximum level attained at a relatively young age but significantly after entry into agriculture [62, p.14; 67, p.115; 43, p.301]. Studies have found significant differences in the importance

of various factors in the investment decision process for farmers of different ages [43, p.301; 56, p.20]. In general, older farmers place more emphasis on leisure time, generally face fewer credit restrictions [8, p.53], do less shopping, tend to have more brand and dealer loyalty [25, p.327], place a higher premium on honesty, use other farmers rather than magazines as a source of information [55, p.42] and are more influenced by family traditions [56, p.20].

Education

Education is generally related to innovativeness and managerial ability. Education leads to greater contact with agricultural scientists and a greater likelihood of reading research literature, and thus, more innovativeness [27, p.30]. Innovativeness leads directly to investment as a means of adopting new technology. Increased managerial ability makes farmers "better able to plan and execute plans" [62, p.15] and, to the degree that success is related to management, increases farmers ability to fund and productively use capital investments. Thus, education is generally positively related to investment [38, p.24; 62, p.15]. However, education tends to be highly, but inversely, related to age and is sometimes omitted from models where age is included [38, p.24]. Also, since education reflects managerial ability, there is a basis for not including it in models with other good measures of management.

Education significantly influences the investment decision making process [44, p. 301]. Those with more education tended to give less consideration to family tradition [56, p. 30], family or dealer persuasion [8, p.54] and general farm magazines [56, p.25], but greater consideration to product quality [56, p.30; 55, p.43], past experience of farmer, level of dealer service [56, p.25], tax considerations and technical factors such as soil texture and topography (for machinery) [8, p.54].

Farming Experience

Farming experience is generally treated as an indicator of managerial ability. Those with more experience are expected to be better able to formulate and execute farm plans and, to the degree that financial success is related to management, should be better able to fund and profitably use capital investments [62, p.15]. Investment is expected to increase as years of experience rises. Like education, this variable may be omitted if other, better, measures of management are available. There is also basis for combining experience with education into a single variable.

In the decision making process, farmers with more experience tend to rely less on family members but more on their gained experience and family tradition [56, p.23].

Table 8. *Factors Believed to Influence Investment*

1. Operator's age
2. Operator's level of education
3. Operator's farm experience
4. Operator's activity in community (exposure to and interest in new ideas)
5. Farm's ownership - legal form of organization
   - number of acres (owned and rented)
6. Farm's size - acres used in operation
   - gross income
   - size of enterprise
   - labor input used
7. Farm type - gross income
   - size of enterprise
8. Farm's location - proximity to urban areas
9. Soil quality
10. Size and type of asset (investment)
11. Reason for purchase
12. Decision process - sources of information used
    - sellers (firms contacted)
    - analytical tools used and by whom
    - recommendations sought
    - time of notion to purchase
13. Profitability of the investment
14. Risk
15. Tax concessions
16. Credit and financial status - use (how much, source chosen, why)
    - sources (alternatives, important characteristics)
    - net worth (current and past)
    - total assets (current and past)
    - stable and larger land value due to urban influence
17. Goals - lands future use
    - operator's general plans
    - operator's primary goals for farm business
18. Energy efficiency - additional cost
    - expected annual savings
    - more complicated to install or use
    - more breakdowns or malfunctions
    - inducements to purchase (i.e., price discount or reduced interest rate loan)
19. Income and internal funds available - latest year's net cash farm income
    - previous year's net cash farm income
    - latest and previous year's nonfarm income (cash)
20. Income expectations - current expectations of future farm and nonfarm income
    - implicit rental price of capital
    - prices received by farmers
21. Capital stock - list of assets
    - value and age of farm assets
22. Replacement needs (depreciation)
23. Output (current, past and expected)

Table 9. *Factors Influencing Investment Behavior for the Literature that Used Time Series Analysis*

Factor	Studies 13	19	23	38	58	67	72
1. Operator's Age				S		X	
5. Farm Ownership				S			
6. Size of Farm							
(total assets)				S		X	
(gross farm income)						X	
(number of dependents)						X	
7. Farm Type (income source)				S		X	
16. Credit Considerations							
(equity)						X	
(land prices)		S					
(liquidity)		X					
(change in aggregate debt)							X
19. Internal Funds							
(real cash flow)	S						S
(net cash income)						X	
(real transitory cash income)							S
(nonfarm income)						X	
20. Income Expectations							
Implicit Rental Price of Capital (C)	X		X		X		
(market price of investment good)		X	X		X		X
(rate of depreciation)	X		X		X		
(depreciation tax deduction proportion)	X		X		X		
(investment tax credit)	X	X	X		X		
(income tax rate)	X	X	X		X		
(interest charges -- tax deduction proportion)			X		X		
(interest rate)	X						
(discount rate)	X	X	X				
(cost of funds -- debt or equity)			X		X		
(deflator -- price index)	X	X					
Prices Received (P)	X		I		X		
(change in $\frac{P}{C}$)			X				
21. Value of Capital Stock		X					S
22. Replacement (capital depreciated)	S						
(proportion of capital stock depreciated)			X				
23. Output (change in)	S		X		X		
(change in value of)		X			X		S
Others							
Percent Corn Shelled Sold				S			
Storage Capacity				X			
Drying Changes				X			
Composite of Elevator Services				X			

