The effect of farm expansion on Iowa-farmland-sale prices

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THE EFFECT OF FARM EXPANSION ON IOWA-FARMLAND-SALE PRICES

Iowa State University

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Phillip Richard Eberle

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CHAPTER I. INTRODUCTION

Farm-expansion buyers have been a dominant force in the farmland market. In a recent survey by the Federal Land Bank of Omaha (1981) conducted from April 1980 to April 1981, it was found that 70 percent of the 4,000 land transactions polled in Iowa, Nebraska, South Dakota and Wyoming were made by farm-expansion buyers. Another 15 percent of land purchases were by beginning farmers and 15 percent by farmland investors. The Federal Land Bank's survey results were consistent with survey results published in the USDA's "Farm Real Estate Market Developments" (1975, p. 23), which indicated that 68 percent of farmland purchases in the Cornbelt during 1971 were by farmers, and in 1975, 69 percent of purchases in the Cornbelt were by farmers. Although the sample area in these two surveys is different, both samples include the state of Iowa, and both samples indicate that farm-expansion buyers comprise the majority of buyers.

This dominance of the farmland market by farm-expansion buyers implies that farm-expansion buyers are willing and able to outbid other buyers in the farmland market. Assuming all buyers or potential buyers in the farmland market are free from cash flow or other restraints, personal or institutional, this dominance suggests that farm-expansion buyers place a higher value on farmland than their competitors in the majority of farmland transactions. Or, assuming all buyers or potential buyers in the farmland market place an equal value on a parcel of land but are subject to restraints, the dominance of farm-expansion buyers
would imply that their bid prices are less affected by these restraints than are the bid prices of other potential buyers.

This dominance of farm-expansion buyers in the farmland market raises questions concerning efficient allocation of resources and ownership structure of farmland. As for efficiency, the question arises whether farmers in their competition for farmland ignored the opportunity cost of their own labor and other owned resources, thus allowing them to raise their bid for farmland. Ignoring such opportunity costs results in an inefficient allocation of resources. As for ownership structure, the question arises whether farmers in their competition for farmland drive the price of land up to a point where the price has created a barrier to new entrants. Such an entry barrier could lead to an increased concentration of farmland ownership.

The focus of this thesis is not directly on the policy issues of efficiency and ownership structure. Instead, the objective of this thesis is to investigate the factors that allow farm-expansion buyers to dominate the farmland market successfully and the effect these factors have on land prices. More specifically, the objectives of this thesis are:

1. review from the existing literature hypothesized explanations for the dominance of farm-expansion buyers and the consequential effect on farmland prices;

2. theoretically examine the validity of those hypothesized explanations; and

3. empirically test the validity of those hypothesized explanations.

In Chapter II, a number of the factors affecting land prices that have been discussed in the literature are reviewed with the focus on
those studies that included factors related to farm expansion. In Chapter III, the theoretical validity of those factors affecting farmland prices is evaluated. Empirical tests of those factors that allow farm-expansion buyers to dominate the farmland market are conducted in Chapters IV, V and VI. Chapter IV describes a micro-land-price data set used in this study. Chapter V discusses the empirical model used to test the hypothesized factors and the results obtained from this model. Chapter VI presents a summary of the results and the conclusions.
CHAPTER II. RELATED LITERATURE

Although this study focuses on the effect of farm expansion on land prices, a brief review of other studies that have focused on other important issues affecting land values is presented. Such a review is necessary to identify other variables that are important for the explanation of land values. Failure to consider these factors may lead to errors that result from excluding variables. This section on other issues is followed by a review of land value studies that include the farm-expansion effect on land prices.

Farmland Value Studies Not Addressing the Farm-Expansion Issue

There have been a number of land valuation studies, but not all of the land value studies have examined the farm expansion issue. For example, Reinsel and Krenz (1972), Boxley and Gibson (1964), Hedrick (1962) and Boxley and Anderson (1973) have estimated the effects of government payments on farmland values. The effect of federal income taxes on land values was examined by Dean and Carter (1962) and Martin and Gatz (1968). Differences in productivity was the main factor explaining land value differences in a study by Blase and Hesemann (1973) and Hammill (1969). Hammill also found distance from urban center as a major factor explaining land values. The effect of roads and location were important variables in studies by Edwards et al. (1964) and Ahmad and Parcher (1964). Van Hove (1978) analyzed the effect of installment land contracts on selling prices of Iowa farmland. The influence of technological change on land values was tested by Herdt and Cochrane (1966).
The above list of studies is by no means exhaustive, but those studies identify a number of important factors affecting land values. Their impact will be considered later in the empirical testing of expansion-related factors affecting land values.

Land Value Studies Addressing the Farm-Expansion Issue

Studies that have addressed the farm-expansion issue have been both theoretical and empirical in nature. A study by Harris and Nehring (1976) presented a theoretical farm bid model with simulated results. Their work provided a useful conceptual model to consider the effects of increasing returns to land over time, marginal income tax rates, increased returns due to economies of scale, a farmer's degree of risk aversion toward the variability in income from the land and the effect of wealth on the degree of risk aversion. Although conceptually appealing, the Harris and Nehring model is difficult to test empirically, because it requires the knowledge of an individual's utility function.

The farm-expansion hypothesis has been tested in a number of empirical studies. Heady and Tweeten (1963), Tweeten and Nelson (1966), Reynolds and Timmons (1969) and Kuhlman (1978) included the farm-expansion hypothesis as an explanation of variation in aggregated U.S. farmland price data. Other studies by Klinefelter (1973), White, Musser and Sheffield (1977), Walker (1976) and Montgomery and Tarbet (1968) included the farm-expansion hypothesis in an analysis of state or county land prices. The following paragraphs provide a brief summary of each of the farm-expansion studies listed above plus a brief summary of a study
by Pope, Kramer, Green and Gardner (1979) that has tested three of the above models for structural changes.

Heady and Tweeten (1963) developed a single-equation-price-adjustment model to explain land value trends in the United States from 1910 to 1959. The factors influencing land values in their model were: farm expansion, residual return to land, capitalization rate and technological change. Heady and Tweeten hypothesized and tested a number of other factors which were not included in the final model due to collinearity problems. The variable used to capture the farm-enlargement effect was average acres of cropland used for crops per farm. The estimated coefficient was significant and had the hypothesized sign. Long-run and short-run elasticities of land prices with respect to average cropland acres per farm were 0.6 and 2.7, respectively. With these results, Heady and Tweeten concluded that farm expansion has had a major effect on farmland price increases.

Tweeten and Nelson (1966) estimated the variation in a deflated United States land price index for the time period from 1923 to 1963 using a single-equation price-adjustment model and a five-equation-recursive model. The single-equation model had land prices as a function of: number of acres in farms, number of transfers of farm real estate, number of farms, net farm income, return on nonfarm investment and the previous year's land price. For the five-equation-recursive model, the actual variables -- number of acres in farms, number of transfers of farm

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1Tweeten and Martin (1966) essentially present the Tweeten and Nelson model in their article, but concentrate their discussion on the methodology of predicting land prices.
real estate and farm numbers -- were each treated as a dependent variable in separate models, which were estimated by a number of predetermined variables. An additional equation estimated cropland used for crops, a variable in the number-of-acres-in-farms equation. The predicted values for these variables were then used in the land-price equation.

The variables selected by Tweeten and Nelson (1966) were used to capture a number of hypothesized factors of which the farm-consolidation, farm-expansion hypothesis, was one. The number-of-farms variable was used to capture the farm-consolidation hypothesis. Besides capturing the farm-consolidation effect, the number-of-farms variable indirectly captured a number of other effects. For example, in the recursive model, the variable for farm numbers was estimated as a function of machinery stock, a ratio of nonfarm workers' earnings to farm workers' earnings adjusted by the nonfarm unemployment rate, capital gains and farm numbers from the previous year. These variables, machinery stock, ratio of wage earnings and capital gains, capture the effects of excess machinery capacity, excess labor and past changes in land values on land prices. The estimated coefficients had the hypothesized signs, but the farm-numbers coefficient was borderline for statistical significance. Tweeten and Nelson concluded that farm consolidation and government programs restricting land were the major contributors to land price increases from 1950 to 1963.

Reynolds and Timmons (1969) developed a two-equation recursive model to identify the factors affecting average United States farmland values for the years 1933 to 1965. Reynolds and Timmons also used their
recursive model in a cross-sectional analysis using average state land values for the 48 states for the years 1940, 1950, 1954 and 1959. The land-price equation was a function of predicted voluntary farm transfers, government payments, conservation payments, capital gains, change in average farm size (the farm-expansion variable), one over the rate of return on common stocks, and net farm income. The predicted voluntary farm transfers variable was also a function of change in average farm size, debt-to-equity ratio, ratio of farm earnings to nonfarm earnings (an opportunity cost of labor variable), capital gains and man-hours of labor per acre (a technological change variable). The farm-expansion variable had a direct effect on land values, because it was an explanatory variable in the land-price equation, and it also had an indirect effect on land values, because it was an explanatory variable in the voluntary-farm-transfer equation. Voluntary-farm-transfers was also an explanatory variable in the land-price equation. The estimated coefficient for the change in the average-farm-size variable had the expected sign and was statistically significant in the time-series model, but the estimated average-farm-size coefficient in the cross-section model had the opposite sign and was statistically insignificant.

Kuhlman (1978) used a single-equation model to test factors affecting average U.S. farmland values from 1940 to 1977. Land values were hypothesized to be a function of inflationary expectations, technological advance, government programs, real estate taxes, population, urbanization, ease of financing, alternative employment, farm consolidation, net income from farming and capital gains. Due to problems of collinearities,
a number of variables were dropped from the final estimated equation. The average-size-farm variable representing the farm-expansion hypothesis was dropped, because the estimated coefficient was statistically insignificant and did not have the hypothesized sign. Kuhlman reported a 0.999 correlation coefficient between the average-farm-size variable and the population variable, and he also reported correlation coefficients of 0.9 and greater between average farm size and four other variables.

Klinefelter (1973) used a single-equation model to estimate changes in average Illinois state land values for the time period 1951 to 1970. He tested the influence of inflation, net returns to farmland, expected capital gains, farm enlargement, technology, number of farmland transfers and government payments. Due to multicollinearity problems, Klinefelter included only four variables in his final model: net return, average farm size, number of voluntary transfers and expected capital gains. Klinefelter referred to the farm-enlargement hypothesis by Tweeten (1964), as did Reynolds and Timmons (1969). Klinefelter also referred to a hypothesis by Tolley (1970) that the shift in cost curves for farms is due to larger, high-level management farms replacing smaller, low-level management farms. Average farm size was the variable used to capture the farm-enlargement effect. The estimated coefficient for average farm size was significant and had the correct sign. Due to the collinearity problem, average size of farm was also capturing the effect of technological change. Klinefelter reported a 0.98 correlation coefficient between average farm size and a moving average of corn yields, the technological change variable.
White, Musser and Sheffield (1977) applied Tweeten and Nelson's model to examine average state land values in Georgia for the years 1960 to 1974. They hypothesized that the farm-expansion effect on land values was declining due to the outward migration from farming and the decentralization of nonfarm employment into rural areas. Such decentralization provides employment for part-time farmers as well as increased demand for small hobby farms or small farms to supplement workers' income in the nonfarm rural industries. Their results supported their hypothesis. The farm-numbers variable was not statistically significant.

