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Predicting future farm labor in Iowa for small geographical areas

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INTRODUCTION

Age cohort analysis is a method to predict future farm employment. With this method, one is able to use agricultural census data to study occupational mobility and the characteristics of the post-war farm labor market. Many factors affect occupational mobility including age, education, skills, geographical location and job opportunities.

An example of this can be seen in Nassau County, New York. At the close of World War II, the county was primarily a farming community. As time went on it became harder and harder to make a good living by farming. There was also a shortage of housing and developers were buying land to build houses. Many farmers sold their farms. Many of these original owners were old and could retire. However, their sons, who also worked on the farms, were forced to find other occupations. Many found jobs as construction workers, truck drivers, and laborers in land related industries such as landscaping. The sons of the original landowners changed their occupations in response to the new job opportunities that became available. As the houses were finished other services such as schools and shopping areas were needed. These services increased the demand for non-agricultural labor with the result that more and more people left agriculture.

This example shows us that declines in the demand for agricultural labor may be accompanied by increased demands for non-agricultural labor as the character of a region changes. Not all regions, however, have as easy a time adjusting to change as did the people in Nassau County. In some declining regions, there are no new job opportunities available for the underemployed (or unemployed) farmer or farm laborer. In this situation unless new jobs are created by the arrival of a new industry or some other exogenous force the only recourse may be to move people out of the depressed region. Various factors enter into the determination of the rate of labor mobility. One of these factors is age. The present study shows us one way of looking at the ages of farm laborers and estimating the number that might want to seek other occupations.

Age cohort analysis information disaggregates census data into age cohorts to study the replacement rate of older farmers by younger farmers. The overall decrease we observe in the total number of farmers since World War II is the result of a modification in the process of retirement and replacement because of a decrease in the rate of entry and/or an increase in the rate of leaving.[1] The rates of entering and leaving

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[1] Don Kanel, "Age Components of Decrease in the Number of Farmers, North Central United States, 1890-1954," J. of Farm Economics, 43 (May, 1961 , 247).

agriculture are changing because of the increased size of farms, increased nonagricultural incomes and increased competition in bidding for resources.

A cohort is a group of people (in this case, farmers) born in the same time period. This period is ten years since the Census of Agriculture gives information about the ages of farmers in ten year time periods i.e., farmers 25-34 years of age. The cohort has two dimensions: (1) size and (2) pattern. The size of the cohort is measured at its maximum point 35-44 years of age. The cohorts that entered farming in 1910, 1920 and 1930 were all large. These cohorts are being replaced by successively smaller cohorts. This is a reflection of the decreasing rate of entry into agriculture.

The study of cohort size and pattern can lead to a simple estimate of the number of new farmers who are replacing the older generation. This method of analysis will be used to predict future farm employment on a state level for 1969. The year 1969 was used since the more recent census data is not available at the time this is being written. This knowledge can then be applied to predict further farm consolidation and to help determine future manpower policies. By predicting future farm consolidation we also predict future underemployment (or unemployment) of agricultural labor. In keeping with the policy goals expressed in the Emergency Employment Act of 1971,[2]

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[2]Emergency Employment Act of 1971, P.L. 92-54.

we expect that manpower policies should be adopted today which will result in retraining programs for farmers and farm laborers who we estimate will become unemployed in the near future.

CHAPTER I.   REVIEW OF LITERATURE

Age cohort analysis has been used to predict future farm employment by Don Kanel on the North Central United States, by Brian B. Perkins on Canada, and by Robert Crown on the Province of Ontario. These studies predict farm employment for different types of regions. Don Kanel tested age cohort analysis on a region of thirteen states. Since there is no government agency at this level, the North Central United States is not the type of region that may conveniently be used as a base for planning. The studies by Perkins and Crown are over large geographic areas combined within governmental units, but these areas are so large that specific problems of small regions within Canada or Ontario cannot be isolated and studied. These studies demonstrate that age cohort analysis may be used meaningfully in formulating agricultural policies for large areas.[3] The object of my study is to apply this method of analysis to small regions and to study the functioning of the farm labor market for the purpose of planning.

Farm Markets

Capital, land, labor and management are the factors of production in agriculture. We shall assume that the farmer

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[3]Robert Crown, "Forecasting Farm Labor Employment in Ontario to 1981" (unpublished M.S. thesis, University of Guelph, 1967), p. 57.

combines the factors of production in such a way as to maximize his output, thereby maximizing his income. In short, we assume farmers act rationally, maximize profits, and prefer more to less. Both output and income can be maximized by applying maximization techniques to the following three relationships: (1) factor-product relationships, (2) factor-factor relationships, and (3) product-product relationships. In the factor-product case (or alternatively the input-output relationship) resources must be combined so that no greater amount of final output can be produced from the same collection of inputs or that the same output cannot be produced with fewer inputs. Price relationships can be used to find the maximum profits for the farm.[4] This relationship is specified by the following equation:

$$P_x/P_y = \Delta Y/\Delta X \tag{1}$$

where P_x is equal to the price of factor X, P_y is equal to the price of product Y, and $\Delta Y/\Delta X$ denotes the change in output of Y for each one unit change in the input of X, i.e., the marginal product of each unit of resources.[5]

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[4]Earl O. Heady, Economics of Agricultural Production and Resource Use (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1952), pp. 95-96.

[5]Ibid., p. 99.