Table 10. *Factors Influencing Investment Behavior for the Literature that used Models Other Than Time Series in Their Analysis*

Factor	Studies 5	12	17	20	36	40	41	48
4. Participation in Program		X						
5. Farm Ownership				X				
6. Size of Farm				X				
(gross income)							X	X
7. Farm Type		X					X	
9. Soil Type	X							
10. Type of Asset	X							
14. Risk							X	
15. Tax Delays			X					
16. Credit			X					
19. Farm Income (net)						X	X	X
20. Discounted Net Returns	X		X		X		X	
Price of Output					X	X		X
Amounts of Other Inputs						X		
Value of Labor							X	
Marginal Factor Cost of Capital						X	X	X
(price of a unit of capital)			X			X		
(level of tax rates)			X			X		
(level of interest rates)			X			X		
(time pattern for depreciation)			X			X		
(time pattern of physical deterioration)						X		
Input-Output Coefficients					X			
21. Residual Value of Asset			X					
Marginal Value Production of Capital						X		
Amount of Capital used						X		X
23. Quantity of Output (desired)				X		X		X
Others								
Resources Available					X			
Percent Corn Harvested Fed				X				
Storage Capacity				X				
Planned Storage				X				

Table 11. *Factors Influencing Investment Behavior for the Literature that did not use any Modeling Analysis*

Factor	Studies 1	8	18	24	25-29	39	43	51	55-56	69	71
1. Age		X			X		X	X	X		
2. Education		X					X	X	X		
3. Experience (farming)								X	X		
(buying)				X					X		
4. Operator Involvement								X			
5. Farm Ownership				X				X	X		
6. Farm Size		X		X	X		X	X	X		
(gross income)					X					X	
7. Farm Type	X	X			X		X	X			
9. Soil (zone texture topography)		X			X		X				
10. Machinery Prices		X	X	X	X	X				X	
Technical Performance				X	X				X		X
Size of Machinery		X			X		X				
Item Investing in	X										
11. Reason for Purchase		X					X				
12. Sources of Information		X		X	X				X		
Influenced by Others		X		X	X		X		X		
Benefit/Cost Analysis		X					X				
Purchase (decision) time					X						
15. Investment Tax Credit		X	X				X				
Tax Rates		X	X				X				
16. Credit Considerations	X	X	X		X		X		X		
Real Interest Rates			X			X				X	
17. Farm/Operator's Goals								X			
18. Fuel Efficiency		X					X				
19. Net Income			X							X	
20. Prices (expected)											X
21. Capital Stock Value		X				X	X				
23. Output (change)											X
Others											
After Sales Service				X	X				X		
Custom Hiring		X					X				
Brand Considerations		X			X				X		
Renting		X									
Distance to Purchase					X				X		
Product Availability									X		
Governmental Influences									X		
Return to Labor						X					

Table 12. *Factors Influencing Investment Behavior Through Other Factors (studies not focusing on investment but recognizing the indirect impacts to investment)*

Factors	Study's Focus:	Risk			Credit			Taxes			
	Study:	53	46	42	64	62	73	50	9	4	66
1. Age of Farmer						X	X				
2. Education						X					
3. Experience						X					
Management Capabilities					X						
Prior Experience in Borrowing [18]							X	X			
4. Contact with Extension Service						X					
6. Size of Farm						X	X				
Number of Children -- labor						X	X				
7. Farm Type						X					
10. Type of Investment									X		
14. Risk		X	X	X							
15. Tax Considerations		X									
Taxes								X	X	X	X
ITC								X	X	X	X
16. Loan Purpose					X						
Repayment					X						
Collateral					X		X	X			
Pricing					X						
Net Worth				X							
17. Plans for Farm (goals)						X	X				
19. Nonfarm Income							X				
Net Farm Income											X
20. Returns to Investment		X	X			X		X			
Perception of Profitability						X					
Cost of Capital											X
Prices											X
21. Life of Asset								X			
Salvage Value		X									
Years Owned								X			
22. Depreciation								X			
Others											
Government Programs			X								
Market Conditions					X						
Full Time/Part Time Farmer [6]						X					
Race								X			
Interest Rate [16, 28]								X			X

Operators Activity in Community

Operator activity in the community refers to participation in activities that could be expected to expose the operator to new ideas. Examples include contacts with the extension service [62, p.15], participation in special programs for farmers [12, p.49] or participation in agricultural politics (farm organizations) [51, p.153]. The introduction of new ideas leads to an evaluation of alternatives and, thus, to investment. Research indicates a positive relationship between the level of activity and investment [12, p.49] and both short and long term credit demand [62, p.16]. Since activity is directly related to innovativeness, it would be expected to be highly correlated to education and managerial ability.

