Factors Affecting Farmland Values in the United States

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SUMMARY

Farmland value has more than quadrupled since 1940. Before the early 1950's, however, changes in farmland value had been closely related to changes in farm product prices and net farm income. But since that time, farmland value has increased substantially without a corresponding rise in net farm income. This widening spread between farmland values and net farm income created the interest for this study.

Our major objective was to identify the principal factors affecting farmland value and to estimate the effect of these variables. To accomplish this objective, we developed hypotheses to explain the changes in farmland value that included the effect of expected net farm income, government farm-program payments, expected capital gains, technological advance, farm enlargement, the number of voluntary transfers of farmland and an increasing demand for land from a growing population.

A 2-equation recursive model of farmland market was developed, and deflated time-series data of the aggregate U.S. farmland market were used to fit this model. A unit of observation for the time-series analysis, which covered 1933 to 1965, was the annual U.S. average for each variable for each year in the series.

Our findings indicate that the number of voluntary transfers of farmland is a function of the debt-to-equity ratio, the expected ratio of farm to nonfarm earnings, farm enlargement, expected capital gains and the man-hours of labor used per acre (a proxy measure of the level of technology). These variables explained 98.4 percent of the variation in the number of voluntary transfers. The estimates indicated that, as the debt-to-equity ratio increased by 1 percent, the number of voluntary transfers declined by 7,360 farms. A 1-percent increase in the expected ratio of farm to nonfarm earnings was associated with an increase of 1,580 voluntary transfers.

The hours of labor per acre were used in the analysis to represent the level of technology. We estimated that, with a 10-percent decrease in La (an increase in the level of technology), the number of transfers declined by 10.3 percent. An increase of 1 acre in the average farm size (farm enlargement) was associated with a decrease of 3,350 voluntary transfers, and an increase of $1 per acre in expected capital gains was associated with an increase of 1,900 farms transferred during 1933 to 1941 and an increase of 4,860 farms transferred during 1942 to 1965.

The predicted number of voluntary transfers of farmland, government payments for land diversion, conservation payments, expected capital gains, farm enlargement, the inverse of the rate of return on common stock and expected net farm income explained much of the variation in farmland value: It was estimated that, with a decrease of 1,000 voluntary transfers, the average value of farmland increases 23 cents per acre. With a $1-per-acre increase in government payments for land diversion, we would expect farmland value to increase about $12 per acre, and with a $1 increase in conservation payments, we would expect an increase in farmland value of about $7.50 per acre. Payments made through government farm programs are evidently capitalized into farmland value. Payments for land diversion are capitalized into farmland values at a higher rate than are conservation payments.

A $1 increase in expected net farm income was estimated to increase the value of farmland $2.02 per acre during 1933 to 1955 and $2.25 per acre from 1956 to 1965. These estimates support the hypothesis that expected net farm income has a positive effect on farmland value. The rate of return on common stock (r) was used to reflect the capitalization rate. The elasticity of the value of farmland with respect to 1/r indicated that, with a 10-percent increase in 1/r, farmland value increases by about 2 percent.

The elasticity of the value of farmland with respect to La is consistent with our technological advance hypothesis. With a 10-percent decrease in La (an increase in the level of technology), farmland value was estimated to increase by about 5.1 percent. The results of the time-series analysis were also consistent with the farm-enlargement hypothesis: A 1-acre increase in the average farm size (farm enlargement) increased the average value of farmland by $1.15 per acre.

During 1942 to 1965 a $1 increase in expected capital gains was associated with an increase in farmland value of $1.25 per acre. The expected capital gains variable had a negative effect on farmland value from 1933 to 1941. This resulted from a larger negative effect from the transfer equation than the positive effect in the value of farmland equation.

A 1-percent increase in the debt-to-equity ratio was associated with a $1.69 increase in the per-acre value of farmland. But a 1-percent increase in the expected ratio of farm-to-nonfarm earnings would be expected to decrease farmland value by 36 cents.

Farm enlargement has a greater effect on the value of farmland without farm buildings than it does on the value of farmland with farm buildings. This conclusion is consistent with the hypothesis that farmland without farm buildings is preferred for farm-expansion purposes.

The coefficients for the inverse of the capitalization rate suggested that the same capitalization rate is used when valuing farmland regardless of whether it has farm buildings or not. The coefficients for net farm income were about the same in estimating the value of farmland with buildings as they were in estimating the value of farmland without farm buildings.

The cross-sectional analysis was used as an alternative approach to the study of farmland values. The units of observation in the cross-sectional analysis were the 48 contiguous states (Alaska and Hawaii excluded). That is, the observational unit was the state average for each variable. Cross-sectional equations were estimated for 1959, 1954, 1950 and 1940.

Expected capital gains, expected net farm income and the nonfarm population density had a strong positive effect on farmland values. These variables explained over 97 percent of the variation in farmland value among states in 1959 and over 93 percent of the variation in 1954. Expected capital gains were not significant in 1954. The nonfarm population density was not significant in explaining variation in the value of farmland without buildings.

The coefficient for expected net farm income increased in each of the time periods, indicating further support for the hypothesis that a larger portion of expected net farm income is being allocated to farmland. A comparison of the coefficients for nonfarm population density for each of the time periods indicated that the effect of the nonfarm population on farmland value has increased over time.

In conclusion, farmland value in the United States is affected by a number of variables. A positive effect was exerted by: expected net farm income, government payments for land diversion, conservation payments, expected capital gains, farm enlargement, nonfarm population density, technological advance and the ratio of debt to equity. But a negative effect was exerted by voluntary transfers of farmland, the capitalization rate and the expected ratio of farm-to-nonfarm earnings.

FACTORS AFFECTING FARMLAND VALUES IN THE UNITED STATES[1]

by John E. Reynolds and John F. Timmons [2]

Before 1950, economists had become conditioned to a close relationship between net farm income and farmland value. Farmland values and net farm income increased from 1940 to 1950. But during the early 1950's, farmland value continued to increase in spite of a declining net farm income. This phenomenon raised the question of what are the major factors affecting farmland values. The primary goal of this study was to identify the major factors affecting farmland values and to estimate the effect of these variables.

Problem and Its Setting

Landowners, prospective buyers, farm mortgage lenders, tax assessors and other participants in the land market must place a value on farmland. Many of these participants and observers of the land market have become concerned because farmland value has risen substantially and almost continuously since the mid-1950's, but without a corresponding rise in net farm income. This divergence between farmland value and net farm income, combined with the increase in farm size, has contributed to a doubling of the outstanding farm mortgage debt in the past decade. The debt, which totaled almost 6.6 billion dollars in 1940 (55), declined during World War II, but has increased steadily since that time. Debt per acre declined from $6.21 in 1940 to $4.33 in 1945. But in 1965, debt per acre was $16.36, more than triple the 1945 figure. The total 1965 farm mortgage debt was 18.9 billion dollars.

In the United States, farmland was valued at 33.6 billion dollars in 1940. By 1965, however, the value had increased more than 4 times-to 159.4 billion dollars (55). The value of farmland accounted for about three-fourths of the physical assets of agriculture in 1965, and the average value of farmland per acre increased from $31.71 in 1940 to $145.75 in 1965 (table 1). During this period, the average per-acre value increased each year, except from 1949 to 1950 and from 1954 to 1955.

If the expected future returns of farmland are based on present net farm income, we would expect positive correlations between changes in the present farmland value and changes in net farm income. This relationship has not held, however, for all periods (table 1). Both net farm income and farmland values increased from 1940 until about 1950, but net farm income began a general decline about 1950 and reached a low of $11.23 per acre in 1955. During this period farmland value rose more than $20 per acre. In 1965, the average net farm income per acre was $15.30, about 17 percent above the 1950 level, but during this same period, farmland values more than doubled.

The decline in the ratio of farmland values to net farm income indicates that net farm income increased faster than farmland values during the 1940's. But during the 1950's, the ratio increased substantially. The first part of the increase, from 1950 to 1955, resulted from an increase in farmland values and a decline in net farm income. Since 1955, however, farmland values have increased faster than net farm income, causing the ratio to rise from 7.60 in 1955 to 9.53 in 1965.

The lack of a close relationship between net farm income and farmland values in recent years indicates that there may be other important factors affecting farmland value. The problem is to identify these other factors.

Before proceeding, an explanation of the meaning of land should be developed. Land is a term that has received wide application. Barlowe (2, p. 7) defines the economic concept of land as the total of the natural and man-made resources over

[1] Project 1043 of the Iowa Agriculture and Home Economics Experiment Station. This report is a summary of a Ph.D. thesis at Iowa State University. For more detail see: John E. Reynolds. An econometric investigation of farmland values in the United States. Ph.D. Thesis. Iowa State University, Ames. (Mic. 67-5615, Univ. Microfilms, Ann Arbor, Mich.) 1966.

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Table 1. Farmland value and net farm income in dollars per acre and the ratio of net farm income to farmland value, 1940-1965.

Item	1940	1945	1950	1955	1960	1965
Farmland[a] value per acre	31.71	47.20	64.94	85.32	116.48	145.75
Net farm[b] income per acre	4.92	12.00	13.09	11.23	12.23	15.30
Ratio of farmland value to net farm income	6.45	3.93	4.96	7.60	9.52	9.53

[a] Value of farmland and buildings as of March 1.

[b] Net income of farm operators, including inventory changes, plus interest paid on farm real estate and net rents to nonfarm landlords.

Sources: U.S. Department of Agriculture, Economic Research Service. Agricultural Finance Review. Vol. 26 Supplement. 1966; U.S. Department of Agriculture. Handbook of agricultural charts, 1965. U.S. Dept. Agr. Handbook 300. 1965.

which possession of the earth's surface gives control. This definition is comparable to the term, land resources, used by Chryst and Timmons, who define land resources to mean all attributes of a particular land tract, including 1) natural attributes (i.e., soil and climate); 2) socially created attributes (i.e., location and publicly supplied improvements such as highways, drainage and flood control); and 3) capital investments in land that become fixtures (i.e., terraces and fertility) (8, p. 254). The term land resources has also been applied to subsurface and suprasurface resources in addition to surface resources (47, p. 58).

From a legal standpoint, land (or real estate) is considered any portion of the earth's surface over which ownership rights might be exercised (2, p. 7). And since the ownership rights in land (including land resources as just defined) are transacted within a legal framework, we use the broad legal concept of land.

Objectives

The purpose of our study was to identify the major factors affecting farmland value and to estimate the effect of these variables. More specifically, we wanted 1) to identify the major variables affecting farmland value, 2) to describe and quantify the relevant variables, 3) to develop a method to test the importance of the variables identified and 4) to apply this procedure to estimate the importance of relevant variables in explaining farmland values.

Methods and Procedures

We used a recursive model of the farmland market to estimate the effect of hypothesized variables upon farmland value, and least-squares regression techniques were used to estimate the parameters of this recursive model. Dummy variables are used to permit changes in the intercept and in the slope coefficient.

Time-series data of the aggregate U.S. farmland market are used to fit the model. Government program payments are expected to significantly affect farmland value. Crop and marketing controls were initiated by the Agricultural Adjustment Act of 1933. Therefore, the period chosen for the time-series analysis is 1933 to 1965. The unit of observation in the time-series analysis is an annual U.S. average (Alaska and Hawaii excluded) for each variable.

Because of the frequent occurrence of multicollinearity and autocorrelation in time-series studies, a cross-sectional analysis is included as an alternative approach. The unit of observation for this analysis was the state average for each of the variables. The cross-sectional analysis allows us to approximate regional effects (e.g., soil quality differences, nonfarm population pressures, etc.) that cannot be determined in the aggregate time-series analysis. The cross-sectional analysis is conducted by states for 4 different years, which allowed us to observe how the coefficients of the model change over time.

POSSIBLE EXPLANATIONS OF CHANGES IN FARMLAND VALUE

In the frontier economy of a century ago, land was valuable primarily because it was useful for producing food and fiber. At that time, land was used almost exclusively for farming and was valued primarily on the net income that could be obtained from the farm products grown on it. During the past century, the demand for land has grown to include a wide variety of other uses, which are likely to become even more important in the future as population increases and as new technology increasingly adds to productivity (41). Possible explanations of changes in farmland values include net farm income, government farm programs, technological advance, farm enlargement, transfers of farmland, pressure from an increasing population and capital gains.