Walker (1976) developed a cross-section analysis of average Iowa county land values. Land values were considered a function of net income per acre, the county's five-year average corn yield, percent of land in row crops in a county, ratio of cattle marketed in a county compared to cattle marketed in the state, geometric mean of land value appreciation, population per square mile in a county and average farm size in a county. The coefficient estimated for the average farm size, the farm-expansion variable, was statistically insignificant and did not have the hypothesized sign. Therefore, the average-farm-size variable was dropped from the model.

Montgomery and Tarbet (1968), through a descriptive analysis of two samples of wheat-pea farmers in the Northwest, identified several characteristics of potential land buyers. One sample of actual farm sales provided information with which Montgomery and Tarbet derived a set of criteria to identify potential land buyers. The criteria were
ability to make a 30 percent downpayment, and ability to pay back the loan in 20 years on the average size farm tract sold during 1963. From a second survey containing income and wealth data on 35 farmers, only 11 farmers were considered potential farm buyers by the above criteria. These potential farm buyers farmed a larger acreage, had a greater return to land, had greater wealth and carried more debt than the non-potential farm-buyer group. Although the potential farm-buyer group was larger in size than the nonpotential buyers, Montgomery and Tarbet concluded that farm expansion was not a major factor, since 40 percent of the land sales in their first sample involved farmers purchasing land they already farmed through renting.

A study by Pope, Kramer, Green and Gardner (1979) reestimated models used by Tweeten and Nelson, and Reynolds and Timmons by using more recent data, and they modified Klinefelter's model to use U.S. data instead of Illinois data. The modified Klinefelter model resulted in average farm size, having a negative sign for the years 1913 to 1972 and a positive sign for the years 1946 to 1972. A number of other variables in the Klinefelter model resulted in coefficients with incorrect signs, yet the total model explained 99 percent of the variation in land prices. Reynolds and Timmons' estimated coefficient for the change-in-average-farm-size variable had the incorrect sign and was insignificant. Tweeten and Nelson's farm-number variable had a smaller coefficient and was statistically significant in the single-equation model but not in the recursive model.
The above studies can be categorized into several groups. The studies by Heady and Tweeten, Tweeten and Nelson, and the time series study by Reynolds and Timmons compose one group of studies that used aggregate U.S. data and had positive results that supported the farm-expansion hypothesis. The studies by Kuhlman and Pope et al. are a second group of studies that used aggregate U.S. data and had results that did not support the farm-expansion hypothesis. In Kuhlman's case, the negative results were due to multicollinearity problems, and in Pope's case, the negative results indicate possible structural changes in the land market or the possible inadequacies of the earlier models. Studies by White et al. and Klinefelter differ from the above two groups in that they used individual state land prices rather than the U.S. farm real estate data. The results of White's study support the possibility of structural change in the land market in which the importance of the farm-expansion effect on land prices was declining. Klinefelter's results indicated the recurring problem of collinearities. The cross-section studies by Walker, and Reynolds and Timmons form a fourth group which obtained unsatisfactory results in estimating the farm-expansion variable. The final study by Montgomery and Tarbet differed from the above studies both in empirical method and in focus. Montgomery and Tarbet's study was descriptive consisting of sample comparisons as compared to the econometric models used in the other farm-expansion studies. As for focus, their study concentrated strictly on the demand side, the buyer's side, as compared to the other studies, which included supply as well as demand factors for land.
Empirical Problems in Land-Price Studies
Addressing the Farm-Expansion Effect

The summary of past empirical studies has revealed two empirical problems, multicollinearity and specification errors. Multicollinearity problems frequently occur in studies that use time-series data due to the common time trend in many of the variables. Multicollinearity results in a loss of precision for the estimated coefficients due to the large variance associated with the estimated coefficients. Reinsel (1973) illustrated that 99 percent of the variation in the U.S. farm real estate index could be explained by the money supply and population. Reinsel's study questioned whether other studies using elaborate models could draw conclusive results due to the high correlation that exists among fundamental economic factors. Heady and Tweeten, Tweeten and Nelson, and Kuhlman all referred to high correlation problems among explanatory variables. Tweeten and Nelson noted that the exact contribution of farm consolidation and government programs, the variables that explained the largest percentage of variation, cannot be pinpointed.

Tweeten and Nelson (1966, p. 48) went on to say:

Because more than one set of variables predicts almost equally well and can be justified from an economic standpoint, the process of selecting the appropriate model is somewhat subjective.

The use of averages such as average farm size and change in average farm size leads to possible specification errors. Specification errors result in biased coefficients and a larger variance associated with the estimated coefficients. Scofield (1964) has argued that farmers operating larger-than-average farms are the primary bidders for farmland.
If Scofield's assertion is correct, use of average farm size as a proxy variable to capture the effect of economies of size on land prices may result in biased coefficients and larger standard errors unless the movement in average-size farms is highly correlated with the movement in efficient-size farms. High correlation with the actual variable is a desirable quality for a proxy variable. In cross-section studies, as illustrated by the studies by Walker, and Reynolds and Timmons, the use of average farm size or change in average farm size proved to be unsatisfactory, because the models did not account for differences among types of farms. For example, an efficient-size dryland farm may be larger and have a lower per acre value than the efficient-size irrigated farm. Unless such differences in farm types are accounted for in the model, the unsatisfactory results obtained by using average farm size to explain aggregate land values are not surprising. Reynolds and Timmons referred to such a case in that the Mountain and Southern Plains states had larger increases in average farm size and lower land values compared to more intensively farmed areas with higher land values.

Delineating the Farm-Expansion Hypothesis

In the existing literature on the effect of farm expansion on land prices, a number of motivating factors for farm expansion have been discussed, but either have not been tested or tested but not as separate hypotheses. Based on a review of prior work, it is possible to delineate the general farm expansion hypothesis into five separate hypotheses: economies of size, excess machinery, wealth, excess labor, and quality of management. The following section provides a brief sketch of the
conceptual arguments presented in the literature for each hypothesis and describes how each hypothesis has been empirically tested.

**Economies of size**

Economies of size was the main argument for the farm-expansion effect on land prices given in the previously summarized studies. The illustration by Tweeten (1964) was the most frequently referenced argument for economies of size. Tweeten's illustration is an adjustment argument where a farmer has previously acquired new labor-saving machinery and then finds himself with excess machinery capacity. By acquiring additional acreage, the farmer is able to reduce his average costs per acre, which implies a greater residual return per acre with the acquisition of additional land. Although Tweeten's example introduced the term excess machinery capacity, this is not essential to the argument. The essential point that distinguishes this argument as an economies of size hypothesis is the reduction in average cost that occurs with increases in farm size.

To empirically test for size economies, a measure of farm size would be desirable. In the previously summarized studies farm numbers, average farm size and change in average farm size were used. Because of the aggregate land price data set, these variables were probably the best available although average size may not capture the true size effect on land prices. Actual sales data for the farm unit with information on farm size after the sale would more likely capture the size effect on land prices.
The empirical farm expansion studies previously summarized have not considered the case of a flat long-run average cost curve. A study by Fulton (1975, p. 105) indicated that most size economies in Iowa can be obtained by 600 acres. If the long-run average cost curve is relatively flat, one would conclude that the size of farms beyond a certain minimum acreage would have little impact on farmland prices. Over time, however, this certain minimum acreage point may increase due to technological change, which has been the historical case. In a cross-section study of land price data, or a shorter time-series study of land prices in which technology is fixed, the effect of economies-of-size on land prices would be smaller than in a longer time-series study which captures the technological effects.

**Excess machinery**

Another motive for the farm-expansion effect on land prices is the excess-machinery hypothesis. Heady and Tweeten (1963, p. 407) presented another economies-of-size illustration that differs slightly from the above Tweeten (1964) illustration. It is from the Heady and Tweeten illustration that this study draws its excess machinery hypothesis. The illustration is as follows:

A farmer owning 160 acres with receipts above variable costs of $50 per acre and with nonland fixed costs of $30 per acre earns $20 as the imputed return to land. Based on a discount rate of 10 per cent, he could pay $20/.10 = $200 per acre for the "home" acreage. But suppose an additional 40 acres is available nearby and he can farm it with existing machinery and other "fixed," discrete inputs. Again, the receipts above operating costs are $50 per acre, and since marginal machinery and other overhead costs are near zero, the return to land is nearly $50. Discounting at the same rate as
before, the farmer may pay up to $50/\text{.10} = $500 per acre for the additional 40 acres. It is clear that in circumstances where available equipment can be used profitably on more acres, farmers intending to expand acreage can outbid those intending to farm only the purchased land.

Although very similar to the economies-of-size example used by Tweeten, and Tweeten and Nelson, this earlier illustration by Heady and Tweeten differs in that fixed costs are treated as zero in calculating the residual return to land, where in the later illustration by Tweeten, and Tweeten and Nelson, fixed costs per acre are reduced by spreading the fixed costs over the total acreage.

This earlier example by Heady and Tweeten ignores some issues. If the farmer in fact pays $500 per acre, and if a competitive market for farmland exists which implies a single price for all land, then this $500 per acre price would also be the opportunity value for the "home" acreage. The "home" acreage, after the purchase of the additional 40 acres, is still receiving a residual return of 20 dollars per acre, a 4 percent return on the value of the land, which is less than the farmer's 10 percent capitalization rate. The farmer is unable to cover the cost of land ownership. This observation leads to the conclusion that the capitalization of the $50 return as a perpetual return to land is in error. In the short run, a farmer could afford to pay $50 an acre in rent for the additional 40 acres. In the long run, as the farmer replaces machinery, all costs become variable and a profit-maximizing farmer would calculate the residual to land after all costs have been considered. The rational farmer would only capitalize the short-run return over the life of his present machinery complement, but not as a
perpetual return. It may well be that farmers in competition for farm­land lose sight of the long-run perspective and capitalize the short-run return to land as a perpetual income stream. For this study, the excess machinery hypothesis refers to the capitalization in the short run of those increased returns to land that result from excess machinery capacity.

In Tweeten and Nelson's study, excess machinery capacity had an indirect effect on land prices. Tweeten and Nelson's excess machinery capacity represented unrealized or potential size economies. The aggregate stock of machinery was used by Tweeten and Nelson to explain farm numbers, the farm-size variable. Increases in the aggregate stock of machinery over time capture the substitution of machinery for labor but do not necessarily imply excess machinery capacity in the hands of those bidding for farmland. A measure of machinery capacity per acre such as horsepower per acre before the acquisition of farmland would better capture the effect of the excess-machinery hypothesis.

Wealth

The wealth hypothesis refers to a land buyer who uses profits or returns to owned land or past accumulated profits, wealth, to acquire additional land. There are two arguments for this hypothesis. The first argument is that profits to owned land and wealth provide the land buyer with funds to overcome possible cash flow restraints that would limit his bid for land. Tweeten and Nelson's discussion (1966, p. 18) of the farm enlargement hypothesis noted that farmers who already have efficient-size farms are making profits that may be used for
additional farmland investment and that owned land provides a useful credit base. The second reason is that the farmland buyer uses the profits from owned land or accumulated wealth to make a higher bid for land to insure the acquisition of land for personal reasons, such as status or pride of ownership. Raup (1978, p. 306) makes the following argument:

With full economic rationality, they (family farmers) can include in their calculation of rate of return a variety of nonmonetary rewards including pride of ownership, continuity of family, freedom of choice of work time and place and ability to identify effort with reward.

The wealth hypothesis has not been empirically tested. Although Tweeten and Nelson mentioned the credit value of owned land, they did not specify a specific variable to capture the wealth effect other than their general farm-enlargement variable.