Form of Ownership

Legal form of organization for most farm businesses is sole proprietorship, partnership or closely held (family) corporation. Corporations tend to be few in number and often operate very much like partnerships. For these reasons, studies have generally not incorporated form of business organization as a potential determinant of investment behavior or had so few corporate observations that only single proprietorship and partnership are used in any analysis [56]. Much of the observed difference in investment between business forms is likely due to business size, operator management and other factors rather than form itself.

Investment behavior studies comparing proprietorship to partnership (family or nonfamily) find that single proprietorships give more consideration to spouse opinions and product quality and less to dealers.

It has been hypothesized that the security of a home base and elimination of the landlord problem in sharing costs would result in a positive relationship between land ownership and machinery investment. However, machinery investment studies have not found a significant relationship between machinery investment and whether a farmer owned all, part or none of the acreage used in production [38, p.25; 20, p.64]. **Tenancy** would be expected to influence buildings investment by itself. Unless land is purchased at the same time, the potential legal problems involved with buildings on rented or leased land would be expected to severely limit investment. Conversely building investment may be substantial when land is purchased at the same time. It may be that the hypothesized relationship between tenure and machinery investment fails because the reduced land and buildings investment of tenants increases their ability and desire to invest in machinery and livestock.

Farm Size

Larger farms invest more because of the need to replace a larger stock of assets. Further, larger farms tend to be more growth oriented [67, p.115]. This result is, of course, at least partly because growth oriented farmers have expanded and, thus, own larger farms. There appears

to be a threshold size above which farmers are more likely to invest [20, p.64].

When making equipment purchases, size (acreage) differences do not appear to influence the importance of various factors considered in the buying decision [43, p.300]. However, the need to replace machinery, and expanding the size of a farm operation were ranked, respectively, as the first and second most important factors influencing machinery purchase [8, p.18]. Size is a significant factor in determining credit use [73, p.53]. The probability of use increases with size [62, p.17].

Farm Type

Type of farm influences the characteristics of the assets owned and, thus, the level of new and replacement investment required to maintain or expand a viable business. Although the specific characteristics that cause differences in investment for alternate farm types have not been identified, variation in net investment by type of farm has been observed [67, p.114].

Farm Location

Nearness to expanding population centers tends to reduce investment in real estate improvements such as new farm buildings, orchards or drainage system [Conklin, p.24]. Urban scatteration at the fringe of urban areas tends to reduce the returns to such investment through higher property taxes, regulation and vandalism, and shortens the time horizon for which the property can be expected to be used for agricultural purposes.

Studies of buying behavior consistently show that nearness to suppliers is an important factor affecting farmers purchase decisions [25, p.330; 27, p.27; 55, p.41].

Soil Quality

Theoretically, soil quality affects investment behavior through its effect on farm profitability. Higher quality land represents a higher level of land input, resulting in the need for a higher level of other complementary resources to reach the optimum combination of inputs. The higher profitability may also provide cash flow to facilitate additional investment. However, investment in soil quality substitutes (irrigation, equipment to speed planting or harvest and land improvements such as tile drainage) may be higher for lower quality land. For example, responsive soils are significantly more likely to find irrigating equipment profitable but the greatest increase in profitability are found for sandy soils with little water holding capacity [5, p.90]. This finding is supported by buying behavior research which indicates that the importance of time available due to weather and to labor supply were significantly different by soil type (presumably drainage).

Type of Asset

Type of investment influences the profitability of investment. Some types of investments are inherity profitable for most farms and some are more profitable for some farms than for others. This leads to an affinity for investment in certain types of assets for individual types of farms [1, 5]. Tax rules frequently vary by type of asset and, thus, lead to differences in profitability and investment [9]. The desire to reduce production risk also increases the perceived value of certain types of investments [18, 5].

Reason for Purchase

The basic economic reasons for purchase are for replacement, to improve operating efficiency or for expansion of the business. These factors have been found to be the most important factors in investment decisions [8, p.17]. However, this trichotomy is of little use when one considers net investments since net investment is, by definition, expansion investment. Economic theory suggests that the primary reason for expansion investment should be expected profitability. In some cases, profitability is ascribed through the actions of opinion leaders in the community rather than from direct calculations or estimations of expected net income [24, 27]. Nonavailability of labor has also been found to be an important reason for machinery purchases [8, p.36].

Purchase Decision Process

The purchase decision process, or management decision process within which purchase decisions are made, is frequently described as a series of actions or steps such as (1) issue analysis, problem analysis, decision analysis and action planning [43, p.295], (2) problem recognition, information search, alternative evaluation [26], or (3) initiation, review, information seeking, reasoned experimentation, implementation, reassessment [51, p.157]. In general, farmers do not first decide the amount they can invest and then decide how to invest that sum. The investment decision process is usually triggered by a replacement decision or a desire to increase income [27, p.11]. Farmers who use a "deliberate" rather than "habitual" decision making procedure, have been found to pay less for input items [27, p.15]. The use of a "rational" decision making process is positively correlated with degree of mechanization, farm size and farm income [27, p.10] indicating that the decision process appears to influence the quality of investment decision.