Net Farm Income

Although net farm income and farmland value have not always moved in the same direction (table 1), net farm income is still believed one of the major determinants of farmland value. Normally, the larger the stream of expected future returns from a tract of land, the higher is the expected present value of that tract. For an individual to determine the productive farmland value, he needs to estimate the future net returns that the land can be expected to earn for him in production. But data for the expected future net returns of farmland are not available, and these data can be computed only by making certain basic assumptions about expectations and the allocation of net returns among production factors.

Recent studies indicate that the proportion of net farm income allocated to land has been increasing in recent years. In a study of selected farms in Illinois, Strohbehn found that an increasing share of net farm income was capitalized into farmland values during the decade from 1949 to 1959 (43, p. 20). Net returns allocated to farmland by the residual method have displayed an upward trend since the mid-1950's. The residual return to an acre of farmland increased from about $3 in 1955 to about $8.40 in 1965 (37, p. 47). The percentage of residual returns allocated to land changed very little until the mid-1950's, averaging only about 24 percent of net farm income for 1953-1957. Since that time, the residual returns to land have increased almost steadily as the imputed returns to labor declined. For the period 1962 to 1965, the residual returns to land averaged about 40 percent of net farm income (37, p. 47).

Several studies have explored the relationship between farmland values and farm income. Renshaw (28) found that weighted gross farm income per harvested acre significantly affected farmland value from 1920 to 1953. The effect of net farm income on farmland values was investigated cross-sectionally by Scofield (36) for three different time periods, 1936-1940, 1951-1953 and 1961-1963. Net farm income explained from 83 to 89 percent of the variation in farmland values among states. Therefore, net farm income is expected to have a positive effect on farmland value.

Government Farm Programs

Several studies have supported the hypothesis that some of the benefits of government farm programs have become capitalized into land values. Hedrick used a sample of sale values of farms in North Carolina to estimate the values for per-acre allotments of peanuts, tobacco and cotton. His estimates were $669 for peanuts, $1,139 for tobacco and $463 for cotton (15, p. 1751). In a Virginia study, tobacco allotments were estimated to be worth as much as $2,500 per acre (23, p. 39). Wheat allotments have been estimated to be worth more than $100 per acre in eastern Kansas (10).

During the past decade, government farm programs have focused on land as a means of adjusting farm output in line with market demand. Farm programs have attempted to reduce the acreage used in production and thereby to raise prices. The benefits of these programs are distributed to land owners mainly by acreage allotments and through payments for land diversion (7, p. 1270). This procedure has tended to make the right to produce crops included in farm programs a valuable part of the land. It appears that many of the benefits of government farm programs have been capitalized into farmland value.

During World War II, government payments were high compared with the period immediately following the war. The average government payment distributed over all farmland in the United States in 1940 was 68 cents per acre (50, 51). After World War II, payments declined until, in 1955, they averaged only 19 cents per acre. Since 1955, government farm program payments have increased, and in 1965, the average government payment was $2.13 per acre. If the 1965 payments were capitalized into farmland value at a rate of 15 percent, they would account for $14.20 of an acre's value, or about 10 percent of the acre's 1965 value.

If we compute the change in government payments between 1960 and 1965 and compare this change with the corresponding change in farmland value, however, the impact is much larger. The change in the average government payment between 1960 and 1965 was $1.54 per acre. If the $1.54 change in government payments were capitalized at 15 percent, it would account for $10.27 of the change in farmland value or about 35 percent of the change from 1960 to 1965.

The government payment used in the example was an average for the United States. In an area that specializes in crops affected by the program, the impact of government payments on farmland values may be even greater. For example, the average government payment in the Northern Plains for 1965 was $3.12 per acre. If this payment were capitalized at 15 percent, it would amount to $20.80, or about 23 percent of the value of an acre of farmland. The increase in the average government payment for the Northern Plains between 1960 and 1965 was $2.49 per acre; capitalized at 15 percent this would amount to $16.60, or about equal to the change in farmland value from 1960 to 1965.

Chryst and Timmons (8) have observed that, inasmuch as government farm programs are usually tied to the land, program benefits tend to become capitalized into land values. It is hypothesized that the impact on farmland value of conservation and land-diversion programs is different from the impact of price-support programs. Payments made through the price-support programs are included in net farm income.

Many of the benefits of the Agricultural Conservation Program have been for conservation practices that might be considered land improvements (e.g., lime, livestock water reservoirs, drainage of farmland and irrigation). It is hypothesized that the impact of conservation payments on farmland value is different from that of government payments for land diversion. Conservation payments will be considered separate from government payments for land diversion.

Chryst (7) has hypothesized that technological advance, when coupled with price and income support programs, has a strong positive effect on farmland value. Before discussing this hypothesis, we will examine the effect of technological advance without price- and income-support programs.

Technological Advance

Technological advance is defined as an increase in output produced from a given set of resources or the same amount of output produced with fewer resources. In general, a technological advance would lead to greater output of farm products. And because of the inelastic demand for most farm products, technological advance would result in a price decline greater than in proportion to the increased output, causing gross farm income to decline (7, p. 1267). With a decline in gross farm income, we would expect net farm income to decline unless costs were reduced more than gross farm income. And a decline in net farm income would be expected to decrease the returns to all factors (including land) unless the proportion allocated to each changes. A decrease in the return to land is expected to have a negative effect on farmland values.

Price- and income-support programs attempt to raise or maintain prices and income. When technological advance occurs concurrently with price- and income-support programs that tend to maintain prices near the level they were before the technological improvement, gross farm income increases instead of declines. The increased output and (or) decreased unit costs, without comparable decreases in product prices, would be expected to increase the returns to land and increase farmland values.

The separate effect of technological advance would be expected to have a negative effect on farmland value. It is hypothesized, however, that the occurrence of technological advance with price- and income-support programs results in a positive effect on farmland value.

Farm Enlargement

Tweeten (46, p. 215) has suggested that the demand for larger acreages per farm has been the principal explanation for the recent rise in farmland value. Larger machinery (one form of technological advance) makes it possible for the farmer to handle a larger acreage and, consequently, gives rise to the demand for land for farm enlargement. An additional tract of land may enable the operator to reduce his unit costs by spreading the overhead costs over a larger acreage. The higher farmland values warranted for a tract of land for farm enlargement can be illustrated by the following example (46, p. 215):

> Suppose that a farmer operates 200 acres at average operating costs of $30 per acre and nonland overhead of $10 per acre with gross returns of $55 per acre. The $15 residual land return, capitalized at 5 percent, suggests a land price of $300 per acre. Suppose the farmer has an opportunity to buy a contiguous 40 acres of the same soil productivity. He can farm it with no change in the complement of machinery, hence (assume) his nonland overhead (on the new unit) is reduced $5 per acre. With the same gross returns and operating expenses, residual land return per acre on the new marginal unit is $20. Capitalized at 5 percent the land is worth $400 per acre - one-third more than the "home" acreage.

Heady and Tweeten (14) estimated the short-run and long-run elasticities of the value of farmland with respect to farm size to be 0.6 and 2.7, respectively. These elasticities are similar to those estimated by Britney (5). Heady and Tweeten concluded that the major source of increases in farmland values has been farm consolidation and associated scale economies from larger acreages.

The proportion of all transfers that have been for farm enlargement purposes has doubled since about 1950 (55). About 54 percent of the purchases in the United States were for farm enlargement in 1965. Simultaneously, the average size of farm has increased rapidly, from 173 acres in 1940 to 342 acres in 1965, and the number of farms has declined, from 6.3 million in 1940 to 3.4 million in 1965 (58). Thus, the demand for additional land for farm enlargement should have a positive effect on the value of farmland.

Transfers of Farmland

A small proportion of the land in the United States is offered for sale each year. The number of farms offered for sale is limited largely by the ownership pattern within a community and depends considerably on cultural attitudes (2, p. 206). In a few areas, the owners are reluctant to sell because of their ties to the land.

Total transfers of farmland include voluntary transfers, foreclosures, defaults, inheritances, gifts, tax sales, and administrator's and executor's sales. Voluntary transfers of farmland are offered for sale in the "open" market, but many other types of transfers are not. In this study, therefore, voluntary transfers are used to reflect the quantity of farmland being traded in the market.

Only a small portion of the total number of farms is transferred within any year. The number of voluntary transfers in the United States was only 96,000 in 1965 (table 2). The number of voluntary transfers increased during World War II and then started to decline. Since 1950, the rate of transfers has declined slowly until, in 1965, there were only 28.4 voluntary transfers of farm real estate per 1,000 farms, about 3 percent.

The steadily declining number of farms transferred since 1945 suggests increasing competition for the few available farms. A strong demand for farmland for farm enlargement, combined with a declining number of farms being transferred, is expected to have a strong positive effect on farmland values.

Table 2. Number of voluntary transfers and number of voluntary transfers per 1,000 of all farms, United States, 1940-1965.

Item	1940	1945	1950	1955	1960	1965
Number (thousands)	192.4	307.3	209.0	148.5	121.2	96.0
Number (per 1,000 farms)	30.3	51.5	37.0	31.9	30.7	28.4

Source: U.S. Department of Agriculture, Economic Research Service. Agricultural Finance Review. Vol. 26 Supplement. 1966.

Pressure From an Increasing Population

The steadily increasing population in the United States suggests an increasing demand for food and for additional land for nonagricultural uses. The population of the United States (Alaska and Hawaii excluded) more than doubled from 1910 to 1965 (59). In 1910 the population density was 31 people per square mile, but the population density has increased steadily over time, until in 1965, the average density was 64.9 per square mile.

As the population increases, the nonagricultural uses of land also expand: More land is needed for industries, residences, transportation and shopping centers as urban areas grow. Our new complex transportation systems are requiring large quantities of land. Each mile of new right - of - way for interstate highways requires about 40 acres of land. Level land, normally well suited to farming, is required for airport facilities, and land is also required for military and other government installations and for recreation facilities. Approximately 1 million acres of farmland are taken annually for these nonfarm uses (40). In some local areas where there is a small number of farms offered for sale and there is a strong demand for land for nonagricultural uses, farmland values may increase substantially.

Pressure from an increasing population was a significant factor in explaining the variation in farmland value among counties in California (31) and Indiana (33).

The increased demand for land caused by an expanding population is expected to have a positive effect on farmland values.

Capital Gains

It has been hypothesized that rising farmland values have been an important source of income to landowners (4). The rising value of farmland is a capital gain rather than a direct income to the landowner. During a period of rising farmland values, it seems reasonable to hypothesize that the anticipated appreciation of farmland values (expected capital gains) has had an impact on farmland value. Past capital gains create expectations that such gains will continue and consequently increase the number of people who would like to own land. These expectations of capital gains contribute to the increased demand for land and at the same time may tend to reduce the quantity of land offered for sale.

A tract of land may not be considered a favorable investment if the expected return is only 2 to 3 percent annually. But if a capital gain of 7 to 8 percent per year is expected in addition to the regular income from production, the land may compare favorably to other alternative investments.

Farmland is sometimes viewed as an attractive investment because of the income - tax advantage associated with capital gains. Only 50 percent of long - term capital gains are taxable for the noncorporate tax payer. Some landowners (or prospective buyers), particularly those in the higher tax brackets, therefore, may be more interested in future capital gains than current income.

MEASUREMENT OF FACTORS AFFECTING FARMLAND VALUES

Price and value are usually considered equal under conditions of perfect competition (perfect competition is defined in the subsection entitled "Characteristics of the Land Market"). Under actual conditions of the land market, however, prices may be quite different from value (61, p. 471). In this study, value is defined as: a) an estimate of the worth of a tract of land in the minds of the buyer and seller in the theoretical analysis and b) an *estimate* of price in the empirical analysis. The term price is reserved for the actual amount of money a tract of land is exchanged for. The price of farmland is not available for the time - series or cross - sectional analyses. However, the value of farmland as defined is estimated by the USDA, and these estimates are used in the empirical analysis.

Interaction of Demand and Supply

The supply of land as used in this study will mean the quantity of land (both natural and man - made resources) available for use at various prices. We hypothesized that the declining number of farms being transferred has a positive effect on the price of farmland. To the extent that the number of transfers reflects the supply of farmland offered for sale, a decrease in the number of transfers without a corresponding decrease in the demand for farmland is expected to increase the price of farmland.

The demand for land may be thought of as the amounts of land that users want and are willing to buy at various prices. The demand for land arises from the various direct and indirect uses to which land may be put. Direct demand for land results when land itself is used for consumption, such as use for recreation purposes or residential sites (27, p. 29). Most of our demand for land is derived: Derived demand results from the productive potential of land, its location or other advantages rather than the land itself (2, p. 19). The demand for land is the sum of the various direct and derived demands for land.