Excess labor

Tweeten and Nelson (1966, p. 19) made the following excess labor argument:

Accumulation of excess labor and consequent competition for available farming units forces those who remain to pay more and more for control of land and therefore to accept lower residual returns to their labor and management.

The ratio of factory workers' earnings to farm workers' earnings was used by Tweeten and Nelson to capture indirectly the excess-labor effect on land values through the effect of the earnings-ratio variable on farm numbers. It could be argued that this earnings ratio actually is a land-supply variable explaining the outmigration of farmers and, hence, smaller farm numbers, rather than a land-demand variable.
explaining farmers accepting lower returns to labor and management. In fact, Reynolds and Timmons used a similar earnings ratio to explain changes in farm transfers.

**Quality of management**

The final hypothesis is the quality of management hypothesis. High quality management results in a higher residual return to land due to above average production and marketing skills of the farmer.

The quality of management hypothesis has been indirectly cited in the literature. Scofield (1964) hypothesized that a few large, wealthy and better-than-average farmers are the primary bidders for farmland. Montgomery and Tarbet's study supports Scofield's hypothesis, but their study does not specifically conclude whether the higher returns are due to management or size.

Klinefelter, in his discussion of the farm-enlargement hypothesis, referred to a hypothesis by Tolley (1970) that favorable cost-curve shifts have been due to the substitution of fewer, high-level management farms for low-level management farms. Klinefelter did not test for the quality-of-management effect, however, other than through the farm-enlargement variable.

The purpose of this study is to test the above five hypotheses related to farm expansion by using data on actual land-price sales. Hopefully, from micro land-price data, more specific inferences about the effect of those hypotheses on Iowa farmland prices can be made as compared to the general conclusions drawn from research using aggregate land-price data.
CHAPTER III. THEORETICAL VALIDITY OF HYPOTHESES

A discussion of valuation models is in order before discussing the five hypotheses affecting farmland prices. Following the discussion of valuation models, the theoretical validity of each hypothesis and the effect of that hypothesis on the land valuation model is presented. Also, a discussion of why each hypothesis is applicable to farm-expansion buyers more than to other classes of farmland buyers is included.

Valuation

The value placed on farmland by a farmland buyer reflects the present value of an anticipated income stream generated from the land. The valuation of this income stream expressed as a general equation is

\[ V_0 = \frac{R_1 - C_1}{(1+k)} + \frac{R_2 - C_2}{(1+k)^2} + \ldots + \frac{R_n - C_n}{(1+k)^n}, \]

where \( V_0 \) represents the present value of an acre of farmland, \( R_1 \) is the total revenue per acre received at the end of the first year, \( C_1 \) is the total cost per acre for the first year, \( k \) is the capitalization rate and \( n \) is the number of years. If net returns for land are expected to grow over time from the present level of net returns \((R_0 - C_0)\) at a growth rate of \( g \), Equation 3.1 may be written as

\[ V_0 = \frac{(R_1 - C_1)}{(1+k)} + \frac{(R_1 - C_1)(1+g)}{(1+k)^2} + \frac{(R_1 - C_1)(1+g)^2}{(1+k)^3} + \ldots + \frac{(R_1 - C_1)(1+g)^{n-1}}{(1+k)^n}. \]
If farmland is assumed to have an infinite life \((n \rightarrow \infty)\) and the growth rate is less than the capitalization rate \((g < k)\), Equation 3.2 simplifies to

\[
V_0 = \frac{R_1 - C_1}{k-g}.
\]

If returns are expected to be constant over time \((g = 0)\), Equation 3.3 reduces to

\[
V_0 = \frac{R_0 - C_0}{k},
\]

which is the standard capitalization formula for a perpetual income stream with constant returns.

Before concluding the discussion on valuation, a remark about the effect of marginal income tax rates on valuation is in order. The effect of marginal income tax rates on valuation has been addressed by Adams (1977), Baker (1981) and Jeremias (1981). From their work, it is evident that the effect of marginal tax rates on valuation depends on whether growth or constant returns are assumed. For example, valuation Equation 3.4 adjusted for taxes is

\[
V_0 = \frac{(R_0 - C_0)(1-t)}{k(1-t)}
\]

where \(t\) is the marginal tax rate. In this case, the tax rate has no effect on valuation. Now adjusting valuation Equation 3.3, the case of real growth over time, for taxes, the equation becomes

\[
V_0 = \frac{(R_1 - C_1)(1-t)}{k(1-t)-g}.
\]
Because

\[ (3.7) \quad \frac{\delta V_0}{\delta t} > 0, \]

valuation increases with increases in the marginal tax rate. Thus, marginal tax rates have either a positive effect or no effect at all on valuation. Because of the indeterminant effect of tax rates on valuation, tax rates were ignored from further discussion.

**Economies of Size**

In the short run, a firm maximizes profit by adjusting the firm's mix of variable inputs to equate marginal cost to output price. In the long run, a firm adjusts the mix of all inputs to achieve minimum cost per unit of output. If economies of size exist, a firm is able to lower its cost per unit of output by expanding output. In agriculture, such economies of size occur over time with the introduction of larger machinery complements that allow an individual to farm more acres at a lower cost. Adjustment to a larger size farm is not an instantaneous process. Early adopters of a larger size machinery complement acquire additional land at prevailing prices and receive economic profits due to a decrease in per unit costs resulting from economies of size. As more and more farmers expand to larger-size farm units, those economic profits are bid into the price of land.

Figure 3.1 illustrates the above discussion. The cost curves in Figure 3.1 include all costs except land charges. Land is assumed to be a complement to other inputs and output. To use more inputs requires more land, and to produce a greater output, more land is required.
Figure 3.1. Illustration of economies of size
For simplicity, assume there exists only one available line of machinery represented by the short-run average cost curve \( SAC_1 \), the price of output is \( P_1 \) and the present level of production is \( Q_1 \), which is equivalent to using \( L_1 \) acres of land. The area \( P_1 \ a \ b \ P_0 \) represents the economic rent or return to \( L_1 \) acres of land. If the market rent for an acre of land is \( P_1 \ a \ b \ P_0 \div L_1 \), then at \( L_1 \) acres, price would equal marginal costs and income would be maximized. The maximum rent a farmer would pay for \( L_1 \) acres would be the area \( P_1 \ a \ b \ P_0 \).

Now, assume another line of farm implements comes on the market represented by the short-run average cost curve \( SAC_2 \). Assuming that farmers adopting this new machinery maintain present price expectations and assuming that the supply of land is fixed (which is a reasonable assumption, considering the local market in which a farm-expansion buyer operates), and also assuming the supply of other farm inputs is perfectly elastic, then the per-acre rental value is bid up as farmers compete for land in order to gain economies of size available with the new line of farm implements. Figure 3.1 illustrates that point. The maximum rent for \( L_2 \) acres is \( P_1 \ c \ d \ P_2 \div L_2 \), which is greater than the maximum rent with \( L_1 \) acres. Thus, economies of size result in larger rents to land.

In reality, instead of only two short-run-average-cost curves, there are an infinite number of short-run-average-cost curves. Empirically, the question is whether the long-run-average-cost curve, the envelope curve which encompasses all short-run-average-cost curves, is a U-shaped curve with cost minimized at a single level of output or
whether the long-run-average-cost curve is an L-shaped curve with costs minimized over a wide output level. The empirical study by Fulton (1975, p. 105) referred to in Chapter II indicated that most economies of size can be obtained by 600 acres. Thus, the effect of economies of size on land rents would be minimal beyond 600 acres.

By relating the above discussion to our valuation models presented earlier, it is evident that economies of size result in a lower cost component $C_1$, and thus a higher net return which in turn implies a higher maximum value or a higher maximum bid price on land. Increasing farm size has a positive effect on value. The effect of increasing farm size on value diminishes until average nonland costs are minimized, at which point the value of land would be at its maximum.

The effect of economies of size on bid prices is not limited to farm-expansion buyers. An entering farmer purchasing an optimal size farm, 600 acres or more, would bid the same price per acre as would a farm-expansion buyer purchasing an add-on-unit to achieve the same optimal size farm. An outside investor could buy land and in turn rent it to a farmer who would then have an optimal size farm. Although the effect of economies of size is not limited to farm-expansion buyers, the opportunity for an entering farmer to obtain an optimum size farm is limited. For a family-farm-type entrant, capital may be a limiting factor. For other entrants with adequate capital, the limitation may occur due to a lack of efficient-size farm units for sale. Most land sales involve acreages of less than efficient size units. In the data set used in this study, 160 of the 186 land transactions consisted of transactions of less than
200 acres. Although outside investors could still acquire the smaller units and rent them to established farmers who have obtained size economies, the outside investor may be deterred because of the uncertainty of obtaining a good tenant. The point to be made from this discussion is that a farm-expansion buyer is less likely to face restrictions in achieving a farm of efficient size.

Excess Machinery

The excess machinery phenomenon is a short-run constrained maximization problem. It is assumed that the farm firm possesses a machinery complement capable of obtaining size economies, but the farm firm does not have the land complement to achieve these economies. It is also assumed that there is no market to hire out excess machinery capacity. The question for the farm firm is how much rent can the firm afford to pay for an additional acre or tract of land for the current production period. The problem is formulated as

\[
\pi = PQ - C(Q) - FC + \lambda_1 (L_0 - L(Q)) + \lambda_2 (M_0 - M[L(Q)]) ,
\]

where:

- \( \pi \) = profits,
- \( P \) = price per unit of output,
- \( Q \) = unit of output,
- \( C(Q) \) = short-run cost function,
- \( FC \) = fixed costs,
- \( L_0 \) = current land base,
- \( L(Q) \) = land used which is a function of output,
M_0 = machinery capacity with current machinery complement,

M(L(Q)) = machinery capacity used as a function of land used,

\( \lambda_1 \) = lagrangian multiplier or shadow price on land, and

\( \lambda_2 \) = lagrangian multiplier or shadow price on machinery capacity.

Kuhn-Tucker conditions for profit maximization are:

\[
\frac{\partial \pi}{\partial Q} = P - \frac{\partial C}{\partial Q} - \lambda_1 \frac{\partial L}{\partial Q} - \lambda_2 \frac{\partial M}{\partial L} \frac{\partial L}{\partial Q} \leq 0 ,
\]

\( Q \geq 0 , \)

\[
\frac{\partial \pi}{\partial Q} \cdot Q = 0 ,
\]

\[
\frac{\partial \pi}{\partial \lambda_1} = L_0 - L(Q) \leq 0 ,
\]

\( \lambda_1 \geq 0 , \)

\[
\frac{\partial \pi}{\partial \lambda_1} \cdot \lambda_1 = 0 ,
\]

\[
\frac{\partial \pi}{\partial \lambda_1} = M_0 - M[L(Q)] \geq 0 ,
\]

\( \lambda_2 \geq 0 , \) and

\[
\frac{\partial \pi}{\partial \lambda_2} \cdot \lambda_2 = 0 .
\]

Solving for \( \lambda_1 \) given the assumptions of a binding land restraint,

\( L_0 - L(Q) = 0 , \)

and excess machinery capacity, \( M_0 > M[L(Q)] \), which implies \( \lambda_2 = 0 \), gives the following result:

\[
(3.10) \lambda_1 = P \frac{1}{\frac{\partial L}{\partial Q}} \frac{\partial L}{\partial Q} \frac{1}{\frac{\partial L}{\partial Q}} ,
\]
\[ \lambda_1 = P \frac{\partial Q}{\partial L} - \frac{\partial C}{\partial Q} \frac{\partial Q}{\partial L}, \text{ and} \]

\[ \lambda_1 = \text{VMP} - \text{MFC}. \]

Thus, the maximum a farmer would pay in rent for an additional acre of land in the short run is the value marginal product (VMP) less the marginal factor costs (MFC) of farming another unit of land, which is equivalent to gross revenue less operating expenses for the additional unit of land. In the long run, as the farmer replaces his machinery complement, the cost of the new equipment has to be allocated over the total acreage farmed. Determination of rent for the long run is gross revenue less operating and fixed costs. The maximum rent a farmer with excess machinery capacity would pay in the short run is greater than what the farmer would pay over a long period of time. It should be noted if the assumption of no alternative market to hire out excess machinery is relaxed, then rent in the short run equals rent in the long run.