Profitability of the Investment

The fundamental economic basis for investment is that it be profitable. A narrow economic view would say that nothing else is important. Farmers tend to broaden the perspective slightly to say that benefits must outweigh costs, but that those benefits may include items of value that are not monetary in nature [8, p.20], even though the final evaluation of an investment will be judged "according to its contribution

to output" [24, p.302]. Because of the difficulty of accurately measuring the economic benefits of investments for individual businesses, empirical investment behavior research has generally not looked at the relationship between profitability and investment.

Risk

Farmers are generally assumed to be predominantly risk averse and studies attempting to measure degree of risk taking tend to confirm this hypothesis. However, the widely postulated negative relationship between degree of risk aversion and income has found little support [41, p.63]. Studies have found that risk does influence management decisions particularly for enterprises where risk is not modified by government programs [46], and that higher risk investments generally do have higher incomes [42]. Modeling studies indicate that reduced risk aversion does influence optimal enterprise selection and farm size, and thus, that investment levels and patterns can be expected to vary with risk aversion [42, p.168].

Taxes

Taxes influence investment through their effects on profitability. Differential tax treatment of various types of assets implies that the tax effects on profitability will vary. In general, the tax savings from investment in depreciable assets are greater, and thus, the net cost of a particular item is lower, for higher bracket tax payers [9, 18, 66]. Although farm advisors frequently lament that the desire to avoid paying taxes has a greater impact on farmer decision than the pure economic factors would dictate, the analysis of tax effects has generally been done with net present value or similar models that are unable to determine the degree of truth in such statements. Studies of purchasing decision have found that farmers cite tax incentives as one of the important factors in their decisions [8, p.24].

Credit

The availability of credit and the willingness to use it are generally assumed to be positively related to investment [62, 64, 73]. However, the availability of financing appears to be primarily a facilitating or constraining influence on investment rather than a direct cause of the level of investment [19, p.148]. For many businesses, investment can be made only if financing is available. When credit is used, the cost of credit directly influences the profitability of the investment implying that investment should be inversely correlated with interest rates [62, p.18]. Farmers have cited credit availability as a significant factor influencing their decision to purchase machinery [8, p.23].

Farm Operator Goals

Evidence indicates that commercial farmers do incorporate personal goals in their long term planning [51, p.153]. Thus, to the degree that long term goals imply alternate desires relative to farm type, size, structure or growth, goals can be expected to influence patterns and amounts of investment. Unfortunately, a number of factors influence goals, particularly the family life cycle. Also, it "may be impossible to select goals that are completely independent" [73, p.49]. It is clear that the goals of farmers vary considerably.

Energy Efficiency

Energy, or fuel, efficiency influences investment through its affect on the profitability of investments. Farmers ranked fuel efficiency fourth in importance out of 27 factors that influence machinery investment decisions.

Net Income

The level of **farm income** indicates the ability of a business to pay for new investment and may be a proxy for the expected profitability of added investment in a business in that it reflects the profitability of past investment. The positive relationship between various measures of farm income (gross, net, net cash, etc.) and investment is well established [41, 48, 67, 72]. However, it may be more important in determining the time path of investment than the actual level of investment made within a given environment [72, p.150; 19, p.148]. Some evidence suggests that investment is more responsive to net farm income (with accrual adjustments) than net cash income [48, p.21]. This may imply that net farm income is a better indicator of future ability to pay for assets, or that it is the profitability aspects of income that are important to investment rather than the cash flow aspects.

Nonfarm income has the same type of impact on ability to pay for new investments as farm income. However, nonfarm income has also sometimes been found to be negatively related to investment "possibly because nonfarm work is competitive with farm work" [67, p.115]. An alternate explanation for this result is that high levels of nonfarm income is found on smaller part time operations with lower absolute levels of investment than their larger full time counterparts.

When credit is not available or the farmer will not use it, funds to pay for an investment must come from **internal funds**. Thus, the availability of internal funds is also a facilitating or constraining influence on investment. The ability to internally finance machinery purchases has been found to be an important factor influencing farmer decisions [8, p.16]. However, the importance of internal funds decreases as the size of investment increases [43, p.305].

Income (Price) Expectations

The economic profitability of an investment is determined by relative input and output prices over the period in which the investment is used. Since the period of use must occur after the investment is made, any economic calculations or estimations used to evaluate whether an investment should be made must be based on expected price levels. Although perception of profitability has been used in one study [62, p.17], most data sets do not include information on price expectations. A naive expectations approach is often used where current income or profitability is used as a proxy for expected income.

Capital Stock

Maintenance of the current stock of capital through purchase of replacement items is an important part of total investment. It is half of the investment equation where total investment equals replacement investment plus net investment. It is particularly important for investment models using data sets where only total investment can be observed and replacement investment must be subtracted to obtain net investment [13, 19, 23]. In such cases, a rate of depreciation of the capital stock is usually used to represent replacement investment.

Net investment is frequently defined as some function of the difference between the desired capital stock and current capital stock. The real problem with this is that desired capital is unobservable. It exists only in the minds of asset owners and possible investors. It also may change before it can be reached. Proxies generally used are often some measure of output in spite of the fact that investment is usually made to allow increasing the level of output.