It was hypothesized that farm enlargement, the pressure from an increasing population and expected capital gains increase the demand for farmland. An increase in the demand for farmland without a corresponding increase in supply is expected to increase the price of farmland.

On one side of the market, we have the demand for land, which portrays the amount of land users want and are willing to buy at various prices. On the other side, we have the economic supply of land, which reflects the quantity of land that will enter particular uses at various prices. The interaction of the factors of demand and supply make up our concept of the market, and prices are established by the interaction of demand and supply in the market.

The interaction of demand and supply in the land market is illustrated in fig. 1. The dashed lines represent the seller's acceptance price, the dollars per acre he is willing to take for farmland. The arrow on the dashed line represents the minimum amount the seller is willing to accept. Similarly, the solid lines represent the buyer's acceptance price, the amount he is willing to pay. And the arrow here represents the maximum amount the buyer is willing to pay.

Fig. 1 presents three examples that may occur in the farmland market. In Example A, the buyer and the seller would not establish a price, since the seller is willing to take $300 or more per acre for the tract of farmland, but the buyer is only willing to pay up to $200 per acre. In Example B, the seller's acceptance price of $300 per acre is equal to the buyer's acceptance price of $300 per acre, and assuming all other conditions for the transfer are met, a price of $300 per acre would be established.

In Example C, the seller is willing to take as

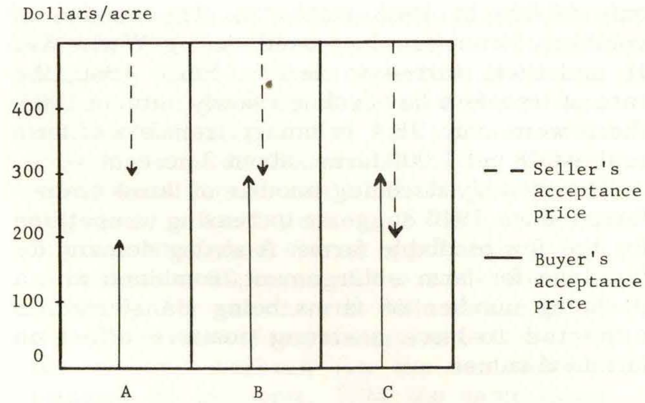

Fig. 1. The interaction of the buyer's acceptance price with the seller's acceptance price to establish the price of farmland.

low as $200 per acre and the buyer is willing to pay up to $300 per acre for a tract of land. Therefore, the price established for this land will be between $200 and $300 per acre, depending upon the bargaining between the buyer and the seller.

Characteristics of the Land Market

The land market, because of the peculiar characteristics of land, does not have the usual characteristics of a purely competitive market, which are: 1) the product of each seller is identical (i.e., homogeneous) with that of every other seller; 2) there are many buyers and sellers in the market, and the sales and purchases of each individual are small in relation to the aggregate volume of transactions; and 3) there is free entry into and exit from the market for both buyers and sellers. In addition to the characteristics just enumerated for a purely competitive market, both buyers and sellers possess perfect knowledge in a perfectly competitive market.

Agriculture has often been referred to as a purely competitive industry. There are a large number of firms, and the individual firm faces a perfectly elastic demand curve for most of its products. A different situation occurs in the land market, however, since land is a heterogeneous resource that varies greatly in quality. Many times parcels of land are identified with particular people, schools, churches and transportation facilities that differentiate each parcel from the next. Land is not like a carload of No. 2 yellow corn, which can be bought and sold without seeing the corn. Also, land is very difficult to classify because of the subjective nature of the classes. For example, the Federal Land Bank classifies farms as A, B, C, D and E. The factors they use in classifying farms are: the soil, size of unit in relation to the type of farming, normal net earnings, ability of the farm to support indebtedness and the community in which it is located (30, p. 16). Therefore, two class A farms could be quite different under the Federal Land Bank classification. In addition, the Federal Land Bank classification is for farm valuation purposes and is not adapted to a comparable classification for urban or commercial purposes.

In the land market, there is not always a large number of buyers and sellers. There may be a large number of buyers, but only a few landowners willing to sell; or there may be a large number of landowners wanting to sell, but only a few buyers as there were in the 1930's. These conditions may affect free entry into and exit from the market.

The availability of credit is a factor that may also affect free entry into and exit from the market. If credit is not available, a person without a large cash reserve may be unable to buy land. And even when conventional mortgage credit is available, the required down payment may eliminate some potential buyers. Low-equity financing (such as the land installment contract) may enlarge the demand for land, which should increase the price of land (unless the supply is perfectly elastic).

The land market, therefore, does not meet the requirements for a purely competitive market.

The land market depends largely upon *local* supply and demand conditions. For example, a prospective buyer from New York would find it very difficult, if not impossible, to learn of and inspect all the farms for sale in Iowa. Normally, the seller only brings his property to the attention of a few potential buyers. Real estate brokers and national listing services seek to correct this limitation of the land market by multiple-listing services, catalogs and personal contact with other brokers (34, p. 186). But this is still a limitation, and the buyers and sellers must still operate in many small local markets.

The average buyer and seller only participate in the land market occasionally, and as a result, their experience is limited. Partly because of this infrequent experience, buyers and sellers commonly use brokers' services. Brokers are important in bringing buyers and sellers together by their advertising and joint-listing arrangements with other brokers. They help bridge the gap in the flow of information between the buyer and seller.

The large considerations involved in most land transactions are another distinction between the land market and the market for most goods. Buyers of land may spend their entire life savings, plus all the money they can borrow, on the properties they buy in one market transaction. This is quite different from the day-to-day transactions of many goods.

The fixed location of the resource is another characteristic of the land market. Land must always be sold where it is located. (The fertile land of the Matanuska Valley in Alaska cannot be moved closer to the large urban centers.) This fixed location tends to localize the market for it.

Capitalization of Future Net Returns

Land acquires its value from a series of anticipated net returns that will become available over a period of years. In this respect, land has value for the same reasons as other goods. Since land has a greater durability as a production factor than do many other goods, the future earning capacity of land becomes important in valuation (27, p. 222). Theoretically, the value of land should always equal the present value of its future net returns; i.e., should equal the sum of its future net returns discounted back to the present (2, p. 188).

On the demand side of the market, potential buyers determine a value of land based on their anticipated future net returns. Theoretically, they will offer the amount that represents the discounted value of their expected future net returns. On the supply side, owners of land (the potential sellers) determine a value based on their estimation of future net returns. The seller's value will also represent the discounted value of his expected future net returns.

What is the discounted value of expected future net returns It is based on the idea that people prefer present returns to future returns. An individual would prefer $100 today to $100 1 year from now if he could earn a positive rate of return on it during the year. If he received $100 today, it would be worth $100 (1 + r) 1 year from today since he could earn r rate of return on it. Therefore, any positive rate of return would give him more than $100 1 year from today. For example, if the rate of return is 4 percent, he would have $104 next year instead of $100. If an individual has x dollars today, compounded at a rate r, it will be worth $x(1 + r)^n$ in year n. Let $A = x(1 + r)^n$. Then, $x = A/(1 + r)^n$. From this, we can see that x dollars now is equal to A dollars in year n discounted back to the present.

Since the buyer of land is actually buying the right to receive a future series of annual net returns, we have to discount each year's net returns back to the present. The discounted value of expected net returns or present value (PV) is the sum total of the future net returns discounted back to the present:

$$PV = A_1/(1 + r)^1 + A_2/(1 + r)^2 + \ldots + A_n/(1 + r)^n \quad [1]$$

where A_1 represents the annual net returns for the first year, A_2 for the second year and so forth.

If the annual net return A is the same each year, this expression becomes a geometric series.

The sum of the geometric series can be expressed as (64, p. 165):

$$PV = A/r[1 - 1/(1 + r)^n] \quad [2]$$

As n approaches infinity, equation 3 reduces to:

$$PV = A/r \quad [3]$$

This is the commonly accepted formula for capitalizing the series of expected annual net returns into land values, where PV is the value of land, A is the average annual net returns to land and r is the capitalization rate. For example, if a tract of land had an expected average annual net return in perpetuity to land of $10 per acre and the appropriate capitalization rate was 5 percent, the tract would have a discounted value of expected future net returns or capitalized value of $200 per acre.

Equation 3 illustrates that an increase in A would result in an increase in PV, the present value of land. This supports our hypothesis about net farm income and government payments. An increase in net farm income is expected to increase the net returns to land A and result in an increase in PV. Similarly, an increase in government payments would increase A and result in an increase in PV (assuming r is constant).

The valuations we make are anticipations. For the buyer or seller to determine what he is willing to give or take for a tract of land, he must 1) estimate the future net returns that this tract of land will yield and 2) determine the capitalization rate by which these future net returns will be translated into present values.

CAPITALIZATION RATE

The determination of the appropriate capitalization rate is important because a small change in the rate can have a large effect on the capitalized value. For example, at a capitalization rate of 4 percent, the capitalized value of a tract of land would be 25 times its annual income, but at a rate of 5 percent, the capitalized value would be 20 times its annual income. An average annual net return in perpetuity of $10 per acre capitalized at 4 percent would give a value of $250 per acre; however, capitalized at 5 percent, it would only support a value of $200 per acre. Scofield (35, p. 39) says that "ideally, the rate should represent the prevailing opportunity cost of capital as determined by the rate of return, after taxes, that could be realized from other investments having the same liquidity and risk characteristics as farmland." He points out that nonfarm income-producing real estate, such as apartments, office buildings and common stock, are most nearly comparable with farmland in an investment sense. However, many farmland buyers may not even consider these alternatives.

In practice, the common capitalization rate is taken as the average rate of interest on farm mortgages. Hurlburt (19, p. 22) indicates that this serves the purpose for general application, as an expression of what the average operator might be willing to take as a rate of return on money invested in land. He points out, however, that the average rate of interest on farm mortgages is not a sufficient guide for determining the actual factor price or indicating the individual's time preference. More appropriately, the operator should determine the income-earning opportunity within the firm. The operator can invest in land profitably up to the price per acre at which the expected rate of return is the same as that on money invested in the other factors. That is, the firm can invest in land profitably up to the point where the price of land is equal to the value of the marginal product. The theory of resource allocation tells us that the firm will invest until the value of the marginal dollar spent on inputs is the same in every use.

The capitalization rate may vary among buyers or sellers at any particular time because of different attitudes toward the uncertainty attached to the income flow of land. The buyer with a capitalization rate of 10 percent will not be willing to pay as much for land as a buyer with a capitalization rate of 5 percent (assuming both buyers have the same estimates of future net returns). If the price of land is above the buyer's "capitalized value," it will be more profitable for him to invest in other factors. If land is priced and acquired above its "capitalized value" or its earning capacity, money is tied up in land that could be earning a higher rate of return invested in some other factor, say, fertilizer. We are assuming that the rational investor will invest so that his value of marginal product will be equal for all factors or in all projects. This may not be a valid assumption. An individual's capitalization rate is an expression of what he is willing to do. If he has a preference for farming and a desire to live in a particular area, he may be willing to accept a low rate of return on his investment.

The internal earning rate is the basic capitalization rate to start with. From this rate, a subjective discount may be made to reflect the preference for farming as an occupation or some other preference attached to the land. The amount of risk and uncertainty involved is another element that requires attention when determining the appropriate capitalization rates. An allowance for risk and uncertainty should usually be added to the rate. Normally, the greater the risk and uncertainty involved in estimates of future income, the higher the capitalization rate will be.

ESTIMATING FUTURE NET RETURNS

The buyer or seller must estimate the future net returns to land before he can determine what he is willing to give or take for a tract of land, and this can present a problem. In theory, the individual should try to determine the average annual net returns that the land can be reasonably expected to earn in the future. Actual income histories of properties have limited use because it is the prospective future net returns (not the actual realized net return) that are subject to the discounting process (1, p. 429). Sometimes, however, the most recent past net returns are the best data we have, and an individual's estimates may be weighted quite heavily by the net returns received in the past. When past net returns have been fairly stable, greater certainty is attached to the forecasts.

What share of the net returns should be allocated to land? Land should receive, as a reward for its use, a payment exactly equal to its actual contribution (20, p. 176). According to marginal productivity theory, land should receive a reward equal to the value of its marginal product.

A number of studies have estimated the net returns to land. Several methods of allocating net farm income to the factors of production have been used in the search for a satisfactory procedure. Strohbehn (43) used marginal productivity analysis to distribute income among factors of production for a selected sample of Illinois farms. He used a linear, homogeneous production function analysis to estimate the marginal value product of each group of inputs used in the farm business.