Relating the above discussion to valuation Equation 3.1, it is evident that the cost component \( C_1 \) is lower at least for the short run. This implies that the farm-expansion buyer with excess machinery capacity would be capitalizing higher net returns in the earlier years than would an entering farmer or an outside farmland investor or a farm-expansion buyer without excess machinery capacity. Excess machinery capacity is then hypothesized to have a positive effect on land values.
Wealth

Two hypotheses for the wealth effect on farmland prices were outlined in Chapter II. Those two hypotheses were the Tweeten and Nelson (1966) hypothesis, that wealth in terms of owned farmland provides a useful credit base for further expansion, and the Raup (1978) hypothesis, that farmers receive nonmonetary rewards or utility from land ownership. Although those nonmonetary rewards are not directly related to wealth, the ability to add those returns to farmland bids is limited by the amount of wealth. In other words, the enjoyment of the nonmonetary rewards of land ownership requires a certain amount of wealth.

To illustrate the effect of wealth on credit and consequently on the bid price, consider the following formulation:

\[
\pi = \Pi Q(L_o + L_p) - C(L_o + L_p) + \lambda (K(w) - R L_p),
\]

where:  
\( \pi \) = profits,  
\( P \) = price of output,  
\( Q(L) \) = quantity of output as a function of land,  
\( C(L) \) = total cost as a function of land,  
\( L_o \) = acres of owned land,  
\( L_p \) = acres of purchased land,  
\( K(w) \) = amount of credit available for purchasing land as a function of current wealth,  
\( R \) = price of land, and  
\( \lambda \) = lagrangian multiplier or shadow price on credit restraint.

Maximizing profits and solving for \( \lambda \) assuming credit is limiting \( (K(w) - R L_p = 0) \), gives the following result:
If \( \lambda \) is greater than the buyer's capitalization rate, \( k \), then the maximum value placed on the last acre purchased, \( \left( \frac{\partial Q}{\partial L} - \frac{\partial C}{\partial L} \right)/k \), is greater than the price of land. If the credit restraint is relaxed by an increase in wealth, then the buyer could either buy more land, or if the land available for purchase is limited, the buyer could place a higher bid on the land for sale.

To illustrate Raup's hypothesis where utility is obtained from land, consider the following formulation:

\[
(3.13) \quad U = U(C,L) + (R(L) - P_c C - rL),
\]

where:
- \( U \) = utility,
- \( C \) = consumption goods,
- \( L \) = land,
- \( R(L) \) = net revenue as a function of land,
- \( P_c \) = price of consumption goods,
- \( r \) = rent, and
- \( \lambda \) = lagrangian multiplier.

The utility maximization condition is:

\[
(3.14) \quad \frac{\partial U}{\partial C}/P_c = \frac{\partial U}{\partial C}/(r - \frac{\partial R}{\partial L}).
\]

Assuming nonsaturation of consumption \( \frac{\partial U}{\partial C} > 0 \) and \( \frac{\partial U}{\partial L} > 0 \), then rent is greater than the returns from the last unit of land \( (r > \frac{\partial R}{\partial L}) \). The revenue from that last acre is not sufficient to pay the rent. The utility maximizer will have to pay for this difference, which represents the value of nonmonetary returns from land, from his wealth or earnings from his wealth.
The wealth hypothesis again is not strictly restricted to farm-expansion buyers, but the likelihood of a farm-expansion buyer with his own land base facing a credit restriction would be less than that for an entering farmer. The outside investor may not have credit restrictions on his farmland bid but is more likely to be investing in land for strictly profit motives and not for the utility gained from farmland ownership and the farm lifestyle.

Excess Labor

In order to calculate a net return for an additional land parcel, labor costs associated with the output from that parcel must be determined. In the case where labor is hired, the labor cost is simply the wage rate times the amount of labor. In the case of excess-owner-operator-labor, where the owner operator has sufficient labor to farm an additional unit of land, the labor cost is the operator's opportunity cost of labor times the amount of labor. The opportunity cost assigned to labor varies from the current market wage rate to zero depending on each operator's perception of his opportunity cost. An operator who uses a major portion of his available labor in his current farm operation and has excess labor to farm an additional unit, but who finds any alternative off-farm employment opportunities to be nil, would consider the opportunity cost of his excess labor to be zero. This excess labor argument is equivalent to the excess machinery argument illustrated in Equation 3.8, but in this case the machinery capacity restraint is replaced by a labor restraint. Other operators who have alternative off-farm employment which pays at a wage rate equivalent to farm labor
may still value their own labor at a lower value because of uncertainty about the availability of off-farm employment. Owning a farm to fully utilize the operator's labor provides a certain employment security which off-farm employment does not. Other operators may simply find the alternative employment wage to be less than the farm wage.

Another case which gives rise to excess labor is the case of a son entering the farm business. In this case, because of the kinship relationship, both father and son value their labor at less than their true opportunity cost. The father accepts a lower return in order to insure an adequate land base to employ the son's labor. The son accepts a lower return for his labor in exchange for long-range security. He stands to inherit the farm business at some time in the future.

Thus, the effect of excess labor in terms of an individual operator or the father-son partnership is to lower the cost component $C_1$ in the valuation model, because the operators accept a lower return for their labor. The reduced costs imply a higher value placed on land.

Again, the argument can be made that the excess labor hypothesis does not exclusively apply to farm-expansion buyers. Outside investors could buy land and rent it to farmers having excess labor with no alternative employment opportunities. A counter argument is that a farmer with excess labor would require a higher wage if renting because of uncertainty about retaining the lease.

**Quality of Management**

High-quality management results in higher net returns to land. In terms of our valuation model, quality of management affects the returns
and/or cost components of the model. High-quality management results in higher yields and higher prices, as well as lower costs due to the production and marketing skills of the farmer. Thus, high-quality management has a positive effect on valuation.

Those higher returns to land due to management skills are actually a quasi-rent to management. A quasi-rent for a farmer's management is the value of management that exceeds the opportunity cost of a farmer's management. A common illustration of a quasi-rent for one's individual skill is a professional athlete who earns a million dollars a year but has an opportunity cost for his labor of only twenty-thousand dollars a year. The amount in excess of this opportunity labor cost is a quasi-rent for the athlete's skill. The farmer, unlike the athlete, does not have a market that bids for his management skills. Instead, the farmer must employ himself and acquire a land base in order to realize a reward for his management in excess of his off-farm opportunity cost of labor and management. If there are a number of farmers with high-quality management skills competing for additional acreage, the quasi-rents are bid into the price of land. The portion of quasi-rent bid into the price of land depends on the degree of competition. The greater the competition, the greater is the proportion of quasi-rents bid into the price of land up to the point where the quasi-rent is exhausted and a farmer would receive only a value equivalent to his opportunity cost for management.

High-quality management is a function of education, experience and individual characteristics. Because of these factors, the quality of
management hypothesis applies to farm expansion buyers with high-quality management skills. Entering farmers would lack experience in management. Outside investors for the most part do not participate or do not completely participate in management. Thus, quality of management is viewed as applying exclusively to farm-expansion buyers.
CHAPTER IV. DATA

The primary data used in this study were collected by students in Economics 440, Real Estate Appraisal, during the spring quarters of 1978 and 1979 at Iowa State University. Each student was required to do a farmland appraisal based on comparable land sales. A comparable sale worksheet was developed for the students' use. It was this worksheet completed by the students which forms the primary data base. The following section consists of a description of the comparable sale worksheet and of additional secondary data. This description is then followed by summary statistics of the data set.

Comparable Sale Worksheet and Secondary Data

The comparable sale worksheet (Appendix A) is divided into five sections. Section I contains transfer information obtained from the county auditor's office. From Section I, the size of purchase and location of purchase are identified. Section II contains sale price and financing information from the county recorder's office. From Section II, information concerning sale price and type of financing (mortgage, contract, cash, etc.) and the terms of financing is obtained. Section III contains assessment and tax information from the county assessor's and treasurer's office. Assessed building values provide information on the value of buildings on purchased land. Section IV contains information on characteristics of the farm. From this section, information on quality and location of land and types and conditions of buildings is obtained. Section V, the final section, contains information
on characteristics of the buyer and provides the information to formulate variables to test the farm-expansion hypotheses.

In addition to the data collected from the comparable sale worksheet, additional data were collected on crop prices, horsepower and labor requirements of Iowa farms, average county land values and inflation. Two sets of price data for corn were obtained: average annual prices received by Iowa farmers for corn as reported by the Iowa Crop and Livestock Reporting Service (1981, p. 88) and Thursday's mid-range-cash price for corn for the six Iowa districts as compiled by the Iowa State Extension Service from USDA reports for the years 1974 to 1979. Data on horsepower, months of labor and size of farm in acres for the years 1975 to 1979 were obtained from the Iowa Farm Business Association records compiled by the Iowa State Extension Service. Average county land values were obtained from Harris, Lord and Weirich (1980). The gross national product price deflator (GNPFL), a measure of inflation, for the year 1979 was taken from the United States Department of Commerce Survey of Current Business (1980a, p. 16). For the years preceding 1979, the GNPFL was taken from United States Department of Commerce Business Statistics (1980b, p. 259).

Summary Statistics for Sales Data

The data set consists of 186 observations. Table 4.1 lists the frequency of land sale observations by year of transaction. The observations span the years 1969 to 1979, although 90 percent of the observations occur after 1974. Due to the relatively few observations prior to 1975, only the observations from 1975 and later were used in
Table 4.1. Frequency of land sale observations by year of transaction

<table>
<thead>
<tr>
<th>Year of transaction</th>
<th>Number of land sale observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>1</td>
</tr>
<tr>
<td>1970</td>
<td>1</td>
</tr>
<tr>
<td>1971</td>
<td>1</td>
</tr>
<tr>
<td>1972</td>
<td>2</td>
</tr>
<tr>
<td>1973</td>
<td>4</td>
</tr>
<tr>
<td>1974</td>
<td>8</td>
</tr>
<tr>
<td>1975</td>
<td>11</td>
</tr>
<tr>
<td>1976</td>
<td>24</td>
</tr>
<tr>
<td>1977</td>
<td>42</td>
</tr>
<tr>
<td>1978</td>
<td>51</td>
</tr>
<tr>
<td>1979</td>
<td>32</td>
</tr>
</tbody>
</table>
this study. Out of the remaining 160 observations, an additional 32
observations, in which the buyer was a local or absentee investor, were
dropped because those observations were incompatible with the model to
be developed.

The remaining 128 observations concerned land sales from 48 counties
out of the 99 counties in Iowa (see Figure 4.1). The data were grouped
by the six price-reporting districts also outlined in Figure 4.1. Table
4.2 lists the frequency of observations by price-reporting districts.
Forty-four percent of the observations are within the North Central
district.