Depreciation

Economic depreciation represents the amount of replacement investment that must be made to maintain the capital stock. Tax depreciation influences the tax savings connected with an investment and, thus, may directly influence investment profitability.

Output

Output has frequently been used as a proxy for desired capital investment [23, 67]. Since output is usually measured in dollars, the measure incorporates changes in the relative price of the products included in agricultural output compared to other products in the economy, and thus, includes a naive measure of price expectations.

APPENDIX A

Key for Variables in Equations

I = gross investment

I^n = net investment

I^r = replacement investment

Q = output

Q^{max} = maximum output

p = produce price

c = price of capital (i.e., user cost, implicit rental price)

K^D = desired capital stock

K = actual capital stock

MV = market value of the firm

RC = replacement cost of the firms assets

d = rate at which capital stock depreciates

Y_T = transitory income

Y = income

D = level of real debt

F = cash flow

B = accelerator constant (desired capital output ratio)

L = proportion of available funds

NI = net income

T = taxes (the rate of tax in equation 16)

$Depr$ = Depreciation

P^c = cost of capital equipment

r = the opportunity cost of money

d = the true depreciation rate (constant)

Z = present value of allowances on a unit of capital expenditure

t = the time period (applicable to all above variables)

u = error term

$J(L)$, $G(L)$, $C(L)$, $R(L)$, $B(L)$ = polynomial lag operators

$w(D)$ = lagging operator (a power series in the delay operator D)

fi, gi, i, bi = weights assigned due to regression analysis

Δ = change

APPENDIX B

Influence of Tax on Implicit Rental Price of Capital

The terms used by Lamm and Fisher were used much earlier by Hall and Jorgenson in their discussion of the effect of taxes on investment [35]. They start their derivation of the cost equation from the assumption that the price of investment goods must equal the discounted value of capital services. The relationship is expressed as:

$$q(t) = \int_t^{\infty} \underbrace{e^{-r(s-t)}(1-U)c(S)e^{-\delta(s-t)}}_{1} + \underbrace{U(1-k)q(t)D(s)ds}_{2} + \underbrace{K_q(t)}_{3}$$

where q = price of capital good
t = time of acquisition of the capital good
r = discount rate
s = time at which the capital goods are supplied
U = tax rate
c = the cost of capital services or the rental value of capital services
= rate of replacement
D(s) = proportion of the asset depreciated in time s
K = investment tax credit rate

This equation basically says that the price of a capital good will be the sum of; 1) the present value of the after tax rental value of the capital services, 2) the present value of the depreciation deductions, and 3) the investment tax credit. The c term is already expressed as the rental value of the services or the marginal value product of the services provided. The product obtained from use of the service is taxed so the rental value is multiplied by 1-U.

From this equation and the assumption of static expectations, Hall and Jorgenson derive the much used cost of capital equation which even they (more appropriately) refer to as the implicit rental value of capital services.

$$c = \frac{q(r+s)\delta(1-k)(1-UZ)}{1-U}$$

where Z = the present value of the depreciation deduction on one dollar's investment

Taking the derivative of the implicit rental value (c) with respect to the tax rate results in:

$$\frac{dc}{du} = \frac{(1-U)(-Zq(r+\delta)(1+k) + q(r+\delta)(1-k) - UZq(r+s)(1-k)}{(1-U)^2}$$

$$= \frac{(1-Z)(q(r+\delta)(1-k))}{(1-U)^2}$$

Since all terms in the numerator are positive by definition, it is clear that the equilibruim implicit rental price of capital increases when the tax rate is increased. Increases in the tax rate reduce the after tax value of the marginal value product [(1-U)(MVP)]. The value of the tax deductions increases [U(D)], thus reducing the marginal factor cost. With a reduced MVP and a reduced MFC the equilibrium cost *increases*.

$$c = \frac{q(r+\delta)(1-k)(1-UZ)}{1-U} = \frac{q(r-\delta)(1-k) - UZq(r+\delta)(1-k)}{1-U}$$

$$\frac{dc}{du} = \frac{(1-U)(-Zq(r+\delta)(1-k) - (-1)[q(r-s)(1-k) - UZq(r+\delta)(1-k)}{(1-U)^2}$$

$$= \frac{-Zq(r+\delta)(1-k) + UZq(r+\delta)(1-k) + q(r-s)(1-k) - UZq(r+\delta)(1-k)}{(1-U)^2}$$

$$= \frac{(1-Z)(q(r+\delta)(1-k))}{(1-U)2}$$

Lower Tax Rate	lower value of depreciation deductions higher MVP
Higher Tax Rate	higher value of depreciation deductions lower MVP
MFC	higher tax rate value of depreciation deductions increase value of ITC is constant MFC decreases
MVP	higher tax rate MVP declines

References

[1] Appa Rao, V. "Income, Savings and Investment of Small Farmers: A Micro Cross-Sectional Analysis." Financing Agriculture. (Jan/Mar 1981) 13(1):30-34.

[2] Bartel, C. "Understanding the Profitability of an Investment." Poultry Tribune. (Aug 1983) 89(8):12-13.