Scofield (35, 38) has estimated the net returns to land by using the residual method: He assumes that labor and nonreal-estate capital are paid at their respective cost rates and that the residual return is allocated to land. The general approach in these studies was to impute a cost of family labor and nonreal-estate capital (based on opportunity or market cost rates) and to allocate the remaining net returns to land.

In the long run under competitive conditions, market prices might be expected to equal the value productivity of resources (13, p. 406). This condition, however, need not hold true in the short run or in a dynamic economy with imperfect expectations and where competitive conditions do not always exist. Therefore, the residual method of allocating net returns to land may not allocate a return to land equal to its productivity.

If the returns to land are misstated, it may lead to the conclusion that land is more (or less) productive than it actually is. Another disadvantage to the residual method, which Scofield (37, p. 44) recognizes, is that any estimating error in any of the other factors becomes incorporated into the residual return.

Net rents to landlords have been used to estimate the net returns to farmland (3, 4, 20). This estimate is calculated by dividing net rents paid to landlords by the ratio of the value of rented farmland to the value of all farmland. This procedure assumes that the net returns on rented land bear the same relationship to net returns on all land as the value of rented land does to the value of all land (20, p. 726). It appears that rented land is concentrated in the Corn Belt, the Delta area and Texas (24, p. 21). This would provide an estimate of rental returns in an area weighted heavily with crops such as corn, cotton, wheat and other feed grains. A further handicap is in the estimate of net rent to landlords. Cash rents are easy to handle, but sharecrop arrangements complicate the dollar estimate of net rent to the landlord.

Equation 3 assumed that there is a constant annual net return to land. In reality, the net return usually fluctuates from year to year. Modifications in the capitalization formula are needed to adjust for this fluctuation in net returns. If the net returns to land are expected to increase at a constant arithmetic rate, the present value can be calculated by:

$$PV = A/r + I/r^2 \qquad [4]$$

where A represents the current average net returns to the land, I is the average expected annual increment of increased net returns and r represents the appropriate capitalization rate.

Decreases in net returns may take place as virgin stocks of fertility are used up or as soil erosion occurs. The present value when a decrease in net returns is anticipated at a constant arithmetic rate is given by the equation:

$$PV = \mathrm{Max}[A/r - I/r^2, 0] \qquad [5]$$

Equation 5 indicates that PV is equal to $A/r - I/r^2$ or 0, whichever is larger. That is, we would not expect the present value to be negative. If I is not constant and is expected to be negative in some years and positive in others, the present value can be expressed as:

$$PV = A/r + [I_1/(1+r)^1 + I_2/(1+r)^2 + \ldots + I_n/(1+r)^n] \qquad [6]$$

where the increment or decrement is indicated as I_1 for the first year, I_2 for the second year and so forth.

Up to this point, we have considered that there is an average annual net return A that lasts forever. But soil improvements or buildings usually are not expected to last forever. Resources such as this have terminable net returns; that is, the net returns are realized for a limited time only. In the case where the terminable net return is the same each year and lasts only n years, the present value of the resource is expressed by equation 2.

Some landowners and prospective buyers may be interested in how much the land will be worth at some future date. These individuals may be expecting something, such as urban expansion, to increase land value. If the value increases, they will be able to realize a capital gain.

In addition to the regular annual net returns they receive, individuals who expect a capital gain consider the future value of the farmland and the net returns an increase in value will provide for them. After estimating farmland value at some future time, these individuals should consider the capital-gains tax that must be paid on any long-term capital gain. They should deduct an amount equal to their anticipated capital-gains tax to arrive at a net return for the land. If the seller of farmland receives over 30 percent of the purchase price in the year of the sale, the entire capital gain is taxable that year (30, p. 4). However, if the seller receives less than 30 percent of the purchase price in the year of the sale, the capital-gains tax can be reduced by spreading the gain over the length of the purchasing agreement (e.g., mortgage or land contract). That is, from each payment the seller receives, he would pay capital-gains tax that year only on that portion of the principal that was gain. By paying capital-gains tax only on the gain received each year, it usually enables the seller to pay at a lower rate than when the entire amount is paid in the year of the sale.

This suggests that an individual who expects a capital gain would have two parts to his capitalization formula. First, he considers what the land will be worth at some future date and what net returns the capital gain will yield him. This net return should be discounted back to a present value. Second, he considers the annual net returns that he will receive from the land while he holds it. If he assumes a constant average annual net return to land, the individual might apply the following equation to determine the value of the land to him:

$$PV = AP/(1 + r)^n + A/r[1 - 1/(1 + r)^n] \qquad [7]$$

where AP is the anticipated net price of the land at the end of n years. The other variables have been defined previously.

As an example of how equation 7 would be applied, assume a tract of land will have an average annual net return of $10 per acre, the effective capitalization rate is 5 percent and the anticipated net price of this land 10 years from now is $250 per acre. Under these assumptions a prospective buyer would be willing to pay $230.70 per acre for this land.

In equation 7 we did not explicitly consider the capital-gains tax or investment and depreciation in land. These factors are considered in estimating AP in year n. The cost of the investment should be added and the depreciation and capital-gains tax subtracted to arrive at an estimate of AP.

This example illustrates that expected capital gains resulted in a value of $23.70 per acre for a tract of land. If the average annual net return of $10 per acre was capitalized at 5 percent and there was no expected capital gain, the value of land would be $200 per acre. Therefore, we conclude that expected capital gains has a positive effect on farmland value.

METHODS OF MEASUREMENT AND THEIR APPLICATIONS

The Recursive Model

A recursive system is composed of a sequence of causal relationships. It consists of a set of equations each containing a single endogenous variable other than those that have been treated as dependent in prior equations (12, p. 2). The endogenous variables enter the system one by one, like links in a chain where each link is explained in terms of earlier links.

Recursive models seem appropriate in agriculture - both as a basis for practical forecasting and as tools of realistic economic theory (60, p. 734). It seems logical that the current supply quantity often is determined by past prices and that the current price is a function of the predetermined quantity. The cobweb model, a recursive model, has been used for many years.

We hypothesized that the price of farmland is determined by the current quantity of farmland transferred in the market and other variables exogenous to the farmland market. The current quantity of farmland transferred in the farmland market is determined by exogenous variables (e.g., expected capital gains, level of technology, and relative earnings between farm and nonfarm employment). The use of the recursive model in the farmland market assumes that the decisions regarding the current quantity of farmland transferred are made exogenously of the current price of farmland.

The data on the price of farmland transferred are not available. The value of farmland (V), as estimated by the Economic Research Service of the U.S. Department of Agriculture, is used in the place of price data. Data on the number of acres of farmland transferred in the market are not available. One would suspect that, as the average farm size continues to increase, the size of farm being transferred would also increase. But in 1965, the available evidence did not indicate that the size of the farmland transfer had changed significantly.[3] Therefore, the number of voluntary transfers of farmland, T, was used to represent the quantity of farmland transferred.

The model can be specified in two equations.

[3] William H. Scofield. Economic Research Service, U.S. Department of Agriculture. Washington, D.C. Transfers of farmland. Private Communication. 1965.

The value of farmland is assumed a function of the following variables:

$$V = f(T; NFI, GP, Cg, r, A) \quad [8]$$

where T is endogenous and the remaining variables are exogenous. V and T have previously been defined. The other variables are defined as: NFI = expected net farm income, GP = government payments, Cg = expected capital gains, r = rate of of return on common stock and A = increase in farm size (farm enlargement).

The voluntary transfer of farmland is assumed a function of exogenous variables:

$$T = f(Cg, F/NF, TE, D/E, N) \quad [9]$$

where Cg = expected capital gains, F/NF = ratio of farm to nonfarm earnings, TE = measure of technology, D/E = ratio of farm mortgage debt to equity and N = change in number of farms.

Equation 9 is estimated first. The predicted values of T are then used to estimate equation 8. Use of predicted values of T in equation 8 essentially makes it an exogenous variable. This procedure is used to insure that the disturbances in T are not correlated with the disturbances in the V equation.

After both equations have been estimated, equation 9 can be substituted into equation 8. The reduced form of the resulting equation denotes the effects on V of the variables included in equation 9. The use of the recursive model usually allows the researcher to determine the effect of a larger number of variables than can be included in a single - equation model.

National time - series data were used to fit the recursive model. The unit of observation for this data was the annual U.S. average for each variable. When this kind of aggregate data is used, certain regional effects may be canceled out. For example, the northeastern United States, which has a high density of nonfarm population, would seem to have a stronger nonfarm demand for land than the Plains States. Since national time-series data would not reflect this, an attempt to measure these regional effects was made by applying cross-sectional data to the model.

The variables used in this analysis are presented in table 3. The first column gives the designation of the variable, and a brief description of the variable is given in the second column. Several dummy variables were used in the analysis and are not included in table 3. The dummy slope variables are designated by the years for which they cover. For example, NFI_{56-65} is used to designate expected net farm income for the years 1956 to 1965. That is, this variable is equal to zero for the years 1933 to 1955 and equal to NFI for the years 1956 to 1965.

The over-all intercept (where ones are entered in the X matrix for all observations) is designated by b_0. The dummy intercept variables are also designated by the observations they cover. For example, b_{42-47} is used to designate a dummy intercept for 1942 to 1947. This variable consists of ones entered as the data for 1942 to 1947 and zeros in all other years.

Table 3. Identification of variables used in the time-series and cross-sectional models.

Designation[a]	Description[b]
A	Change in the average size of farm (acres)
b	Intercept
Cg	Expected capital gains (dollars/acre)
CP	Conservation payments (dollars/acre)
D/E	Ratio of debt to equity (percent)
D/V_1	Ratio of debt to value of farmland (percent)
E(F/NF)	Expected ratio of farm to nonfarm earnings (percent)
GFI	Gross farm income (dollars/acre)
GP	Government payment tied to land (dollars/acre)
GPL	Government payments for land diversion (dollars/acre)
i	Farm mortgage interest rate (percent)
La	Labor (hours/acre)
N	Change in the number of farms (1,000 farms)
NFI	Expected net farm income (dollars/acre)
PD	Nonfarm population density (people/square mile)
r	Rate of return on common stock (percentage)
T	Voluntary transfers of farmland (1,000 farms)
$\hat{T}$	Predicted voluntary transfers of farmland (1,000 farms)
Tv	Voluntary transfers of farmland per 1,000 farms
$\hat{T}v$	Predicted voluntary transfers of farmland per 1,000 farms
V_1	Value of farmland (dollars/acre)
V_2	Value of farmland without farm buildings (dollars/acre)

[a] Variables are mnemonically designated whenever possible.
[b] The unit of measure of the data is given in parentheses.

V_1 is the average value of farmland per acre as estimated by the Economic Research Service. These estimates are based on estimates provided periodically from regular USDA crop reporters through the Statistical Reporting Service and a mail survey directed to about 8,000 farm real estate brokers, local bankers, lawyers, county officials and others. V_2 is V_1 minus the value of farm buildings per acre. Therefore, V_2 is an estimate of the value of farmland without the farm buildings. V_1 and V_2 are deflated by P, the index of prices paid by farmers for items used in living and production (1957 - 1959 = 100). V_1 and V_2 are dependent variables to be explained in this study.

T is the number of voluntary transfers of farmland. Data for voluntary transfers are reported as the number of transfers per 1,000 farms. The number of farms was used to convert this data to T, the dependent variable to be explained in equation 9. The predicted value of T is an independent variable in equation 8 and is used in this study to represent the quantity of farmland transferred.

For expectations of future net returns to be included in the analysis, it was assumed that expected future net returns are some function of past returns:

$$A_{et} = f(A_t, A_{t-1}, \ldots, A_{t-h}) \quad [10]$$

where A_{et} are the expected future net returns and $A_t, \ldots, A_{t-h}$ are the net returns of past years.

The expectation model used in this study was based on a weighted average of past net returns, where the most recent returns are weighted the heaviest. It can be stated as:

$$A_{et} = \sum_{i=1}^{m} W_i A_{t+1-i} / \sum_{i=1}^{m} W_i \quad [11]$$

where $W_i = m + 1 - i$ and m is the number of units desired in the weighted average. In this study, m is equal to 3.

Net returns to farmland have been estimated by several methods.[4] Data on returns to farmland are available for the residual method and the net rents to landlord. Because of limitations of computing net returns to farmland by each of these methods, neither of these data series are used in this study.

Realized net income from farming, weighted according to equation 11 and lagged, is used in this study to represent expected net farm income. This variable is designated as NFI. NFI is deflated by the prices paid by farmers for items used in living and production, P.