Table 4.3 provides summary statistics for a number of variables in
the data set. This table provides an idea of the magnitude and varia-
tion of individual variables. The price of land varies from 281 to
3,500 dollars an acre. In terms of 1972 dollars, the range in price
is from $184.81 to $2,150. The average size of purchase was approximately
128 acres. There is a considerable range in corn yields for total acreage
from 28 bushels per acre to 150 bushels per acre. The average farm size,
including acres owned or acres rented, prior to purchase was approximately
608 acres. The number of tractors per farm was over three, which in
terms of total horsepower is 307 horsepower per farm. The average
number of owner-operators per farm was 1.34. When the number of
anticipated owner-operators planning to join the farm is added to the
number of owner-operators, the average becomes 1.68 owner-operators per
farm. The average years of experience and education is 18.08 and 12.66
years, respectively.
Figure 4.1. Map of Iowa indicating price-reporting districts and number of land sale observations by county
Table 4.2. Frequency of land sale observation by price-reporting districts in Iowa

<table>
<thead>
<tr>
<th>Price-reporting district</th>
<th>Number of land sale observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>8</td>
</tr>
<tr>
<td>North Central</td>
<td>57</td>
</tr>
<tr>
<td>Northeast</td>
<td>20</td>
</tr>
<tr>
<td>Southwest</td>
<td>21</td>
</tr>
<tr>
<td>South Central</td>
<td>12</td>
</tr>
<tr>
<td>Southeast</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 4.3. Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of observations</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale price per acre</td>
<td>128</td>
<td>1,838.77</td>
<td>704.70</td>
<td>281.00</td>
<td>3,500.00</td>
</tr>
<tr>
<td>Deflated sale price per acre 1972 dollars</td>
<td>128</td>
<td>1,241.88</td>
<td>445.15</td>
<td>184.81</td>
<td>2,150.00</td>
</tr>
<tr>
<td>Acres purchased</td>
<td>128</td>
<td>127.64</td>
<td>80.47</td>
<td>18.00</td>
<td>760.00</td>
</tr>
<tr>
<td>Average yield for tillable acreage</td>
<td>107</td>
<td>108.79</td>
<td>18.43</td>
<td>41.00</td>
<td>150.00</td>
</tr>
<tr>
<td>Average yield for total acreage</td>
<td>105</td>
<td>101.69</td>
<td>21.22</td>
<td>28.00</td>
<td>150.00</td>
</tr>
<tr>
<td>Assessed building value</td>
<td>122</td>
<td>16,792.54</td>
<td>29,723.00</td>
<td>0.00</td>
<td>207,359.00</td>
</tr>
<tr>
<td>Taxes per acre</td>
<td>119</td>
<td>11.81</td>
<td>3.90</td>
<td>2.45</td>
<td>25.95</td>
</tr>
<tr>
<td>Distance to marketing center</td>
<td>125</td>
<td>4.87</td>
<td>3.47</td>
<td>0.50</td>
<td>21.00</td>
</tr>
<tr>
<td>Distance to property acquired</td>
<td>110</td>
<td>3.15</td>
<td>3.54</td>
<td>0.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Acres owned prior to acquisition</td>
<td>97</td>
<td>433.88</td>
<td>785.55</td>
<td>0.00</td>
<td>7,300.00</td>
</tr>
<tr>
<td>Acres rented prior to acquisition</td>
<td>96</td>
<td>169.64</td>
<td>232.34</td>
<td>0.00</td>
<td>1,380.00</td>
</tr>
<tr>
<td>Number of tractors</td>
<td>85</td>
<td>3.25</td>
<td>1.55</td>
<td>0.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Total horsepower of all tractors</td>
<td>77</td>
<td>306.72</td>
<td>169.77</td>
<td>0.00</td>
<td>850.00</td>
</tr>
<tr>
<td>Number of combines</td>
<td>82</td>
<td>0.99</td>
<td>0.77</td>
<td>0.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Number of owner-operators and expected</td>
<td>119</td>
<td>1.68</td>
<td>0.93</td>
<td>1.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Number of owner-operators</td>
<td>119</td>
<td>1.34</td>
<td>0.68</td>
<td>1.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Average years of experience for all</td>
<td>85</td>
<td>18.08</td>
<td>9.35</td>
<td>0.00</td>
<td>38.00</td>
</tr>
<tr>
<td>Average years of education for all</td>
<td>84</td>
<td>12.66</td>
<td>2.12</td>
<td>2.00</td>
<td>19.00</td>
</tr>
</tbody>
</table>
The micro-land-price data set summarized in Table 4.3 is a much richer data set than data sets previously used in studying the effect of farm expansion on farmland prices. Much of the variation in farmland-sale prices throughout a county, state or the nation is eliminated by the use of average county, state or national data or indices of farmland value. This micro data set provides a number of variables on individual characteristics of the purchased land tract and of the buyer to help explain the variation of selected farmland sale prices in Iowa. Although this micro-land-price data set is deemed superior to the aggregated land value data sets, it is not without its problems. These problems are discussed in Chapter V.
CHAPTER V. EMPIRICAL MODEL AND RESULTS

This chapter presents the empirical model used to test the effect of the farm-expansion factors on sale price. The empirical model was specified in the form of the general linear statistical model and the method of least squares was used to obtain parameter estimates. The assumptions of the general linear model and the least squares estimates are outlined in a number of texts (Kimnta, 1971; Maddala, 1977; Johnston, 1972) and are not presented here. Instead, only those specific problems suggested by the nature of the problem and data are discussed. Among those problems are whether the parameter estimates are homogeneous across time and different regions of Iowa, whether the assumption of homoscedasticity in the general linear model is violated, and how to treat missing observations in the data set. These problems and the procedure adopted to solve them are outlined in the following sections.

Specification of the Empirical Model

Valuation Equation 3.3 suggests the general form for the empirical model. It is assumed the value placed on an acre of land by the buyer is equivalent to the sale price. Thus, sale price is a linear function of revenues less costs. The empirical model can be expressed as:

\[(5.1) \quad \text{PRICE} = f(\text{PQ}, \text{TAX}, \text{ESINV}, \text{DEHP}, \text{WEALTH}, \text{DEXLBR}, \text{QMEXP}, \text{QMED}, \text{MRKTDIST}, \text{DISTACQ}, \text{DCNTRCT}, \text{ACRES}, \text{BLDSPA})\]

where \(\text{PRICE}\) is the sale price per acre deflated by the gross national product price deflator (GNPDL), \(\text{PQ}\) is a three-year-moving-average-corn
price prior to the sale times the average-acre-corn yield based on total acres purchased, TAX is the per-acre property tax deflated by GNPDFL, ESINV is the inverse of total acres farmed including owned acres, rented acres and purchased acres, DEHP is a dummy variable where a 1 indicates excess horsepower prior to the land purchase and a 0 indicates no excess horsepower prior to the purchase, WEALTH is the number of acres owned by the buyer times the average county land value deflated by GNPDFL, DEXLBR is a dummy variable where a 1 indicates excess labor prior to purchase and a 0 indicates no excess labor prior to purchase, QMEXP is the average years of farm experience per owner-operator, QMED is the average years of education per owner-operator, MRKTDIST is the distance in miles between the purchase and the nearest marketing center, DISTACQ is the distance in miles between the owner's home base and the purchased land, DCNTRCT is dummy variable in which a 1 indicates the purchase was financed through a land contract and a 0 indicates the purchase was financed by other means, ACRES is the size of the purchased land tract, and BLDVPA is the assessed building value per acre deflated by GNPDFL.

The first independent variable, PQ, is a measure of expected revenue. Price expectations are assumed to be a function of past prices, so a three-year-moving-average price was arbitrarily selected. Two sets of expected prices were estimated, one set using an annual-state-average price which was assigned to all sales within a given year and another set using annual-average-district price assigned to all sales within a given year and district. The estimated parameter for
PQ should be positive, reflecting the increase in value due to either increases in expected crop prices or increases in productivity. Property taxes per acre is one of the cost components. The estimated parameter should be negative. Since the parameter estimates for PQ and TAX should be equivalent but of opposite sign, PQ and TAX can be combined into one variable, RETURN, which is PQ minus TAX.

The next variable, ESINV, is the economies of size variable. The estimated parameter is hypothesized to be negative and an estimate of capitalized costs. As farm size in acres increases, the cost per acre decreases and the net return per acre increases resulting in increased land values. It is assumed that all acquired land increased farm size. An alternative specification of the economies of size variable is HPA, total horsepower divided by total acres or total horsepower times ESINV. Ayres and Boehlje (1976) have indicated that annual fixed cost of machinery is a linear function of size. Thus, horsepower is used to estimate cost and dividing by acres gives cost per acre. This type of cost relationship would imply that minimum costs could be reached at various size farms. For example, an 80 horsepower tractor used on a 160 acre farm would have the same cost as a 160 horsepower tractor used on a 320 acre farm. If the estimate for HPA is significant, this would not necessarily imply that larger farms have lower average costs than small farms unless the data reveal a trend that larger size farms have in general a lower value for HPA, which happens to be the case as evidenced by a -.44 correlation coefficient between HPA and total acres farmed.

The estimate for the excess machinery variable, DEHP, is hypothesized to be a positive. To determine whether excess machinery existed, a
model was developed using records from the Iowa Farm Business Association. The following equation was estimated:

\[(5.2) \quad HP = 75.41 + 0.3165 \text{ACRES} \quad R^2 = 0.81.\]

The variable HP was average horsepower per size class of farm. The variable ACRES was average total acres within each size class. Standard errors are in parentheses. Data were collected for the years 1975 through 1979. Equation 5.2 was used to estimate an expected horsepower requirement for each farm on the basis of acres owned and rented. If the actual total horsepower exceeded the expected horsepower, excess horsepower was assumed to be the case.

The next variable, WEALTH, is expected to have a positive effect on sale price. This variable is a proxy for actual wealth. It is assumed that land is the largest component of farmer's net worth although a farmer's actual net worth also depends on the amount of debt outstanding. An alternative specification for the wealth variable is to replace WEALTH with the net worth dummy variables: DNW1, DNW2, DNW3 and DNW4 representing the net worth classes of $50,001 to $100,000; $100,001 to $150,000; $150,001 to $200,000 and greater than $200,000, respectively. The estimated parameter should be positive and increase with wealth to indicate the increasing ability to bid in the full value of the nonmonetary rewards of land ownership as well as the decreasing likelihood of facing a credit restraint.

\[1\] An alternative specification for expected horsepower as a function of acres and months of labor per acre was estimated, but the estimate for months of labor per acre was insignificant at a 5 percent level. Also, this alternative did not significantly change the final results reported in the results section of Chapter V.
The excess-labor variable, DEXLBR, is expected to be positive and reflect the reduction in capitalized labor costs. Excess labor was calculated in a similar manner as excess horsepower. The following equation was estimated:

\[(5.3) \quad LBR = 5.866 + 0.01505 \text{ ACRES} \quad R^2 = .97.\]

The variable LBR, months of total labor, is a function of total acres. Equation 5.3 was used to estimate an expected labor requirement for each farm on the basis of acres owned and rented. If total labor which included the operator and anticipated owner-operators joining the farm business, was greater than expected labor, then excess labor was said to exist. All operators were assumed to supply 12 months of labor. An alternative to DEXLBR was DEXOPLBR, which excluded anticipated owner-operators joining the business.