[3] Bischoff, C.W. "Business Investment in the 1970s: A Comparison of Models." Brookings Papers on Economic Activity. (1971) 1:13-58.

[4] Boehlje, M., Carman, H. "Tax Policy: Implications for Producers and the Agriculture Sector." American Journal of Agricultural Economics. (1982) 64(5):1030-52.

[5] Boggess, W.G., Amerling, C.B. "A Bioeconomic Simulation Analysis of Irrigation Investments." Southern Journal of Agriculture Economics. (1983) 15(2):85-91.

[6] Bowers, W. "Guidelines for Tractor and Farm Machinery Purchases, Cost and Return Planning." Oklahoma Agricultural Experiment Station, (1976) Research Report 740:22-29

[7] Brake, J.R. "Farm Finance and National Economic Policy - Some Gaps in Knowledge." American Journal of Agricultural Economics. 56 (1979) 1056-62.

[8] Brown, W.J. and Strayer, R.C. "Purchasing Farm Machinery: A Summary of Responses from Farmers, Agricultural Representatives, and Farm Machinery Dealers." A report submitted to the Chairman, Saskatchewan Research Council, Saskatoon, Saskatchewan, July 1981.

[9] Burrell, A.M., Hill, G.P. and Williams, N.T. "Grants and Tax Reliefs as Investment Incentives." Journal of Agricultural Economics. (1983) 34(2):127-38.

[10] Butchard, J.F. and Davison, D.J. "Farm Machinery Ownership and Replacement." New Zealand Agricultural Science. (1981) 15(2):84-98.

[11] Cargill, T.F. and Meyer, R.A. "Some Time and Frequency Domain Distributed Lag Estimators: A Comparative Monte Carlo Study." Econometrica. (1974) 42(6):1031-44.

[12] Chauhan, K.K.S., Mundle, S. and Jahav, D. "Income, Saving, and Investment Behavior of Small Farmers." Indian Journal of Agricultural Economics. (1972) 27(4):43-50.

[13] Clark, P.K. "Investment in the 1970's: Theory, Performance, and Prediction." Brookings Papers on Economic Activity. (1979) 73-113.

[14] Conklin, H.E., (ed.) "Preserving Agriculture in an Urban Region." New York's Food and Life Sciences Bulletin Number 86, Cornell University, 1980.

[15] Conway, R., Durst, R., Hurbovcak, J. and LeBlanc, M. "Economic Consequences of Tax Reform on Agricultural Investment." Technical Bulletin Number 1741, USDA, ERS, February 1988.

[16] Cook, T.D. and Campbell, D.T. "Quasi-Experimentation: Design and Analysis Issues for Field Settings." Rand McNally College Publishing Co., Chicago. (1979).

[17] Crabtree, J.R. "The Appraisal of Machinery Investment." Journal of Agricultural Economics. (1981) 32(3):365-75.

[18] Crabtree, J.R. "Machinery Investment and Financing." Farm Management Review. (1980) 14:27-33.

[19] Dawson, P.J. and Dawson, D. "Investment Behavior in UK Agriculture: A Comparison of Alternative Theories." Oxford Agrarian Studies. (1984) 13:137-51

[20] Dixon, B.L., Hill, L.D. and Saffell, M.S. "The Relationship of Farmers' Intentions to Purchase and Their Actual Purchases of Metal Bin Grain Storages." North Central Journal of Agricultural Economics. (1980) 2(1):61-68.

[21] Dobbins, C.L. "Evaluating Alternative Farm Investments." Purdue Farm Management Report, Purdue University, Department of Agricultural Economics , Cooperative Extension Service. (April 1979) 4-8.

[22] Eisner, R. "A Permanent Income Theory for Investment: Some Empirical Explorations." The American Economic Review. (June 1967) 57(3):363-90.

[23] Fisher, B.S. "A Quarterly Model of Agricultural Investment in Australia." Australian Journal of Agricultural Economics. (1974) 18(1):22-31.

[24] Foxall, G.R. "Farmers' Tractor Purchase Decisions: A Study of Interpersonal Communication in Industrial Buying Behavior." European Journal of Marketing. (1979) 13(8):299-308.

[25] Funk, T.F. "Fertilizer Buying Behavior of Ontario Farmers." Canadian Journal of Agricultural Economics. (1982) 30(3):319-32.

[26] Funk, T.F. "The Farmer Decision Process in Purchasing Herbicides." Canadian Journal of Agricultural Economics. (1980) 28(2):26-40.

[27] Funk, T.F. "Farmer Buying Behavior: An Integrated Review of Literature." Guelph, Ontario: School of Agricultural Economics and Extension Education, University of Guelph. 1972.

[28] Funk, T.F. and Blackburn, D.J. "Farmers' Buying Behavior: Where Farmers Get Advice." Agrologist. (1978) 7(4):19.

[29] Funk, T.F. and Downey, W.D. "Fertilizer Purchasing Behavior of Indiana Farmers." North Central Journal of Agricultural Economics. (1983) 5(2):123-37.

[30] Girao, J.A. "The Impact of Income Instability on Farmers' Consumption and Investment Behavior: An Econometric Analysis." Ph.D Thesis, Cornell University, Ithaca, New York. (1971) 221 pp.