It was hypothesized that government - program payments that tend to be tied to land should be divided into two groups: 1) land - diversion program payments and 2) conservation payments. CP is the average conservation payment per acre. GPL is the average payment per acre from land diversion programs. GPL includes payments made under the soil bank, feed grain and wheat programs. CP and GPL were both deflated by P and are both excluded from NFI.

Cg, the expected capital gains on farmland, is computed as the incremental change in farmland value per acre, less the capital improvements added. This quantity was then deflated by P, w weighted according to equation 11 and lagged 1 year. That is, expected capital gains are assumed to be based on past capital gains.

r is the average rate of return on 200 common stocks as reported by Moody's Investors Service and is used as a proxy for the capitalization rate. The average interest rate on farm mortgages (i) appears a more commonly used proxy for the capitalization rate than the yield on common stock. i is used as an alternative proxy variable for the capitalization rate.

[4] These methods were discussed under "Estimating future net returns."

A is the change in the average farm size in acres. Since the average farm size has been increasing over time, A is the increase in the average farm size (farm enlargement). N, the number of farms, has been declining because of farm enlargement and the increased demand for nonfarm uses.

PD is the nonfarm population density per square mile. The nonfarm population is divided by the number of square miles of land area. PD is used to represent the nonagricultural demand for land.

La, man-hours of labor per acre, is used as a proxy measure of technology. Much of technology tends to be labor saving. Therefore, a decline in hours of labor per acre will be used to reflect an increase in technology.

F/NF is the ratio of farm to nonfarm earnings, and E(F/NF) is the expected ratio of farm to nonfarm earnings. E(F/NF) is computed by weight - ing F/NF by the procedure given in equation 11, where F is the average annual income per farm worker, and NF is the average annual wage per employed factory worker.

D/E is the ratio of debt to equity, where D is total farm mortgage debt outstanding, and E is equity or net worth (total assets minus total liabilities). The recursive model was estimated by least - squares regression. Since it has become common to explore a range of alternative formula - tions, several equations were estimated besides those specified in our proposed recursive model. From this range of alternative formulations, the most suitable equations are selected to represent the farmland market.

The empirical results of the study are presented in two parts: The first consists of the results of the time - series model, and annual U.S. averages are used to estimate this model for 1933 to 1965. The second part contains the results of the cross - sectional analysis. The cross - sectional analysis is conducted for four years: 1940, 1950, 1954 and 1959.

Time-Series Analysis

The estimates of the number of voluntary transfers of farmland for the national time - series model are reported in table 4. The equation numbers are given in the first column, the R^2 is given in the second column, the F-test for the equation is given in the third column, and the Durbin-Watson statistic is given in the fourth column. The fifth column and all following columns report the regression coefficients on the first line and the standard error of the coefficient on the second line. The significance of the regression coefficients is indicated by # at the 10-percent level, * at the 5-percent level and ** at the 1-percent level. This format is used in all subsequent tables that report regression coefficients.

The signs of all coefficients presented in table 4 are consistent and in the direction suggested by theory. The magnitude of the coefficients remained consistent when various alternative formulations of the model were estimated. The coefficient of determination is above 0.98. The F-tests for all equations are highly significant, and most of the coefficients in each equation are significant at the 5-percent level or better.

As the ratio of debt to equity increases, a less-favorable debt position results. A poor debt position places restraints on the ability to purchase farmland and, thus, reduces the competition for farmland. That is, a higher debt-to-equity ratio results in fewer potential buyers for farmland and the number of farms transferred declines. This hypothesis is supported by the negative sign on D/E in table 4.

La is used as a proxy measure of technology. Since technology has tended to be labor saving, a decrease in La reflects an increase in technology. That La is positive in table 4 is consistent with the hypothesis that an increase in technology will be associated with a decline in the number of farms transferred. Farms have also enlarged to take advantage of some of the technological advance. That N is positive is consistent with the hypothesis that, as farm enlargement occurs, the number of farms declines, and the number of farms transferred declines.

The ratio of farm to nonfarm earnings has a positive effect on the number of voluntary transfers of farmland. That is, as farm earnings rise relative to nonfarm earnings, voluntary transfers of farmland increase. The positive sign on the expected capital gains variable indicates that an increase in Cg increases the activity in the farmland market.

The linear equations reported in table 4 were also estimated in the doublelog form: $\log Y = \log b_0 + b \log X$. This function is equivalent to $Y = b_0X^b$ fit to the original data. The R^2 for the linear form ($Y = b_0 + bX$) and the doublelog form are not directly comparable. To compare the R^2's, one should take the antilog of the $\hat{Y}$'s for the doublelog form and then find the coefficient of determination with the observed values of Y (11, p. 217). Although this procedure was not performed here, the linear form of equations was selected for the transfer equation because of the higher F ratios and because of the low number of significant variables in some of the doublelog equations. The estimates of the doublelog form for the equations in table 4 are not included in this report.

Examination of the data for the dependent variable disclosed that the number of voluntary transfers of farmland during 1942 to 1947 was considerably higher than during the rest of the period. A dummy intercept variable was added for 1942-1947. The t-test on the dummy intercept variable indicates that it is significantly different from the intercept for the other years included in this analysis.

The simple correlation between A and T was higher than the correlation of N and T. Therefore the farm enlargement variable, A, was substituted for N.

The expected capital-gains variable was negative for several of the years during 1933 to 1941. Equation 13 includes a dummy slope variable for Cg for this period. The t-test on the coefficient of Cg_{33-41} indicates that the coefficient is significantly different from the coefficient for 1942 to 1965.

Equation 13 was selected to represent the voluntary transfers of farmland in the recursive model. The coefficients of all independent variables are significant at the 10-percent level or better. The independent variables explain 98.4 percent of the variation in the number of voluntary transfers. Adjusted for the degrees of freedom the corrected coefficient of determination ($\bar{R}^2$) is 0.979.[5] Equation 13 would be written as follows for

[5]The following formula is used to calculate $\bar{R}^2$ (13, p. 217): $\bar{R}^2 = 1 - (1 - R^2)(n - 1)/(n - k - 1)$, where n is the number of observations and k is the number of independent variables.

Table 4. Voluntary transfers of farmland (T) estimated by least squares by using annual data for 1933-1965, coefficients, standard errors (in parentheses) and other related statistics.

Equation number	R^2	F	d^a	b_0	b_{42-47}	D/E	La	E(F/NF)	N	A	Cg	Cg_{33-41}
12	0.982	230.4	1.83	-40.88	30.57**	-7.10**	14.35**	1.96**	0.11#		2.72**	
				(26.12)	(8.62)	(1.14)	(1.00)	(0.44)	(0.06)		(0.82)	
13	0.984	217.7	1.84	-11.23	31.67**	-7.36**	13.76**	1.58**		-3.35*	4.86**	-2.96#
				(34.74)	(8.31)	(1.04)	(1.13)	(0.47)		(1.53)	(1.52)	(1.55)

a Durbin-Watson statistic.
# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

1933 to 1941: T = -11.23 - 7.36 D/E + 13.76La + 1.58 E(F/NF) - 3.35A + 1.90 Cg
for 1942 to 1947: T = 20.44 - 7.36 D/E + 13.76 La + 1.58 E(F/NF) - 3.35A + 4.86 Cg
for 1948 to 1965: T = - 11.23 - 7.36 D/E + 13.76 La + 1.58 E(F/NF) - 3.35A + 4.86 Cg.
Equation 13 indicates that, as the debt-to-equity ratio increases by 1 percent the number of voluntary transfers of farmland declines by 7,360 farms. A 1-percent increase in the expected ratio of farm to nonfarm earnings is associated with an increase of 1,580 voluntary transfers.

The elasticity of voluntary transfers of farmland with respect to La is 1.03.[6] This elasticity indicates that, with a 10-percent decrease in La (an increase in the level of technology), the number of voluntary transfers of farmland decreases 10.3 percent. As farm enlargement occurs, the number of transfers declines. The coefficient of A indicates that, with a 1-acre increase in the average farm size (farm enlargement), the number of voluntary transfers declines 3,350. An increase of $1 in expected capital gains was associated with an increase in the number of voluntary transfers of 1,900 farms during 1933 to 1941 and with an increase of 4,860 farms during 1942 to 1965.

The predicted number of voluntary transfers of farmland from equation 13 and the actual number of voluntary transfers of farmland are shown in fig. 2. The y axis is in thousands of voluntary transfers of farmland, and the x axis is the period from 1933 to 1965. The predicted values follow the actual data very closely.

[6]The elasticity is computed at the mean by the following formula: $e = b\,\bar{x}/\bar{y}$, where b is the regression coefficient, $\bar{x}$ is the mean of the independent variable and $\bar{y}$ is the mean of the dependent variable.

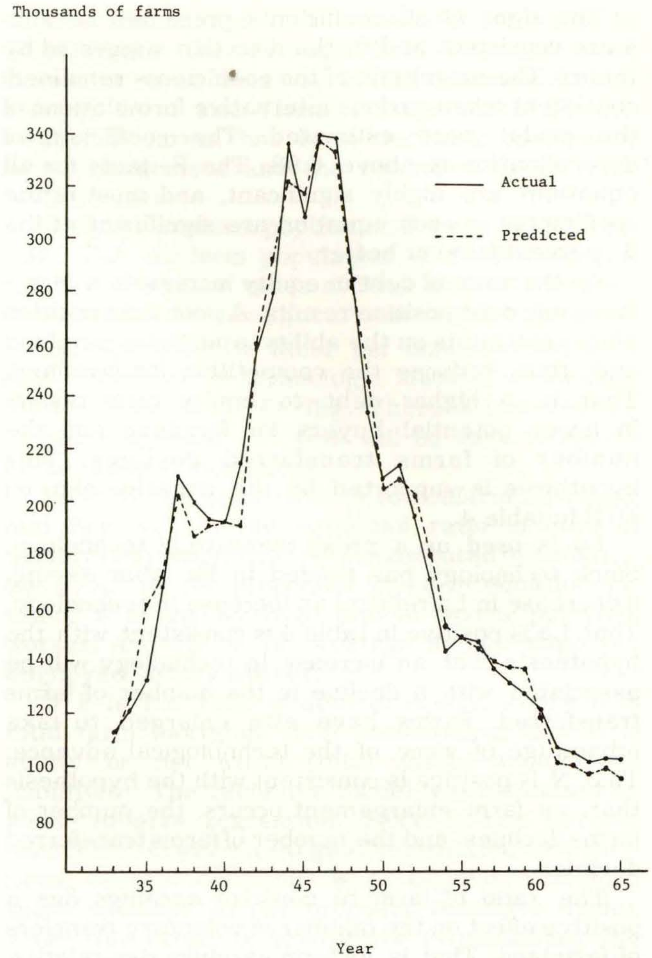

Fig. 2. Actual and predicted voluntary transfers of farmland for the United States, 1933-1965 (equation 13).

Table 5. Value of farmland with buildings (V_1) estimated by least squares using annual data for 1933-1965, coefficients, standard errors (in parentheses) and other related statistics.

Equation number	R^2	F	d^a	b_0	$\hat{T}$	GP	GP_{56-65}	GPL
14	0.946	75.8	1.18	107.98**	-0.23**	12.08**		
				(7.29)	(0.04)	(2.55)		
15	0.955	92.2	1.48	45.92**	-0.20**	10.32**		
				(12.23)	(0.04)	(2.38)		
16	0.971	118.6	1.87	55.40**	-0.14**	0.86	15.97**	
				(10.39)	(0.04)	(3.24)	(4.36)	
17	0.967	105.9	1.76	55.42**	-0.15**			16.96**
				(11.08)	(0.04)			(3.00)
18	0.974	110.5	1.94	52.39**	-0.13**			14.88**
				(10.26)	(0.04)			(2.89)
19	0.985	164.3	2.21	72.99**	-0.23**			11.97**
				(9.44)	(0.04)			(2.36)

Table 5. (Cont'd).