The next two variables, QMEXP and QMED, are measures of management quality. Quality of management is hypothesized to be a function of experience and education. The estimated parameter is expected to be positive and an estimate of the above-average returns capitalized into the sale price due to quality of management.

The remaining variables are additional variables that affect sale prices. The distance variables, MRKTDIST and DISTACQ, are included to capture transportation costs in hauling outputs or inputs. The parameter estimate is expected to be negative and an estimate of capitalized

\[\text{An alternative specification for expected labor as a function of acres and horsepower per acre was estimated, but the estimate for horsepower per acre was insignificant at a 5 percent level. Also, this alternative did not significantly change the final results reported in the results section of Chapter V.}\]
transportation costs. The parameter estimate for the variable DCNTRCT is expected to be positive reflecting higher sale prices when financed by contracts. This higher value is the result of sellers negotiating for a higher selling price and a lower interest rate so sellers may report more income in terms of capital gains which are taxed at a lower rate than interest income. Buyers agree to such terms because the terms of the contract typically require lower downpayments. The parameter estimate for the variable ACRES is expected to be negative, reflecting credit limitations in bidding for larger units. The expected estimate for BLDVPA should be positive. If assessed building values are an accurate measure of value, the expected parameter value should be near one.

The variables PQ, TAX, RETURN and BLDVPA are deflated by GNPDFL. This is consistent with valuation theory, which suggests that valuation can be done in either nominal or real terms. If net returns reflect increased returns due to inflation, then the capitalization rate should also be adjusted by the inflation rate, thus the effect of inflation is cancelled out except for the possible tax effect (Jeremias, 1981). If the above variables were not deflated, then the estimated parameters for the variables used to obtain cost estimate such as ESINV would not be constant since costs increase year by year due to inflation. This would restrict the use of the model to data from any one year. If parameters for the 1975 to 1979 model were estimated using nominal values, the estimated parameters for variables such as ESINV would be a weighted average cost figure weighted by an inflation index and such a variable would be difficult to interpret.
Pooling the Data

It was desirable to pool all observations into a single data set to obtain more efficient estimates, since the number of observations for any time period and district was too small to test a model with a large number of variables. In order to pool the data, it was assumed the parameters were homogeneous over time and districts. Intercept parameters were allowed to vary with time and price-reporting district to capture the effects of missing information not included in the model, such as local land market conditions and changes in returns and cost that are not captured by the variables in the model.

The test for the homogeneity of the slope estimates involves an F test as outlined by Johnston (1972, p. 199). The test is as follows:

\[
F = \frac{(ESS_r - ESS_u) / (df_r - df_u)}{ESSu / df_u} \geq F_{0.05, df_r - df_u, df_u},
\]

where \( ESS_r \) is the error sum of squares of the restricted model, the pooled model in this study, and \( ESS_u \) is the error sum of squares for the unrestricted model where the slope parameters are allowed to vary, \( df_r \) and \( df_u \) are the degrees of freedom for the restricted model and unrestricted model, respectively. If the calculated statistic is greater than the F statistic at the 5 percent error level, then the null hypothesis of homogeneous parameters over time and region is rejected and the pooled model would not be appropriate.

Rather than estimate a model for each district for a given year, the assumption was made that parameters are homogeneous for all districts within a year. A test for equality of parameters over time is made. If the results of this test suggest the null hypothesis cannot be
rejected, then equality of parameters across years is assumed and equality of parameters across districts is tested. If the null hypothesis of equality of parameters among districts is not rejected, then the pooled model is used. If the null hypothesis is rejected in either case, then the model should be restricted to data from the year and district with the most observations.

Tests for Heteroscedasticity

One assumption of the general linear statistical model is homoscedasticity, which implies that the variance of the error term is constant for all observations. Violation of this assumption implies that the least squares estimates no longer have minimum variances. The use of a data set that has sale-price observations gathered over time and different districts may result in heteroscedasticity, unequal variances for the error term. Land prices have increased over time due to inflation and other economic factors. These increases in land prices over time may also imply increases in the variance of the error term over time. Across districts, variation in land prices is due to variation in expected yields as well as the variability of yield due to weather conditions. Changes in variability of yield across districts would likely result in increased variability in sale prices and in unequal variances of the error term across districts. Areas with less productive soil and greater chances of drought such as the southwest district in Iowa have lower land prices than areas with more productive soil and less likelihood of drought such as the north central district. Smaller variances of error terms would be expected with these lower
land prices. The problem of heteroscedasticity is partially if not totally remedied by the specification of the model. Deflating land prices and other variables expressed in nominal terms adjusts for unequal variances due to inflation. Allowing intercept parameters to vary by year and district corrects for differences in variances peculiar to any year and region.

To test whether the specified model corrects for differences among variances of error terms, a test for equality of variances was made. An estimate of the variance for each year and region was obtained from the test for equality of parameters. The appropriate test is:

\[ F = \frac{\text{ESS}_1/df_1}{\text{ESS}_s/df_s} \leq F_{0.05, df_1, df_s} \]

where \( \text{ESS}_1/df_1 \) is the year or district with the expected largest mean square error, and \( \text{ESS}_s/df_s \) is the year or district with the expected smallest mean square error. Among years, one would expect to find larger errors associated with 1979 than with 1975. Among districts, the north central district historically has the highest land prices, whereas the south central and southwest districts have the lower prices. If the calculated F statistic is larger than the F statistic at the 5 percent error level, then the null hypothesis of homoscedasticity is rejected. If the null hypothesis is rejected, then a weighted least squares model is used to account for the additional information of unequal variances. If the null hypothesis is not rejected, then ordinary least squares is used.
Missing Observations

Before any of the statistical tests covered in the previous section can be tested, a solution to the problem of missing observations must be found. A summary of different solutions is presented in Maddala (1977). Three solutions for missing values are the classical method, the first-order method and the zero-order method. The classical method ignores all observations with missing values, which results in a loss of information since other explanatory variables are dropped if only one variable for an observation has a missing value. In the first-order method, missing values are replaced by regression. The variable with missing values is regressed on the other independent variables. The estimates obtained from the first-order method are biased, but are often more efficient due to the gain in additional information. In the zero-order method, missing values are replaced by the sample mean. If the missing values occur only among the independent variables and are missing at random, then the estimates of the zero-order method are unbiased. As for efficiency, Haitovsky (1968) suggests that the zero-order estimates are more efficient provided that the correlation between independent variables is low.

The substitution of sample means is used to replace missing values in the empirical model. The zero-order method was chosen for its simplicity and it allows for more observations to be used. If the first-order method is used, a number of observations would still be dropped, because in many cases, one or more of the other independent variables on which a variable with missing values was regressed would
also contain missing values. Also, the correlation matrix between variables (Appendix B) reveals that the correlation between independent variables is low, which is an indication that the zero-order estimates are likely to be more efficient than the classical estimates.

Results

The two models that are reported are:

\[ (5.6) \quad \text{PRICE} = f (\text{RETURN}, \text{ESINV}, \text{DEHP}, \text{WEALTH}, \text{DEXLBR}, \text{QMEXP}, \text{QMED}, \text{MRKTDIST}, \text{DISTACQ}, \text{DCNTRCT}, \text{ACRES}, \text{BLDVPA}, \text{DNW}, \text{DNC}, \text{DNE}, \text{DSW}, \text{DSC}, \text{D75}, \text{D76}, \text{D77}, \text{D78}) \],

\[ (5.7) \quad \text{PRICE} = f (\text{RETURN}, \text{HPA}, \text{DEHP}, \text{WEALTH}, \text{DEXLBR}, \text{QMEXP}, \text{QMED}, \text{MRKTDIST}, \text{DISTACQ}, \text{DCNTRCT}, \text{ACRES}, \text{BLDVPA}, \text{DNW}, \text{DNC}, \text{DNE}, \text{DSW}, \text{DSC}, \text{D75}, \text{D76}, \text{D77}, \text{D78}) \].

The only difference between Models 5.6 and 5.7 is the specification of the economies of size variable. In Model 5.7, HPA replaces ESINV.

Other models were run with alternative specifications of various variables such as DEXOPLBR for DEXLBR and the net worth dummy variables for WEALTH. The use of DEXOPLBR for DEXLBR did not improve the results. The model with the net worth dummy variables was dropped due to fewer observations and poor survey design, which resulted in most of the observations being placed in the highest net worth class. Also, the three-year-moving-average-district-corn prices were not used because the data series began with the 1974 to 1975 crop year. An attempt to use an estimate of the three-year-average-district-corn price for the years 1975 and 1976 did not improve upon the results obtained by using the three-year-moving-average-Iowa corn price.

Before reporting the results of Models 5.6 and 5.7, the results of the pooled tests and tests for heteroscedasticity are reported.
In Tables 5.1 and 5.2, the ESS for the unrestricted and pooled models for both the yearly and regional models are shown. The calculated F statistic for the null hypotheses of equality of slope parameters among years and regions is also reported in Tables 5.1 and 5.2. The calculated F statistics in Table 5.1 are less than the upper 5 percent F value $\left(F_{0.05,51,55} = 1.58\right)$, which implies the null hypotheses cannot be rejected and pooling the data across years is appropriate. The calculated F statistics in Table 5.2 are also less than the upper 5 percent F value $\left(F_{0.05,48,58} = 1.57\right)$; thus, the null hypothesis cannot be rejected and pooling across districts is appropriate. Using the information in Table 5.1, the F statistic to test the null hypothesis of equal variance between the years 1975-76 and 1979 are .76 and .54 for Models 5.6 and 5.7, respectively. The F statistic is lower than the upper 5 percent F value $\left(F_{0.05,9,11} = 2.90\right)$; thus, the null hypothesis is not rejected. Using the information in Table 5.2, the F statistics to test the null hypothesis of equal variances between the north central and southwest price-reporting districts are 1.21 and 1.15 for Models 5.6 and 5.7, respectively. Again, the null hypothesis is not rejected at the 5 percent upper level $\left(F_{0.05,40,5} = 4.46\right)$. Thus, the least squares method used for estimating parameters for Models 5.6 and 5.7 is an appropriate method.

The parameter estimates, their standard errors and the 95 percent confidence intervals for estimates for Models 5.6 and 5.7 are reported in Tables 5.3 and 5.4. Models 5.6 and 5.7 explained 54 and 55 percent of the total variation in real-per-acre prices, respectively. All the
Table 5.1. Error sum of squares for yearly unrestricted and pooled models

<table>
<thead>
<tr>
<th>Models</th>
<th>ESS Model 5.6</th>
<th>Degrees of freedom</th>
<th>ESS Model 5.7</th>
<th>Degrees of freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975-76</td>
<td>874,576</td>
<td>11</td>
<td>821,608</td>
<td>11</td>
</tr>
<tr>
<td>1977</td>
<td>2,078,297</td>
<td>12</td>
<td>2,116,292</td>
<td>12</td>
</tr>
<tr>
<td>1978</td>
<td>2,574,800</td>
<td>23</td>
<td>2,045,960</td>
<td>23</td>
</tr>
<tr>
<td>1979</td>
<td>545,790</td>
<td>9</td>
<td>366,258</td>
<td>9</td>
</tr>
<tr>
<td>Unrestricted</td>
<td>6,073,463</td>
<td>55</td>
<td>5,350,118</td>
<td>55</td>
</tr>
<tr>
<td>Pooled</td>
<td>11,535,612</td>
<td>106</td>
<td>11,332,547</td>
<td>106</td>
</tr>
</tbody>
</table>

\[ F^{a} = 0.97 \] \[ F = 1.21 \]

\( F \) test for equality of slope parameters.
Table 5.2. Error sum of squares for district unrestricted and pooled models

<table>
<thead>
<tr>
<th>Models</th>
<th>ESS Model 5.6</th>
<th>Degrees of freedom</th>
<th>ESS Model 5.7</th>
<th>Degrees of freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>4,410,795</td>
<td>40</td>
<td>4,327,523</td>
<td>40</td>
</tr>
<tr>
<td>NE</td>
<td>604,263</td>
<td>3</td>
<td>597,952</td>
<td>3</td>
</tr>
<tr>
<td>SC-SE</td>
<td>1,139,274</td>
<td>4</td>
<td>509,930</td>
<td>4</td>
</tr>
<tr>
<td>NW-SW</td>
<td>1,180,709*</td>
<td>11</td>
<td>1,176,846</td>
<td>11</td>
</tr>
<tr>
<td>Unrestricted</td>
<td>7,335,041</td>
<td>58</td>
<td>6,612,251</td>
<td>58</td>
</tr>
<tr>
<td>Pooled</td>
<td>11,535,612</td>
<td>106</td>
<td>11,332,547</td>
<td>106</td>
</tr>
</tbody>
</table>

The ESS for SW only is 456,825 with 5 degrees of freedom.