[31] Girao, J.A., Tomek, W.G. and Mount, T.D. "Effect of Income Instability on Farmers' Consumption and Investment Behavior: An Econometric Analysis." Search Agriculture. (1973) 3(1):1-40

[32] Gramm, W.P. and Nash, R.T. "The Impact of Changes in the Stock of Money on Agricultural Income and Investment." Journal of Money, Credit, and Banking. (1971) 3:709-811.

[33] Griliches, Z. "Distributed Lags: A Survey." Econometrica. (1967) 35(1):16-49.

[34] Gustafson, C.R., Barry, P.J. and Sonka S.T. "Machinery Investment Decisions by Cash Grain Farmers in Illinois." Paper presented to NC-161 Regional Research Project "Evaluating Financial Markets for Agriculture." St. Paul, Minnesota. October 7-8, 1986.

[35] Hall, R.E. and Jorgenson, D.W. "Tax Policy and Investment Behavior." The American Economic Review. (June 1967) 57:391-414.

[36] Helmers, G.A., Lentz, G.W. and Kendrick, J.G. "Specialization and Flexibility Considerations in a Poly period Firm Investment Model." Canadian Journal of Agricultural Economics. (1973) 21(1):41-48.

[37] Hewitt, T.D. "Analyzing the Equipment Purchase Decision for Pecan Producers Carya Illinoensis." Proceedings: Annual Meeting of Florida State Horticulture Society, 1980. (1981) 93:125-127.

[38] Hill, L.D. and Kau, P. "Application of Multivariate Probit to a Threshold Model of Grain Dryer Purchasing Decisions." American Journal of Agricultural Economics. (1973) 55(1):19-27.

[39] Hottel, J.B. and Gardner, B.L. "The Rate of Return to Investment in Agriculture and Measuring Net Farm Income." American Journal of Agricultural Economics. (Aug 1983) 65(3):553-57.

[40] Hughes, D.W. and Adair, A.L. "The Impacts of Recent Changes in Personal Income and Business Profit Taxes on Investments in the Farming Sector." Agricultural Finance Review. (1983) (43):1-8.

[41] Jayasuriya, S., Barlow, C. and Shand, R.T. "Farmers' Long Term Investment Decisions: A Study of Sri Lanka Rubber Smallholders." Journal of Development Studies. (1981) 18(1):27-67.

[42] Johnson, D. and Boehlje, M.D. "Managing Risk by Coordinating Investment, Marketing, and Production Strategies." Western Journal of Agricultural Economics. (Dec. 1983) 8(2):155-69.

[43] Johnson, T.G., Brown, W.J. and O'Grady, K. "A Multivariate Analysis of Factors Influencing Farm Machinery Purchase Decisions." Western Journal of Agricultural Economics. (1985) 10(2):294-306.

[44] Jorgenson, D. "The Theory of Investment Behavior." Determinants of Investment Behavior. R. Ferber, Editor. Columbia University Press, New York 1967.

[45] Jorgensen, D.W. and Siebert C.D. "A Comparison of Alternative Theories of Corporate Investment Behavior." The American Economic Review. (September 1968) 58(4):681-712.

[46] Just, R.E. "An Investigation of the Importance of Risk in Farmers' Decisions." American Journal of Agricultural Economics. (1974) 56(1):14-25.

[47] Koyck, L.M. Distributed Lags and Investment Analysis. Amsterdam: North-Holland Publishing Co. (1954) 111pp.

[48] Lamm, R.M., Jr. "Investment in Agriculture: An Empirical Analysis." Agricultural Finance Review. (Oct 1982) 42:16-23.

[49] LeBlanc, M. and Hrubovcak J. "Tax Policy Aggregate Investment." American Journal of Agricultural Economics. (November 1986) 68(4):767-77.

[50] Lybecker, D.W. "The Economic Impact of Recent Tax Law Changes on Machinery Purchase Alternatives." North Central Journal of Agricultural Economics. (1984) 6(2):157-63.

[51] McClymont, D. "Decision-Making Process of Commercial Farmers in Zimbabwe." Agricultural Administration. (1984) 17(3):149-62.

[52] Murray, J.R. "Patterns of Investment in Biotechnology." Bio/Technology. (May 1983) 1(3):248-50.

[53] Musser, W.N., Tew, B.T. and Clifton, I. "A Break-Even Analysis of Investment in Irrigation Systems for Subhumid Agriculture." Agricultural Finance Review. (1980) 40:35-41.

[54] Nelson, G. "Farm Management Decisions on Buying New Equipment." Annual Report Proceedings of Oregon Horticulture Society. (1976) 67(36): 38-40.

[55] Norvell, D.W. "Farmers' Buying Behavior as Related to the Purchasing of Feeds and Fertilizers in Eastern Kansas." Manhatten, Kansas Agricultural Experiment Station. Monograph, October 1980. 58p.

[56] Norvell, D.W. "Farmers' Buying Behavior as Related to the Purchasing of Farm Implements in Kansas." Manhatten, Kansas Agricultural Experiment Station. Monograph, Feb 1980. 50p.