Equation number	CP	Cg	Cg_{33-41}	A	r	I/r	NFI	NFI_{56-65}
14		0.62		1.07	-5.73**		2.91**	
		(0.44)		(0.69)	(1.33)		(0.78)	
15		0.42		1.29#		1.45**	2.69**	
		(0.41)		(0.64)		(0.27)	(0.71)	
16		0.22		1.22*		1.01**	1.81**	
		(0.34)		(0.53)		(0.26)	(0.63)	
17	1.71	0.34		1.25*		1.09**	1.88**	
	(3.49)	(0.36)		(0.56)		(0.27)	(0.68)	
18	1.81	0.04		1.19*		0.97**	1.93**	0.82*
	(3.21)	(0.35)		(0.51)		(0.25)	(0.62)	(0.35)
19	7.55*	2.37**	-2.25**	0.38		0.73**	2.02**	0.23
	(2.86)	(0.63)	(0.55)	(0.44)		(0.20)	(0.48)	(0.31)

a Durbin-Watson statistic.
# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

The number of voluntary transfers of farmland, as predicted by equation 13, is used as an independent variable in estimating farmland value. Predicted values of T are used to insure that the disturbances in T are not correlated with the disturbances in the V equation.

The estimates of the value of farmland with buildings, V_1, are reported in table 5, and the estimates of the value of farmland without farm buildings, V_2, are presented in table 6. The same variables are used to specify the equations for V_2 in table 6 as were used to specify the equations for V_1 in table 5. V_1 and V_2 were both estimated because it was hypothesized that certain variables (e.g., farm enlargement) would have an impact on V_2 different from that on V_1. Before we compare the coefficients of the V_1 equation with those of the V_2 equation, let us examine the different formulations of the V_1 equation in table 5.

The signs of all coefficients in table 5 are in the direction suggested by theory. The coefficient of determination ranges from 0.946 to 0.985. The F-tests for all equations are highly significant, and most of the coefficients in each equation are significant at the 5-percent level or better.

Equation 14 represents the estimates for equation 8 of our recursive model. The number of voluntary transfers, government payments, farm enlargement, expected net farm income, expected capital gains and the rate of return on common stock explain 94.6 percent of the variation in the value of farmland from 1933 to 1965. The coefficients of Cg and A are not significantly different from zero. The remaining variables are significant at the 1-percent level.

The negative sign on $\hat{T}$ supports the hypothesis that an increase in the quantity of farmland transferred will have a negative effect on farmland value. GP and NFI are income variables. According to the capitalization formula, income should have a positive effect on farmland values. The positive signs on GP and NFI in table 5 are consistent with that hypothesis. The capitalization formula also specifies that the capitalization rate is negatively related to farmland values. The rate of return on common stock (a proxy variable for the capitalization rate) has the expected negative sign.

The change in the average farm size is used in this study to represent farm enlargement. This variable is used to reflect the increased demand for farmland to expand the size of existing farms. Technology has enabled the farmer to handle a larger acreage. By operating a larger farm, he can spread his overhead costs over more acres. The coefficient of A has the expected positive sign; that is, farm enlargement has a positive effect on farmland values. Expected capital gains have a positive sign indicating that, as capital gains are expected, this type of future income is capitalized into farmland value.

Equation 3 implies that the present value of expected future income is not a linear function of the capitalization rate. Equation 3 suggests the use of the doublelog form. The logarithmic transformation of the variables used in equation 14 was used to estimate farmland value. The coefficients of r and NFI were highly significant in the doublelog form, but other variables, such as GP, were insignificant suggesting that they may be linearly related to V_1; therefore, another alternative was attempted. In equation 15, 1/r is substituted for r. The R^2 increased from 0.946 to 0.955, and the standard errors of most coefficients were lowered. The double log equations contained several coefficients that did not have the expected signs and are not presented.

The government started making payments to farmers for land diversion under the soil bank program in 1956. Since that time, there have been substantial payments made to farmers for land diversion. A dummy slope variable (GP_{56-65}) was used to determine if the coefficient for GP since 1956 was different from the coefficient before 1956. Equation 16 contains this formulation. The coefficient of GP_{56-65} was significantly different at the 1-percent level.

In equation 17, GP is divided into two parts: a) conservation payments (CP) and b) government payments for land diversion (GPL). GPL is significant at the 1-percent level, but CP is not significantly different from zero in this equation.

The results of several studies indicate that net returns to land have increased in recent years (54, 37, 32). To test this hypothesis, three dummy slope variables for expected net farm income were tested: NFI_{50-65}, NFI_{59-65}, NFI_{56-65}. NFI_{56-65} had the highest correlation with the dependent variable and gave the best fit. Equation 18 indicates that the coefficient of expected net farm income for 1956 to 1965 is significantly different from the coefficient for the years before 1956.

The annual value for Cg ranges from -16.03 in 1933 to a high of 7.91. The low coefficient for Cg suggests that, by estimating a slope coefficient over the entire period, the negative and positive portions may be off-setting each other. All negative values for Cg occur in the period 1933 to 1941. An alternative way of handling the Cg variable (equation 19) would be to use a dummy variable for the period 1933 to 1941 as we did in the T equation. The R^2 increased from 0.974 to 0.985. The coefficient of Cg_{33-41} is highly significant, which indicates the effect of Cg is different for 1933 to 1941 than for 1942 to 1965.

Several alternative formulations of the value of farmland equation (and the value of farmland without farm buildings) were estimated. PI (personal income of the farm population from nonfarm sources) was used to test the effect of nonfarm income on farmland value. The PI coefficient had the expected positive sign. The coefficient, however, was not significantly different from zero. The farm mortgage interest rate (i) was substituted for r as an alternative proxy for the capitalization rate. This formulation produced a higher R^2, and all coefficients were significant. The coefficient for i, however, has a positive sign, and, if i reflects the capitalization rate, it should have a negative sign. Herdt and Cochrane (16) encountered the same problem in their study of farmland values.

PD was highly correlated with other independent variables used in this analysis. Therefore, the annual change in the nonfarm population density (PD') was used as a substitute measure of the population pressure. The coefficient of PD' was estimated to test the effect of this variable. The coefficient for PD' had a positive sign, but was not significantly different from zero. The nonfarm population density is higher in some areas of the country than in other areas. The unit of observation in the time-series analysis is an average over the 48 contiguous states (Alaska and Hawaii excluded), and the effect of PD on certain areas will be spread over all states. For this reason, the PD might not be expected to be significant in the time-series analysis. The effect of nonfarm population density, however, should be measured more accurately in the cross-sectional analysis.

The results of the estimates of the value of farmland without farm buildings are reported in table 6. Equations 20 to 25 correspond to the formulation of equations 14 to 19 in table 5. (Equation 20 is estimated on the same independent variables as equation 14.) These tables were constructed in this manner so that comparisons could be made of the effect of an independent variable on V_1 with the effect of that variable on V_2.

$\hat{T}$ is highly significant in all equations presented in both tables. The sign of the coefficient on $\hat{T}$ is negative for both V_1 and V_2. Comparison of the $\hat{T}$ coefficient in the two tables indicates that a decrease in the number of farms transferred will account for an increase in V_1 larger than the increase in V_2.

The GPL coefficient is consistently larger in the V_2 equations. An increase in government payments for land diversion results in a larger increase in the value of farmland without farm buildings than for farmland with buildings. That is, GPL are capitalized into V_2 at a higher rate than they are capitalized into V_1. However, the opposite is true for conservation payments: CP is capitalized into V_1 at a higher rate than into V_2. This suggests that the expectations of benefits from CP are higher on farmland with buildings than on farmland without farm buildings.

The Cg coefficient is consistently larger for the V_1 equations than for the V_2 equations, indicating that Cg has a larger effect on V_1 than on V_2.

The larger A coefficient in the V_2 equations than in the V_1 equations indicates that farm enlargement has a greater effect on the value of farmland without farm buildings than it does on the value of farmland with farm buildings. This conclusion would be expected since the demand for land for farm enlargement is usually for farmland without farm buildings. The farmer usually doesn't need the

Table 6. Value of farmland without farm buildings (V_2) estimated by least squares using annual data for 1933-65, coefficients, standard errors (in parentheses) and other related statistics.

Equation number	R^2	F	d[a]	b_0	$\hat{T}$	GP	GP_{56-65}	GPL
20	0.941	69.6	1.08	78.41**	-0.19**	12.06**		
				(6.94)	(0.04)	(2.43)		
21	0.953	88.3	1.47	19.51#	-0.17**	10.37**		
				(11.42)	(0.04)	(2.22)		
22	0.974	134.1	2.07	29.51**	-0.10**	0.39	16.85**	
				(8.95)	(0.03)	(2.79)	(3.76)	
23	0.971	119.0	1.93	29.93**	-0.11**			17.65**
				(9.57)	(0.03)			(2.59)
24	0.976	120.6	2.10	27.48**	-0.09**			15.97**
				(8.99)	(0.03)			(2.53)
25	0.982	141.2	2.11	41.87**	-0.16**			13.93**
				(9.29)	(0.04)			(2.32)

Table 6. (Cont'd).

Equation number	CP	Cg	Cg_{33-41}	A	r	l/r	NFI	NFI_{56-65}
20		0.43		1.25#	-5.33**		2.83**	
		(0.42)		(0.66)	(1.26)		(0.74)	
21		0.22		1.49*		1.38**	2.62**	
		(0.39)		(0.60)		(0.26)	(0.67)	
22		0.01		1.42**		0.91**	1.69**	
		(0.30)		(0.45)		(0.22)	(0.55)	
23	0.92	0.13		1.45**		0.98**	1.73**	
	(3.01)	(0.31)		(0.48)		(0.23)	(0.58)	
24	1.00	-0.11		1.41**		0.89**	1.77**	0.66*
	(2.81)	(0.31)		(0.45)		(0.22)	(0.54)	(0.30)
25	5.01#	1.52*	-1.57**	0.84#		0.73**	1.83**	0.25
	(2.82)	(0.62)	(0.54)	(0.44)		(0.20)	(0.48)	(0.30)

a Durbin-Watson statistic.
\# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

buildings on farmland added to his existing farm. In this case, a farmer would be willing to pay more for the "bare" land since he would have an additional 1 or 2 acres to farm.

The coefficient for 1/r is slightly larger in the V_1 equations (15 to 18) as compared with the V_2 equations (21 to 24). However, when the model is more completely specified (equations 19 and 25), the coefficient is the same for all equations, suggesting that the same capitalization rate is used when valuing farmland regardless of whether the land has buildings or not.

Comparison of the NFI coefficient in tables 5 and 6 reveals very little difference. The NFI coefficient in the V_1 equations, however, is consistently a few cents larger than in the V_2 equations.

Equation 19 was selected to represent farmland value in the recursive model. The predicted value of farmland and the actual value of farmland are presented in fig. 3. The y axis is in deflated dollars per acre, and the x axis is 1933 to 1965.

Equation 25 was selected to represent the value of farmland without farm buildings. The same independent variables included in equation 19 account for 98.2 percent of the variation in V_2. The actual and predicted values for V_2 are presented in fig. 4, which has the same axes as fig. 3.

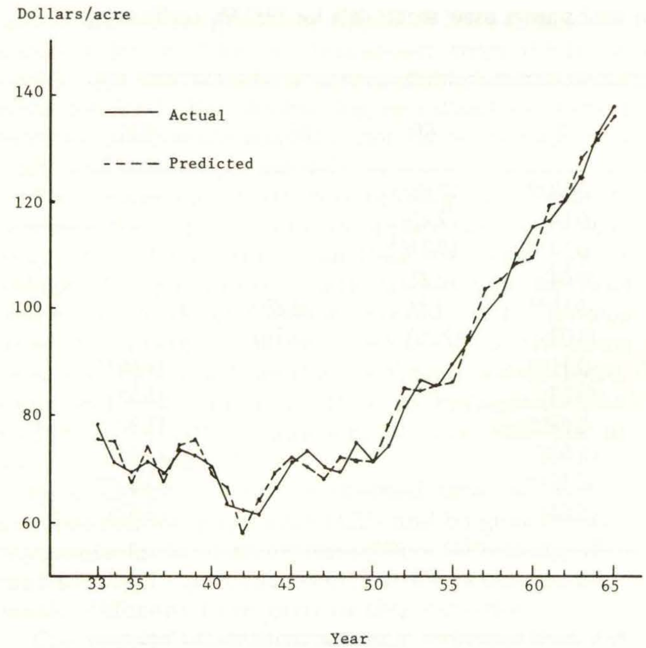

Fig. 3. Actual and predicted value of farmland for the United States, 1933-1965 (equation 19).