The ESS for SW only is 468,535 with 5 degrees of freedom.

F test for equality of slope parameters.
Table 5.3. Parameter estimates for Model 5.6

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>Confidence interval&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>647.77***</td>
<td>372.64</td>
<td>-91.92</td>
<td>1,387.46</td>
<td></td>
</tr>
<tr>
<td>RETURN</td>
<td>4.76***</td>
<td>1.41</td>
<td>1.96</td>
<td>7.56</td>
<td></td>
</tr>
<tr>
<td>ESINV</td>
<td>-18,859.60**</td>
<td>11,356.18</td>
<td>-41,402.00</td>
<td>3,682.00</td>
<td></td>
</tr>
<tr>
<td>DEHP</td>
<td>48.46</td>
<td>79.28</td>
<td>-108.91</td>
<td>205.83</td>
<td></td>
</tr>
<tr>
<td>WEALTH</td>
<td>.31</td>
<td>.32</td>
<td>-0.32</td>
<td>.94</td>
<td></td>
</tr>
<tr>
<td>DEXLBR</td>
<td>60.92</td>
<td>75.40</td>
<td>-88.75</td>
<td>210.59</td>
<td></td>
</tr>
<tr>
<td>OMEXP</td>
<td>-4.33</td>
<td>4.49</td>
<td>-13.25</td>
<td>4.57</td>
<td></td>
</tr>
<tr>
<td>QMED</td>
<td>25.49**</td>
<td>18.32</td>
<td>-10.88</td>
<td>61.86</td>
<td></td>
</tr>
<tr>
<td>MRKTDIST</td>
<td>-15.29**</td>
<td>9.82</td>
<td>-34.78</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td>DISTACQ</td>
<td>-7.19</td>
<td>9.88</td>
<td>-26.80</td>
<td>12.42</td>
<td></td>
</tr>
<tr>
<td>DCNTRCT</td>
<td>105.23**</td>
<td>67.81</td>
<td>-29.38</td>
<td>239.82</td>
<td></td>
</tr>
<tr>
<td>ACRES</td>
<td>-1.04***</td>
<td>.41</td>
<td>-1.85</td>
<td>-.23</td>
<td></td>
</tr>
<tr>
<td>BLDVPA</td>
<td>.25</td>
<td>.30</td>
<td>-.34</td>
<td>.84</td>
<td></td>
</tr>
<tr>
<td>DNW</td>
<td>-16.41</td>
<td>171.52</td>
<td>-356.88</td>
<td>324.06</td>
<td></td>
</tr>
<tr>
<td>DNC</td>
<td>141.98*</td>
<td>126.75</td>
<td>-109.62</td>
<td>393.58</td>
<td></td>
</tr>
<tr>
<td>DNE</td>
<td>-175.20*</td>
<td>139.62</td>
<td>-452.35</td>
<td>101.95</td>
<td></td>
</tr>
<tr>
<td>DSW</td>
<td>-335.41***</td>
<td>137.53</td>
<td>-608.41</td>
<td>62.41</td>
<td></td>
</tr>
<tr>
<td>DSC</td>
<td>-119.28</td>
<td>152.23</td>
<td>-421.46</td>
<td>182.90</td>
<td></td>
</tr>
<tr>
<td>D75</td>
<td>-807.49***</td>
<td>182.73</td>
<td>-1,170.21</td>
<td>-444.77</td>
<td></td>
</tr>
<tr>
<td>D76</td>
<td>-506.84***</td>
<td>125.43</td>
<td>-755.82</td>
<td>-257.86</td>
<td></td>
</tr>
<tr>
<td>D77</td>
<td>-110.97*</td>
<td>102.65</td>
<td>-314.73</td>
<td>92.79</td>
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</tr>
<tr>
<td>D78</td>
<td>-116.08**</td>
<td>89.50</td>
<td>-293.74</td>
<td>61.58</td>
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</tr>
<tr>
<td>R²</td>
<td>.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> A 95 percent confidence interval.

<sup>b</sup> Per 10,000 dollars.

***Significant at 5 percent one tail test.

**Significant at 10 percent one tail test.

*Significant at 15 percent one tail test.
Table 5.4. Parameter estimates for Model 5.7

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>Confidence interval[^a]</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>-10.24 - 61.82</td>
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<td>-30.57 - 8.29</td>
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<td>67.86</td>
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<td>-1.92 - 0.30</td>
</tr>
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<td>.30</td>
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<tr>
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<td>166.22</td>
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<tr>
<td>DNC</td>
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<td>121.49</td>
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<td>D76</td>
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<td>123.83</td>
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<td>88.70</td>
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<tr>
<td>R²</td>
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</tbody>
</table>

[^a] A 95 percent confidence interval.

[^b] Per 10,000 dollars.

***Significant at 5 percent one tail test.

**Significant at 10 percent one tail test.

*Significant at 15 percent one tail test.
parameters have the hypothesized signs with the exception of QMEXP in both models. The variables RETURN and ACRES are the only slope parameters significant at the 5 percent significance level in Model 5.6. In Model 5.7, RETURN, HPA, MRKTDIST and ACRES are significant at the 5 percent significance level.

In Tables 5.5 and 5.6, elasticities calculated at the sample means are presented as well as a 95 percent confidence interval for those elasticities at the mean. In Table 5.6, it is seen that the elasticities are small, ranging from 0.01 percent to 0.59 percent. A 1 percent increase at the mean for PRICE is approximately equivalent to a twelve dollar increase. Thus, a 1 percent increase in RETURN, the variable with the highest elasticity, would result in approximately a seven dollar increase in the real price of land. The second largest elasticity is for QMED, followed by ACRES, MRKTDIST and SIZE. All the other variables have elasticities of .03 percent or less.

The fact that the elasticities are relatively small is not surprising with the exception of the RETURN variable. The major expected explanation of land price variation is the productivity of the land and expected returns, whereas the farm-expansion hypotheses were expected to lead to marginal adjustments in sale prices.

Before concluding the result section, a discussion of the parameter estimates for the farm-expansion variables is in order. The parameter estimates for ESINV and HPA, the economies of size variables, indicate that increases in farm size have an effect on land prices, but most of these economies have been obtained by a 700 acre farm, the approximate
<table>
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<tr>
<th>Variable</th>
<th>Elasticity (percent)</th>
<th>Confidence interval&lt;sup&gt;a&lt;/sup&gt; Lower</th>
<th>Confidence interval&lt;sup&gt;a&lt;/sup&gt; Upper</th>
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<td>-.02</td>
<td>.06</td>
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<sup>a</sup>A 95 percent confidence interval.

<sup>b</sup>Total acres farmed.
Table 5.6. Elasticities for Model 5.7

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<th>Confidence interval&lt;sup&gt;a&lt;/sup&gt;</th>
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<td>-.20</td>
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<tr>
<td>BLDVPA</td>
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<sup>a</sup>A 95 percent confidence interval.

<sup>b</sup>Total acres farmed.
The negative $18,860 estimate for ESINV implies that increases from 500 to 700 acres results in an eleven dollar increase in sale price, whereas an additional 200 acres beyond 700 acres results in a six dollar increase in sale price. For the model using HPA and assuming 300 horsepower, the change from 500 to 700 acres results in a thirty-one dollar increase, and a 200 acre increase beyond 700 acres results in a seventeen dollar increase. The confidence interval for the elasticities ranges from 0.0 to 0.04 percent and 0.0 to 0.12 for Models 5.6 and 5.7, respectively. The greater effect of size in Model 5.7 is due to the inclusion of horsepower in the economies of size variable, HPA, which more specifically captures the buyer's investment in machinery, whereas ESINV is a more general specification measuring economies of size in terms of acres farmed only.

The estimates for DEHP, the excess machinery variable, would indicate that excess horsepower has a positive effect on sale price, but the confidence interval is relatively large. This large confidence interval is not surprising for two reasons. The degree of excess machinery was not actually measured, and in some cases, it could have been quite small relative to the size of purchase that the buyer did not consider he had excess machinery. Another reason is that some buyers consider the fact that their excess machinery has an opportunity value, whereas other buyers have either ignored the opportunity value or considered it having zero value.

The estimates for WEALTH imply that for each $10,000 of gross wealth, the per-acre sale price increases by 31 cents in
Model 5.6 and by 37 cents in Model 5.7. This positive effect is as hypothesized but again the value is not significant. Possibly a better measure of wealth such as net worth would have resulted in more meaningful results.

The estimates for DEXLBR, the excess labor variable, were positive as expected but not significant. This variable attempted to capture excess labor which may not have been the case. It was assumed each operator could work 12 months, where in actuality some operators may have alternative employment and therefore no excess labor.

The two variables specified to capture the quality of management effect give conflicting results. The variable QMEXP implies years of experience has a negative effect on PRICE, although this is not significant. A possible explanation is that years of experience was capturing a difference in attitude between young and older farmers instead of an improvement in management that comes from experience. The attitudes of younger farmers are often more liberal and optimistic than those of older farmers. The estimates for QMED suggest an approximate 25 to 26 dollar increase in sale price for each year of education. Thus, four years of college would imply an 8 percent increase in the average-per-acre-sale price. The confidence interval suggests the effect of a college education would approximately vary from a 3 percent decrease to a 21 percent increase in the average sale price.
CHAPTER VI. SUMMARY AND CONCLUSIONS

In this chapter, a summary of the basic objectives and results is presented. The summary is followed by the basic conclusions drawn from the results. The final section discusses some limitations of the study and areas for further research.

Summary

Five hypotheses were put forth to explain the dominance of farm-expansion buyers in the farmland market. Those hypotheses were: economies of size, excess machinery, wealth, excess labor and quality of management. It was hypothesized that among farmland buyers, farm-expansion buyers are most likely to consider such factors in their bid price for land.

Those five hypotheses have been suggested in the literature, but not all of them have been theoretically evaluated or empirically tested. Those hypotheses that have been tested, were tested by models using aggregate land value data, whereas a micro-land-price-data set of Iowa farmland sales was used in this study.

This data set contained information on sale price; type of financing; tax assessment of land and buildings; characteristics of the farmland such as location, productivity and types of buildings; and characteristics of the buyer such as years of education and farm experience, size of farm operation before acquisition in terms of acres owned and rented, number of tractors and size of tractors in terms of horsepower. From this data set, 128 observations were selected from
the years 1975 to 1979 and were grouped by the six Iowa price-reporting districts.