[57] Patrick, G.F. "Investment Analysis." Purdue Farm Management Report. Purdue University, Department of Agricultural Economics, Cooperative Extension Service. (October 1978) 6-11.

[58] Penson, J.B. Jr., Romain, R.F.J. and Hughes, D.W. "Net Investment in Farm Tractors: An Econometric Analysis." American Journal of Agricultural Economics. (1981) 63(4):629-35.

[59] Schaefer-Kehnert, W. "Methodology of Farm Investment Analysis." Quarterly Journal of International Agriculture (Zeitschrift fur auslandishe Landwirtschaft). (Apr/Jun 1980) 19(2):105-22.

[60] Schaefer-Kehnert, W. "Methodology of Farm Investment Analysis." Quarterly Journal of International Agriculture (Zeitschrift fur auslandishe Landwirtschaft). (Jul/Sept 1980) 19(3):250-67.

[61] Schmidt, P. and Waud, R.N. "The Almon Lag Technique and the Monetary Versus Fiscal Policy Debate." Journal of the American Statistical Association. (1973) 68(341):11-19.

[62] Singh Bagi, F. "A Logit Model of Farmers' Decisions about Credit." Southern Journal of Agricultural Economics. (1983) 15(2):13-19.

[63] Sonka, S.T. and Patrick, G.F. "Risk Management and Decision Making in Agricultural Firms." Risk Management in Agriculture. P.J. Barry, Editor. Ames, Iowa: ISU Press. (1984) p. 95-115.

[64] Stover, R.D., Teas, R.K. and Gardner, R.J. "Agricultural Lending Decision: A Multiatribbute Analysis." American Journal of Agricultural Economics. (1985) 67(3):513-20.

[65] Tauer, L.W. "Calculating the Values of Alternative Investments for a Farmer's Retirement." North Central Journal of Agricultural Economics. (1981) 3(2):101-07.

[66] Traill, B. "Simulating Changes in Investment Grants, Interest and Tax Rates and Inflationary Pressures on Input Markets in UK Agriculture." Journal of Agricultural Economics. (1983) 34(2):203-06.

[67] Trevena, B.J. and Keller, L.H. "Estimating the Investment Behavior of Farm Firms Using the Concept of Rational Distributed Lag Functions." Southern Journal of Agricultural Economics. (1974) 6(1):111-16.

[68] USDA-ERS. "Economic Indicators of the Farm Sector, Income and Balance Sheet Statistics, 1980." Statistical Bulletin 674, September 1981.

[69] USDA-ERS. "Economic Indicators of the Farm Sector." (ECIFS 4-2). Farm Sector Review. 1984.

[70] Vasavada, U. and Chambers R. "Investment in U.S. Agriculture." American Journal of Agricultural Economics. (November 1986) 68(4):950-60.

[71] Waugh, D.J. "The Determinants of Investment in Australian Agriculture - A Survey of Issues: With Particular Reference to the Australian Sheep Industry." Quarterly Review of Agricultural Economics. (1977) 30(2):133-49.

[72] Waugh, D.J. "The Determinants and Time Pattern of Investment Expenditures in the Australian Sheep Industry." Quarterly Review of Agricultural Economics. (1977) 30(2):150-63.

[73] Wise, J.O. and Brannen, R.L. "The Relationship of Farmers' Goals and Other Factors to Credit Use." Southern Journal of Agricultural Economics. (1983) 15(2):49-54.

Other Agricultural Economics Research Papers

No. 88-10	The Potential Impact of Ice-Minus Bacteria as a Frost Protectant in New York Tree Fruit Production	John Love W. Lesser
No. 88-11	Economic Impacts of the Crop Management Program on Western New York Dairy Producers	J. Waldorph W. Lazarus
No. 88-12	The Competitive Position of the United States Grape and Wine Industry	G. B. White D. Blandford
No. 88-13	Lessons Learned From the Farm Debt Crisis of the 1980s, W. I. Myers Memorial Lecture	N. E. Harl Iowa State University
No. 88-14	The Assessment of Economic Impacts of Current and Emerging Agriculture Technologies that Affect Water Quality	L. W. Tauer
No. 88-15	A Survey of Dairy Calcium Consumption, Women in Two New York Counties, 1985 and 1987: An Analysis of an Educational Program's Effectiveness	S. Hurst O. Forker
No. 88-16	A Progress Report on the New York FarmNet Program, April 1, 1987-March 31, 1988	C. Delaney
No. 88-17	Consumer Segmentation Analysis of Grocery Coupon Users	M. Meloy E. McLaughlin C. Kramer
No. 89-1	The Competitiveness of New York State Onions During the 1987-88 Marketing Year	E. Figueroa
No. 89-2	An Analysis of the Acceptance of IPM Techniques in Processed Sweet Corn	J. Waldorph G. B. White
No. 89-3	Statistical Summary of the 1987 Farm Management and Energy Survey	Michael J. Kelleher Nelson L. Bills
No. 89-4	Microcomputers and Small Local Governments in New York: Five Case Studies	Duane E. Wilcox