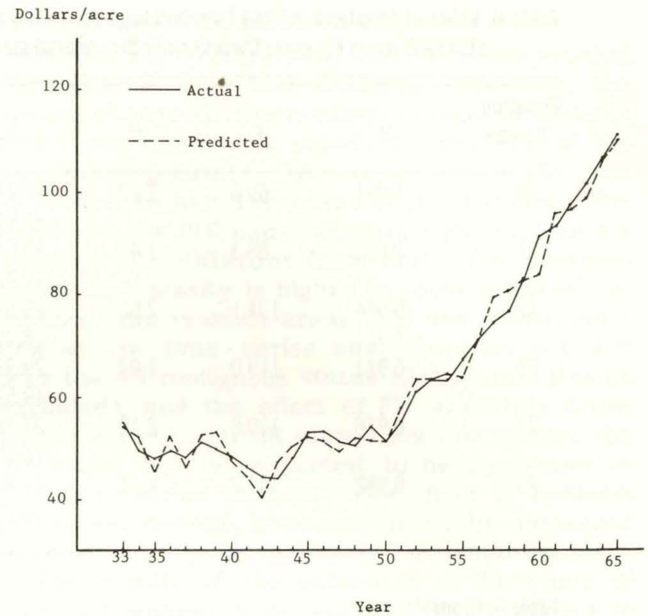

Fig. 4. Actual and predicted value of farmland without farm buildings for the United States, 1933-1965 (equation 25).

Equation 13 can be substituted into equation 19 to obtain the reduced-form coefficients for farmland value. Since dummy variables are used in both equation 13 and equation 19, the reduced form equation is written differently for 4 time periods. The reduced form equation is written as follows for 1933 to 1941:

$V_1 = 75.57 + 11.97\ GPL + 7.55\ CP - 0.32\ Cg + 1.15\ A + 0.73\ 1/r + 2.02\ NFI + 1.69\ D/E - 3.16\ La - 0.36\ E(F/NF)$

for 1942 to 1947:

$V_1 = 68.29 + 11.97\ GPL + 7.55\ CP + 1.25\ Cg + 1.15\ A + 0.73\ 1/r + 2.02\ NFI + 1.69\ D/E - 3.16\ La - 0.36\ E(F/NF)$

for 1948 to 1955:

$V_1 = 75.57 + 11.97\ GPL + 7.55\ CP + 1.25\ Cg + 1.15\ A + 0.73\ 1/r + 2.02\ NFI + 1.69\ D/E - 3.16\ La - 0.36\ E(F/NF)$

for 1956 to 1965:

$V_1 = 75.57 + 11.97\ GPL + 7.55\ CP + 1.25\ Cg + 1.15\ A + 0.73\ 1/r + 2.25\ NFI + 1.69\ D/E - 3.16\ La - 0.36\ E(F/NF)$

The GPL coefficient indicates that, with a $1-per-acre increase in government payments for land diversion, we would expect farmland value to increase $11.97 per acre. That the CP coefficient is much smaller than the GPL coefficient supports our hypothesis that the two types of government payments would have a different impact on farmland value. Under the terms of the conservation program, the conservation practice is a cost-sharing project between the landowner and the government. Therefore, CP represents partial reimbursement to the landowner for the cost of the conservation practice and is not an income payment. However, it does affect the landowner's income since it reduces his cost of the conservation practice. We would expect, therefore, CP to have a smaller impact than GPL on farmland value.

The reduced-form Cg coefficient consists of two parts: a) the effect of Cg on V_1 (the direct effect on V_1) and b) the effect of Cg on T (the indirect effect on V_1). The direct effect of Cg on V_1 is positive. The indirect effect of Cg on V_1 is negative since the Cg coefficient in the T equation is multiplied by -0.23 (the coefficient of $\hat{T}$) to find its effect on V_1. The net effect (combined direct and indirect effects) is -0.32 for 1933 to 1941. The net effect of Cg on farmland value for 1942 to 1964 is 1.25.

The farm-enlargement variable also has a direct and indirect effect on farmland value. Both effects are positive. The reduced-form coefficient of A indicates that a 1-acre increase in the average farm size would be expected to increase the average value of farmland by $1.15.

The rate of return on common stock (r) is used to reflect the capitalization rate. The elasticity of farmland value with respect to 1/r computed at the mean is 0.196, indicating that, with a 10-percent increase in 1/r, the value of farmland increases about 2 percent.

The coefficient on net farm income indicates that, with a $1-per-acre increase in net farm income, we would expect an increase in the value of farmland of $2.02 during 1933 to 1955. The coefficient for 1956 to 1965 suggests that a larger share of net farm income was being allocated to land than during the period before 1956.

The coefficient on the debt-to-equity ratio indicates that an increase of 1 percent in D/E is associated with a $1.69 increase in farmland value. That is, as D/E increases, a less-favorable debt position is reflected. As the debt position becomes less favorable, credit restraints tend to increase, and this would have the effect of reducing the number of voluntary transfers. A decrease in the number of voluntary transfers of farmland has a positive effect on farmland value.

The elasticity of farmland value with respect to La is -0.51 (computed at the mean). With a 10-percent decrease in La (an increase in the level of technology), farmland value increases 5.1 percent. A 1-percent increase in E(F/NF) is associated with a decrease of 0.36 cents in farmland value. As the E(F/NF) increases, the activity in the farmland market increases, resulting in more farms being transferred, and an increase in T has a negative effect on farmland value.

The reduced-form coefficients for the value of farmland without farm buildings would be computed by substituting equation 13 into equation 25. A discussion of the size of the reduced-form coefficients in the V_2 equation relative to the size of the reduced-form coefficients in the V_1 equation would be parallel to our comparison of the coefficients of equations 19 and 25. That is, the GPL and A coefficients are larger in the V_2 equations than in the V_1 equations, and so on. The reduced-form coefficients for the V_2 equations are not reported here.

Cross-sectional Analysis

This section consists of an analysis of cross-sectional data. Because of the problems that often arise in time-series analysis (e.g., autocorrelation and multicollinearity), the cross-sectional analysis is presented here as an alternative approach to the study of farmland values in the United States. The regression coefficients obtained from time-series data, however, will not be directly comparable to coefficients obtained from cross-sectional data. Cross-sectionally derived estimates will reflect long-run adjustments, whereas the time-series estimates will tend to reflect shorter-run reactions (21, p. 208). The size of the coefficients in the cross-sectional analysis is not the primary concern of this analysis. Instead, the cross-sectional analysis is included to determine what factors are significant in explaining farmland value among different areas of the country. These effects cannot be detected in the national time-series analysis.

In the cross-sectional analysis, an attempt was made to fit the recursive model used in the time-series analysis to determine if the same variables were significant in explaining the variation in farmland value among the states. Since the unit of observation was changed, a few variables are not applicable in the same form as they were used in the time-series analysis. The use of the number of voluntary transfers presents a problem since the size and number of farms in each state are quite heterogeneous. For example, 600 transfers would represent a very active market in Rhode Island (50 percent of the total number of farms), but it would represent a very inactive market in Iowa (less than 0.5 percent of the farms). In the time-series analysis, these differences did not appear because the unit of observation was an average over 48 states. The number of voluntary transfers per 1,000 farms (Tv) will be used in the cross-sectional analysis to reflect the activity (quantity transferred in relation to total quantity) in the farmland market.

The use of La presents a similar problem. Because of the different types of agriculture from one state to another La (hours of labor per acre) is not a very good variable to reflect the level of technology. A state with an intensive agriculture would have more hours of labor per acre than a state with an extensive agriculture. Therefore, the change in the hours of labor per acre (La') is used to reflect technology.

The data for two variables used in the time-series analysis are not available by states. The farm-mortgage interest rate will be used as a substitute for r to reflect the capitalization rate. The farm-mortgage interest rate is available only by regions. Equity data are not available by states, making it impossible to compute D/E. D/V_1 was substituted for D/E in the cross-sectional analysis because the correlation between these two variables was 0.94 in the time-series data.

Data were available for the variables (with the exceptions and substitutions just listed) of the recursive model for 1959 and 1954. Data for periods before these years became a problem, and so estimation of the recursive model was only attempted for the years 1959 and 1954. Only farmland value was estimated for 1940 and 1950.

The observation units for the cross-sectional analysis are for the 48 contiguous states (Alaska and Hawaii excluded). Each unit is the state average for each variable.

The estimates of the number of voluntary transfers of farmland per 1,000 farms for the cross-sectional analysis are reported in equations 26-59 to 27-54 in table 7. All equations reported in the cross-sectional analysis were estimated on original values of the data. The equation numbers are followed by 59 equations estimated for 1959 or by 54 for equations estimated for 1954. The remainder of the table follows the format used in reporting the time - series results.

The positive sign on D/V_1 indicates that, in the states where the ratio of debt to farmland value is high, there was a high rate of voluntary transfers of farmland. In the time - series analysis, we were observing how the D/E changed over time and how this variable reflected the changing debt position and its relation to the number of voluntary transfers (not the rate of transfers). In the cross - sectional analysis, however, we are observing a point in time. It appears that D/V_1 reflects credit availability among the states. That is, when D/V_1 is high, it reflects a higher availability of credit, and this is associated with a higher rate of voluntary transfers.

A positive sign on the coefficient of La' is consistent with the hypothesis that an increase in technology will be associated with a decline in the rate of voluntary transfers. A decline in La has been used in this study to reflect a technology increase. Since La' is the change in La, a negative value for La' results when La declines (technology increases). Therefore, a positive coefficient multiplied by a negative value for La' results in a negative effect on the rate of voluntary transfers. The negative sign attached to the 1959 La' coefficient is the opposite of that expected.

The ratio of farm to nonfarm earnings has a positive effect on the rate of transfers. The Cg coefficient is also positive, indicating that an increase in the rate of voluntary transfers is associated with an increase in Cg.

The positive sign on A indicates that associated with an increase in the average farm size is an increase in the rate of voluntary transfers. As farm enlargement occurs, the number of farms declines. The positive sign on the A coefficient indicates that, with an increase in A, one of two things may be happening to result in an increase in the rate of transfers: 1) the number of voluntary transfers is increasing and the number of farms declining or 2) the number of voluntary transfers and the number of farms are both declining, but the number of voluntary transfers is declining slower than the number of farms.

Equations 26- 59 and 26 - 54 represent the estimates of the rate of voluntary transfers for the recursive model. The ratio of debt to farmland value, the ratio of farm to nonfarm earnings, the change in the average farm size and expected capital gains were significant in explaining the rate of transfers in 1959. The expected capital gains variable was not significant in the 1954 equation.

In equations 27 - 59 and 27 - 54, dummy intercepts are added for the Northern Plains and Pacific regions. The Northern Plains consist of North Dakota, South Dakota, Nebraska and Kansas; and Washington, Oregon and California form the Pacific region. The intercept for the Pacific region was significant in both 1959 and 1954, but the Northern Plains intercept was significant only in 1959. The coefficient on the expected capital gains variable is not significant when these dummy intercepts, b_{np} and b_{pac}, are included in the equation.

Equations 27-59 and 27-54, the cross-sectional counterparts for equation 13 in the time-series analysis, were selected to represent the rate of voluntary transfers in the recursive model. The number of voluntary transfers per 1,000 farms,

Table 7. Voluntary transfers of farmland per 1,000 farms (Tv) estimated by least squares using state data for 48 states for 1959 and 1954, coefficients, standard errors (in parentheses) and other related statistics.

Equation number[a]	R^2	F	b_o	b_{np}	b_{pac}	D/V_1	D	La'	F/NF	A	Cg
26-59	0.580	11.6	-3.63			2.18**		-0.61	0.23**	0.11*	0.40*
			(6.51)			(0.51)		(2.16)	(0.07)	(0.05)	(0.18)
26-54	0.439	6.6	13.14*			1.37**		0.20	0.13#	0.06#	0.03
			(5.00)			(0.34)		(1.03)	(0.07)	(0.03)	(0.29)
27-59	0.712	14.1	2.72	-8.17#	16.51**	1.62**		-2.28	0.23**	0.10*	0.24
			(6.08)	(4.63)	(4.39)	(0.49)		(1.95)	(0.06)	(0.04)	(0.17)
27-54	0.682	12.3	17.83**	-3.95	18.89**	0.99**		0.53	0.10#	0.06**	0.01
			(4.19)	(3.43)	(3.51)	(0.30)		(0.81)	(0.05)	(0.02)	(0.23)

a Equations denoted -59 = equations for 1959, those denoted -54 = equations for 1954.
# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

as predicted by equation 27-59, is used as an independent variable in estimating the value of farmland for 1959. Similarly, the number of voluntary transfers per 1,000 farms as predicted by equation 27-54 is used as an explanatory variable in estimating the value of farmland for 1954.

In table 8, the coefficients for the estimated number of voluntary transfers per 1,000 farms has the expected negative sign except in equation 28-54. When dummy intercepts for the Northeast

Table 8. Value of farmland (V_1) estimated by least squares using state data for 48 states for 1959 and 1954, coefficients, standard errors (in parentheses) and other related statistics.