A linear regression model was constructed and estimated by using ordinary least squares to explain the variation in real sale price. Independent variables used to test the hypotheses were the inverse of total acres farmed after the land acquisition, a dummy variable indicating excess machinery, acres owned times the real-average-county land value, a dummy variable indicating excess labor and the number of years of education and farm experience. Other independent variables were included to capture the effect of expected returns, location, land contracts, size of purchase and building value. The intercept was allowed to shift by year and price-reporting district. A second model replaced the inverse of total acres farmed, the economies of size variable, with horsepower per acre. A number of the variables had missing observations, which were replaced by the sample mean.

The results indicate that approximately 54 percent of the variation in real sale price was explained by the two different versions of the model. All of the estimates had the hypothesized sign with the exception of years of experience. Of the variables used to capture the effect of the farm-expansion hypotheses, only the estimate for the horsepower per acre specification of the economies of size hypothesis was significant at the 5 percent level. Estimates for other variables that were significant were expected returns, size of purchase and distance to marketing center.
Conclusions

The basic advantage that farm-expansion buyers or farm-expansion buyers with medium or large size farms have over entering farmers or farmers with smaller farms is the ability to achieve size economies. In our sample of farm sales, 90 percent of the farm tracts sold were less than 200 acres. This lack of large farm tracts for sale implies entering farmers or farmers with small farms are less likely to find land tracts large enough to allow them to achieve size economies. Unless entering farmers can alternatively lease additional land to obtain size economies, they cannot compete with medium or large farms in bidding for small tracts of land. The absence of larger land tracts for sale might imply a limitation of credit for entering farmers, which bars them from entering the land market. Possible evidence for the limitation of credit is the inverse relationship between sale price and size of purchase.

The fact that the variables for excess machinery and excess labor hypotheses are not significant leads to the conclusion that either the specification of those variables or the data sample did not capture the hypothesized effect. Or, the fact that the variables had the hypothesized sign suggests that in some cases, farmers have not valued their labor and machinery in bidding for land, but overall there is no evidence to suggest that farm-expansion buyers ignore or incorrectly compute the opportunity cost of their excess labor and excess machinery.

As for the effect of wealth, either (1) the specified variable did not capture actual wealth, which is quite likely since the specified
variable was a measure of total land assets rather than net worth, (2) the wealthier farm-expansion buyers do not bid in nonmonetary returns to land, or (3) the bidding of nonmonetary returns into land is not related to wealth. As for the relationship between wealth and credit availability, it appears the less wealthy were not restricted in bidding for land. Since the sample contains only successful bidders, it may be that all the buyers in the sample had enough relative wealth or credit availability in relation to the size of their land purchase.

As for quality of management, there is some evidence to suggest that farm-expansion buyers with more years of education are able to bid more for land. As for experience, the results suggest that experience has a possible negative effect if any effect at all on sale price. A possible explanation for the negative effect was suggested in Chapter V. The explanation was that experience was measuring a difference in attitude, where older farmers are more conservative and less optimistic than younger farmers.

In the introduction, the question was raised whether farm-expansion buyers are efficiently allocating resources. If the estimates for the excess machinery and excess labor variables had been significant, this would have suggested that farm-expansion buyers were over-valuing land at the expense of under-valuing the opportunity cost for machinery and labor. Since the estimates for the excess machinery and excess labor variables are not significant, this would suggest that over all, farm-expansion buyers have not over-valued land. The results of the model
suggest the economic factors of expected return, economies of size, distance from marketing center and size of purchase are the major determinants of land prices.

Another concern raised in the introduction was whether farm-expansion buyers have driven the price of land up to a point where it has become a potential barrier to entry and the implications this has for the ownership structure of farmland. Again, the results provide no conclusive evidence that farm-expansion buyers are over-valuing land. It would appear that the motive for farm-expansion buyers is to obtain control over additional land resources in order to attain economies of size. If policy makers, who are concerned about the concentration of land ownership, took action to restrict the acquisition of land by farm-expansion buyers, they may be doing so at the cost of efficiency. On the other hand, the results indicate that a major portion of the size economies have been obtained by the average farm size in the sample (700 acres). Thus, a policy restricting land acquisition beyond a farm size of 700 acres or more would not have much effect on efficiency. This study suggests that the possible barriers to entry are the present fragmented ownership pattern, which makes farm tracts of adequate size unavailable for sale or possibly for rent also. A second barrier is credit limitations suggested by the inverse relationship of sale price and size of purchase. Thus, policy makers concerned about entry into farming should focus their attention on supply of land for sale or rent and credit availability.
Limitations and Areas for Further Research

A major limitation of much research is the lack of adequate data. Although the data set used in this study is more suited to the objectives of the study than the use of aggregate land value data, the data set is not without its problems. The method of using students to collect the data was inexpensive. The use of qualified surveyors to obtain the same information would have been an expensive process. Although the method of data collection was inexpensive, it was not without its cost in terms of quality. It was assumed the students did an accurate job of collection, but this does not rule out the possibility of inconsistencies in collection and manufactured data, which would have resulted in biased estimates. The major problem with the data was the number of incomplete observations.

In addition to the problems of data collection, there is the problem of poor design of the questionnaire and problems of interpretation. From the questionnaire, it was not clear whether the purchased land was previously rented or was a completely new addition. And as mentioned in Chapter V, the design of the net worth categories did not cover a large enough range.

There is always the limitation that the data set does not provide enough information. It was assumed in the present study that the capitalization rate among buyers was the same. In actuality, the capitalization rate is a function of a number of factors that vary among individuals. These factors are the expected interest rate on long-term debt, the rate of return on equity, the desired debt-equity
position, the marginal tax bracket, the expected real growth rate, the expected inflation rate and an individual's aversion to risk. In designing future land value surveys, it would be valuable to collect information or devise ways of estimating those factors.

The present data set does not reveal much about the actual local market conditions in which the sale took place. The final sale price is often the result of a bargaining process between seller and buyer. There is no information about the condition of the sale such as whether the seller was retiring, whether the seller was a small operator or whether the sale was to settle an estate or the result of a foreclosure. Also, there is no information as to the number of buyers. Questions concerning the number of potential buyers farming land adjacent to the land for sale were not asked. An actual interview with the seller, buyer and other potential buyers asking them what factors they considered in developing their bid and asking prices may provide additional insight in explaining the variation in sale prices and in determining whether resources are allocated efficiently.
REFERENCES CITED


I extend my warm and sincere appreciation to:

Michiko Eberle,
Duane Harris,
Raymond Beneke,
William Meyers,
Roy Adams,
John Fiske, and the Agricultural Business Staff.
APPENDIX A. COMPARABLE SALE WORKSHEET
**COMPARABLE SALE WORKSHEET**

Comparable Sale # ____________________  Student Name ____________________

### I. TRANSFER INFORMATION (AUDITOR’S OFFICE)
- A. Seller (Grantor): ____________________  B. Buyer (Grantee): ____________________
- C. Date of Instrument: ____________________  D. Number of Acres: ____________________
- E. County: __________  Township: __________  Nearest Town: ____________________
- F. Legal Description: ____________________

### II. SALE PRICE INFORMATION (RECORDER’S OFFICE)
- A. Deed Book (Verify Legal Description)
  1. Consideration Shown: $ __________
  2. Date of Deed: ____________________
  3. Stamp Tax: $ __________
  4. Other (e.g. assumed mortgage): ____________________

- B. Mortgage and Contract Book
  1. Type of Financing (Check One): Mortgage ____; Contract ____;
  2. Date of Mortgage or Contract: ____________________
  3. Downpayment: $ __________
  4. Amount of Mortgage or Contract: $ __________
  5. Interest Rate: _____%  
  6. Term: _______ years
  7. Payment Pattern
     a. Periodic Payments: $ __________
     b. Balloon Payment: $ __________

- C. Sale Price Verification
  1. Verification by: __________; Date: __________; Place: __________
  2. Consideration Paid: $ __________
  3. Per Acre Value: $ __________

### III. ASSESSMENT AND TAX INFORMATION (ASSESSOR’S AND TREASURER’S OFFICE)
- A. Date of Assessment: __________
- B. Assessed Value
  1. Land: $ __________
  2. Buildings __________
  3. Total $ __________
- C. Tax Levy: $ __________/thousand
- D. Total Taxes: $ __________
- E. Taxes Per Acre: $ __________
IV. CHARACTERISTICS OF FARM (ASSESSOR'S OFFICE AND OTHER)

A. Location:
1. Distance to Nearest Farm Supply and Marketing Center: _______ miles
2. Road Surface (Check One): County Gravel______; County Blacktop______; State Highway______; Federal Highway______

B. Productivity (Under Highest and Best Use):
1. Number of Tillable Acres: ________
2. Number of Acres in Permanent Pasture: _________
3. Number of Acres in Waste and Farmstead: _________
4. Total Farm Average CSR: ___________
5. Tillable Acres Average CSR: ___________
6. Total Farm Average Corn Yield: __________
7. Tillable Acres Average Corn Yield: __________

C. Buildings and Improvements:
1. Buildings Condition (Check One): Obsolete ________; Poor ________; Average ________; Above Average ________; Excellent ________
2. Specialized Facilities (Check Where Appropriate):
   Confinement Hog Operation _____ Confinement Cattle Operation _____
   Harvester Silo(s) ____ Other __________________________ (Describe)
3. Terraces (Check One): None____; Some____; Extensive____
4. Tiling (Check One): None____; Some____; Extensive____

V. CHARACTERISTICS OF BUYER

A. Form of Ownership (Check One): Owner-Operator______; Local Landlord______; Absentee Landlord______

B. Type of Organization (Check One):
1. Single Proprietor____
2. Partnership____; Number of Owner-Operators_____
3. Family Corporation____; Number of Owner-Operators_____
4. Other Corporation____
C. Size of Operation Before Acquisition (If Owner-Operator):
   1. Number of Acres Owned: _______  2. Number of Acres Rented-In:_______
   3. Number of Tractors (over 20hp) Owned: _____
      a. Horsepower: ____; ____; ____; ____; ____
      b. Age: ____; ____; ____; ____; ____
   4. Number of Self-Propelled Combines: _____
      a. Number of Rows on Corn Head: ____; ____; ____
      b. Age: ____; ____; ____

D. Location of Buyer (If Owner-Operator):
   1. Distance from Farm Base to New Acquisition: _______ miles

E. Personal Characteristics of Buyer at Time of Acquisition (If Owner-Operated):
   1. Number Years Farming of Owner-Operator(s): _____ _____ _____ _____
   2. Highest Year of School Completed of Owner-Operator(s):
      _____ _____ _____ _____
   3. Number of Anticipated Owner-Operators to Join Farming Unit During
      Next Five Years: ________
   4. Amount of Off-Farm Income of Owner-Operator(s) and Family(ies) (Check One):
      None____; $1-$5,000____; $5,001-$10,000____; $10,001-$15,000____;
      $15,000 and above____
   5. Amount of Net Worth of Owner-Operator(s) and Family(ies) (Check One):
      $0-$50,000____; $50,001-$100,000____; $100,001-$150,000____;
      $150,001-$200,000____; $200,001 and above____

VI. COMMENTS:
APPENDIX B. CORRELATION MATRIX
Table B.1. Correlation matrix

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<tr>
<th>Variables</th>
<th>PRICE</th>
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