Equation number[a]	R^2	F	b_o	b_{nc}	b_{cb}	b_{pac}	$\hat{T}v$
28-59	0.940	88.8	-123.93				-0.46
			(101.08)				(0.72)
28-54	0.903	63.8	-271.05**				0.40
			(80.77)				(0.60)
29-59	0.950	70.3	-49.76	20.45	22.57	68.05**	-1.76#
			(116.29)	(18.34)	(18.99)	(26.35)	(0.89)
29-54	0.931	66.1	-143.78#	13.19	48.64**		-0.24
			(77.67)	(9.57)	(12.19)		(0.53)
30-59	0.946	100.7	36.51	25.03	32.99*	70.28**	-1.63*
			(22.86)	(15.10)	(16.37)	(26.18)	(0.79)
30-54	0.922	67.7	26.91	18.52#	61.01**		-0.15
			(21.89)	(9.76)	(11.47)		(0.53)
31-59	0.973	247.8	15.56*	-22.69*	41.06**	46.30**	
			(6.00)	(11.00)	(11.42)	(13.84)	
31-54	0.935	121.8	15.43**	-1.68	61.61**		
			(5.52)	(9.86)	(10.09)		

Table 8. (Cont'd).

Equation number[a]	GPL	CP	Cg	A	I/i	NFI	PD	OFW
28-59	-45.16	10.59	5.85**	0.05	7.25#	7.11**		
	(34.08)	(64.43)	(1.26)	(0.20)	(4.23)	(1.06)		
28-54		-6.36	0.61	-0.12	12.61**	5.28**		
		(60.67)	(1.06)	(0.12)	(3.21)	(0.46)		
29-59	-37.44	-0.22	6.10**	0.36	5.05	6.91**		
	(32.81)	(75.56)	(1.20)	(0.22)	(4.80)	(1.01)		
29-54		-48.83	0.55	-0.11	7.10*	5.13**		
		(54.34)	(0.92)	(0.11)	(3.11)	(0.41)		
30-59			6.30**	0.44*		6.59**		
			(1.17)	(0.21)		(0.91)		
30-54		-90.53#	0.40	-0.11		5.22**		
		(53.79)	(0.96)	(0.11)		(0.43)		
31-59			4.21**			4.63**	0.26**	
			(0.81)			(0.68)	(0.04)	
31-54			0.91			3.72**	0.12**	
			(0.87)			(0.44)	(0.03)	

a Equations denoted -59 = equations for 1959, those denoted -54 = equations for 1954.
\# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

and Corn Belt are added to the 1954 equation (equation 29-54), the $\hat{T}v$ coefficient has the expected negative sign.

The negative sign on the GPL coefficient indicates that the states receiving high government payments for land diversion generally are those states that do not have high farmland values. For example, of the states receiving above-average government payments for land diversion, less than 25 percent had above-average farmland values. The negative sign on the CP coefficient evidently indicates that conservation payments are made on the less productive (lower value) farmland. The expected capital gains variable has the expected positive sign.

The negative coefficient on A in the 1954 equations implies that a lower level of farmland values is associated with the larger increases in A. It appears that the negative coefficient resulted because the Mountain and Southern Plains states (where there are many large ranches) had the largest increases in the average farm size and also have a lower level of farmland values. The more intensively farmed areas (where farmland values are higher) had smaller increases in the average farm size. Although A was negatively correlated with farmland value at about the same level in 1959 as in 1954, A had a positive coefficient in the 1959 equations. It was suspected that the correlation between Cg and NFI might be causing the positive sign. To check this, Cg was deleted from the equation, but the results were similar to those before Cg was deleted from the equation. If the effect of farm enlargement on farmland value is to be tested in the cross-sectional analysis, it appears that the rate of change in the level of farmland values should be regressed on the rate of change in the average farm size. This cross-sectional analysis of the level of farmland values is not adequate to test this hypothesis.

The farm-mortgage interest rate is used as a proxy variable for the capitalization rate. The coefficient on 1/i and NFI have the expected positive signs. The positive sign on PD indicates that a higher population density is associated with a higher farmland value. This is consistent with our hypothesis that the demand for land for non-agricultural uses will have a positive effect on farmland value.

Equations 28-59 and 28-54 represent estimates of farmland value for the hypothesized recursive model. Net farm income (NFI) and 1/i were significant in explaining the variation in farmland value. The expected capital-gains variable was also significant in the 1959 equation.

In equation 29-59, dummy intercepts are added for the Northeast, Corn Belt and Pacific. The Northeast consists of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware and Maryland; the Corn Belt includes Ohio, Indiana, Illinois, Iowa and Missouri, and Washington, Oregon and California form the Pacific region. The coefficient on 1/i is not significant when these dummy intercepts are added. Evidently it was picking up some of the regional effects previously. The $\hat{T}v$ coefficient is significant at the 10-percent level. In equation 29-54, dummy intercepts were added for the Northeast and Corn Belt. With the addition of these dummy intercepts, the effect of 1/i is reduced and the $\hat{T}v$ coefficient acquires the expected negative sign.

The deletion of 1/i, GPL and CP in equation 30-59 resulted in little loss in the explanatory power of the equation. In equation 30-54, 1/i is deleted.

PD was added to equations 30-59 and 30-54. The only variables significant with the addition of PD were Cg, NFI and PD. The equation was reformulated to contain only these variables and dummy intercepts. Equations 31-59 and 31-54 report the results of this formulation of the equation. In 1959, expected capital gains, net farm income and population density explained 97.3 percent of the variation of the value of farmland among the states. In 1954, these variables explained 93.5 percent of the variation.

The estimates of the value of farmland without farm buildings are reported in table 9. The only explanatory variable significant in explaining V_2 in both 1959 and 1954 was expected net farm income. The expected capital gains variable was highly significant in the 1959 equations. The rate of voluntary transfers of farmland was not a significant variable in the equations explaining the value of farmland without farm buildings. When farmland value is adjusted for farm buildings, the GPL coefficient has a positive sign.

The coefficient of the population density variable is not significant in explaining the value of farmland without farm buildings. The coefficient is much smaller in the V_2 equations, indicating that it has a much smaller effect on the value of farmland without farm buildings than it does on the value of farmland with buildings. The time-series analysis produced similar results.

The estimates of farmland value for 1950 and 1940 are presented in equations 36-50 to 39-40 in table 10. The signs of the coefficients are in the direction of those in the equations for 1959 and 1954 except for Cg in the 1940 equations. Many of the states had declining farmland values during 1937 to 1939, and as a result, the computed Cg for these states indicated negative expected capital gains in 1940. The coefficient is small in relation to the size of the standard error.

Table 9. Values of farmland without buildings (V_2) estimated by least squares using state data for 48 states for 1959 and 1954, coefficients, standard errors (in parentheses) and other related statistics.

Equation number[a]	R^2	F	b_o	b_{nc}	b_{cb}	b_{pac}	$\hat{T}$
32-59	0.852	33.0	32.23				-0.45
			(89.34)				(0.63)
32-54	0.745	20.0	158.21*				0.32
			(75.30)				(0.56)
33-59	0.944	61.8	64.09	-18.32	49.10**	63.43**	-0.84
			(69.87)	(11.02)	(11.41)	(15.83)	(0.53)
33-54	0.871	33.0	-78.51	-16.17*	44.40**		0.53
			(61.02)	(7.52)	(9.57)		(0.42)
34-59	0.940	88.9	29.94*	-25.78**	47.47**	64.95**	-0.54
			(13.71)	(9.05)	(9.80)	(15.69)	(0.47)
34-54	0.863	35.9	17.81	-13.16#	51.38**		-0.31
			(16.70)	(7.45)	(8.75)		(0.41)
35-59	0.939	104.4	16.73**	-33.10**	48.93**	54.59**	
			(5.12)	(9.41)	(9.76)	(11.84)	
35-54	0.845	45.9	15.95**	-18.68*	50.23**		
			(4.91)	(8.76)	(8.98)		

Table 9. (Cont'd).

Equation number[a]	GPL	CP	Cg	A	I/i	NFI	PD	OFW
32-59	2.30	-134.55*	5.50**	-0.18	1.53	2.75**		
	(30.12)	(56.95)	(1.12)	(0.17)	(3.73)	(0.94)		
32-54		-41.11	1.02	-0.16	8.16**	2.73**		
		(56.55)	(0.99)	(0.11)	(2.99)	(0.43)		
33-59	0.53	-64.27	5.57**	0.06	-0.63	2.63**		
	(19.71)	(45.40)	(0.72)	(0.13)	(2.89)	(0.61)		
33-54		-50.06	0.84	-0.16#	4.01	2.92**		
		(42.69)	(0.72)	(0.08)	(2.45)	(0.32)		
34-59			5.57**	0.09		2.30**		
			(0.70)	(0.13)		(0.55)		
34-54		-73.59#	0.75	-0.16#		2.97**		
		(41.04)	(0.73)	(0.08)		(0.33)		
35-59			5.21**			2.19**	0.03	
			(0.70)			(0.58)	(0.03)	
35-54			0.63			2.46**	0.03	
			(0.77)			(0.39)	(0.03)	

a Equations denoted -59 = equations for 1959, those denoted -54 = equations for 1954.
\# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

Data on net farm income for 1937 to 1939 were not available by states. Gross farm income (GFI) was used as a substitute to compute an expected income variable for 1940. The coefficient for GFI would be expected to be smaller than the coefficient on NFI. GFI has the expected positive sign.

In equations 36 - 50 and 36 - 40, conservation payments, expected capital gains, the inverse of the farm mortgage interest rate, expected income and change in the average farm size are used to explain farmland value. In equations 37 - 50 and 37 - 40, dummy intercepts for the Corn Belt and the Pacific are added. These variables explain about 90 percent of the variation in farmland value.

The population density of the nonfarm population was added as an explanatory variable. NFI, GFI and PD were significant variables in these formu – lations. Equations 39 - 50 and 39 - 40 report the results when CP, 1/i and Cg are deleted. The PD coefficient is not significantly different from zero in the 1940 equation.

Equation 38 - 50 was estimated so that a comparison of the NFI and PD coefficients could be made with those in equations 31 - 59 and 31 - 54 (table 8). The NFI coefficient was 3.56 in 1950, 3.72 in 1954 and 4.63 in 1959. This increase in the NFI coefficient over time gives support to the hypothesis that a larger portion of expected net farm income is being allocated to land. The comparison could not be extended to the 1940 equations since net farm income data were not available for that period and the GFI coefficient would not be comparable to the NFI coefficient. Comparison of the PD coefficient from 1950 to 1959 indicates that the effect of the density of the nonfarm population has increased over time.

Table 10. Value of farmland (V_1) estimated by least squares using state data for 48 states for 1950 and 1940, coefficients, standard errors (in parentheses) and other related statistics.

Equation number[a]	R^2	F	b_o	b_{cb}	b_{pac}	CP	Cg	A	l/i	NFI	GFI	PD	OFW
36-50	0.867	54.7	-48.39			-123.43*	3.52#	-0.10	3.38	5.56**			
			(75.93)			(57.59)	(1.93)	(0.13)	(3.43)	(0.55)			
36-40	0.906	80.8	-66.03			-3.13	-0.16	-0.02	3.64		3.81**		
			(48.08)			(10.90)	(2.52)	(0.08)	(2.54)		(0.20)		
37-50	0.896	49.0	11.17	31.42*	34.28*	-99.78#	3.81*	-0.03	0.10	5.25**			
			(76.60)	(13.03)	(15.72)	(55.91)	(1.79)	(0.12)	(3.46)	(0.53)			
37-40	0.909	56.9	-56.41	7.21	4.78	-4.50	-0.47	-0.02	3.13		3.79**		
			(59.92)	(8.15)	(9.42)	(11.06)	(2.73)	(0.08)	(3.11)		(0.21)		
38-50	0.899	74.6	9.57	41.37**	44.52**		1.84			3.56**		0.09*	
			(7.16)	(11.66)	(13.96)		(1.51)			(0.54)		(0.04)	
39-50	0.895	91.9	13.60*	47.19**	39.10**					3.76**		0.11**	
			(6.38)	(10.70)	(13.31)					(0.52)		(0.04)	
39-40	0.909	107.2	5.08	11.64#	4.80						3.23**	0.04	
			(3.57)	(6.41)	(8.19)						(0.48)	(0.03)	

a Equations denoted -50 = equations for 1950, those denoted -40 = equations for 1940.
# Indicates significance at the 10% level.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

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