The factor-factor relationship determines the profit max-imizing combination of resources which also maximizes output. Resources are hired by equating the price ratio with the marginal rate of substitution and extending production until the product price ratio is equal to the marginal product of the factors of production.[6]

Equilibrium is defined in Equation 2.

$$\frac{MP_c}{MP_L} = \frac{P_c}{P_L} \; . \tag{2}$$

c and L are factors used in the production of a product. P_c is the price of factor c, and P_L is the price of factor L. MP is the marginal product of each factor, i.e., MP_c is equal to $\Delta Y/\Delta c$, etc.[7]

The product-product relationship describes the mix of products produced. To the individual farmer, the product mix represents the problem of how much and what to produce. To maximize farm profits the marginal rate of product substitution is inversely equal to the product price ratio with resources fixed.

$$Y_1/Y_2 = P_{Y_2}/P_{Y_1} \tag{3}$$

Y_1 and Y_2 are final products.[8]

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[6] Ibid., p. 196.

[7] Ibid., p. 196.

[8] Ibid., p. 240.

The farm should be organized so that the following conditions are fulfilled.

$$\frac{MP_L}{P_L} = \frac{MP_c}{P_c} = \frac{MP_m}{P_m} = \frac{MP_1}{P_1} \text{ and } \frac{Y_1}{Y_2} = \frac{P_{Y_2}}{P_{Y_1}} . \tag{4}$$

m = management; L = labor; c = capital; 1 - land.

New technology can change the relationship between the product and the factors of production, between factors, and between products. Since World War II, farmers are using more and more new technological developments. Some technology is neutral and does not change any of the basic relationships, but most of the technology introduced into agriculture has been labor-saving and consequently has changed the marginal rates of substitution for the factors capital and labor. This kind of change forced labor to leave agriculture as less and less labor was needed.

The migration out of agriculture since 1940 has been great. The chances are that in the future it will be even greater.[9] D. Gale Johnson states that in the years between 1940 and 1956 labor migration out of agriculture showed a thirty percent reduction in farm employment. If this rate of

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[9]D. Gale Johnson, "Labor Mobility and Agricultural Adjustment," in Agricultural Adjustment Problems in a Growing Economy, ed. by Earl O. Heady and others (Ames, Iowa: Iowa State University Press, 1958), p. 168.

migration were to continue, it would imply that farm employ-
ment might show another thirty percent decline by 1975.
According to Johnson, changes in the age distribution of the
farm population in the mid-fifties indicated both increased
retirement from agriculture, and decreased rate of entrance
into this field.[10] In another study, Dr. Earl Heady found
that there was more than a thirty percent decrease in the farm
labor force from 1930 to 1960, where farm labor was defined as
including all people actively employed in farm operations. He
states that the increase in output has taken place due to
changes in technology, and that these changes have led to
considerable underemployment of labor resources.[11]

Much of the literature from the late fifties and early
sixties deals with adjustments within agriculture. There is
little information about the characteristics and circumstances
of the people who left agriculture. Brian B. Perkin's[12] study,
Labor Mobility between the Farm and the Non-farm Sector, is
one which is an exception. He uses Social Security data to
study occupational mobility. Some of his results are presented

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[10]Ibid., p. 169.

[11]Earl O. Heady, and others, eds., Agricultural Adjustment
Problems in a Growing Economy (Ames, Iowa: Iowa State
University Press, 1958), p. 146.

[12]Brian B. Perkins, "Labor Mobility between the Farm and
the Non-farm Sector" (unpublished Ph.D. dissertation,
University of Michigan, 1964), p. 30.

in the following paragraphs. His method, however, has one serious drawback. Social Security data is expensive to obtain and use. Cohort analysis, on the other hand, does not provide as much information as Social Security data, but it uses census data which is readily and inexpensively available.

As relative price ratios of resources have changed, less efficient labor resources have been forced to leave agriculture. Leaving is not always easy, but as farm incomes decline over a long period of time, some farmers have been forced to look toward the non-farm sector to supplement their income. Initially, multiple-job holding was looked upon as a compromise for those farmers being forced from agriculture by falling farm prices. People enter farming for many reasons,[13] only one of which is income. Since, for a farmer, a job outside the farm sector does not have the same desirable characteristics as farming, multiple-job holding is often viewed as a compromise and not an alternative. It is the best of two worlds, in the sense that the farmer has both increased income and still works part-time on the farm. Ironically, multiple-job holding often leads to total employment in the non-farm sector partly due to the farmer's own change of attitude toward non-

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[13] Donald Kaldor, and others, Occupational Plans of Iowa Farm Boys (Iowa Agr. and Home Ec. Expt. Sta. Res. Bul. 508, 1962), p. 614).

farm work and partly due to his greater knowledge of opportunities in the non-farm labor market.[14] Non-owner farm labor has experienced a similar pattern of migration.

Most farm laborers are not tied to the farm on a year-round basis. They tend to hold several short-term jobs within the same year. The instability of farm work to the laborer is the main reason why his rate of mobility is significantly different from the farm operator.

Age is also an important factor in mobility. Studies have shown that changes in residence and employment have an inverse relationship.[15] The longer people work and live in one place, the less they want to change jobs and move. There are several explanations for this decreased mobility as people become older. One reason for the relatively low occupational mobility of older people is that their education is often of a lower quality than younger people. Any formal training they may have received is probably obsolete. Another factor is simply age--it is sometimes more difficult for the older person to adapt to new technologies. Farmers are no exception to this pattern. For farmers, as for the rest of the population, mobility is restricted as they grow older. Farmers over

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[14]Ibid., p. 30.

[15]Brian B. Perkins, Movement of Labor between Farm and Non-farm Jobs (Michigan State University State Agricultural Experiment Station, Res. Bul. 13), p. 17.

thirty-five often find that sentimental attachment to homes

and the farm as well as a shortage of transferable skills

impede their locational and occupational mobility.

Perkins has found that younger people have a greater

potential mobility than older people. This is also true for

young farmers. Some reasons advanced for this are (1) training

is more economical for younger people; (2) young people fit

more easily into pension plans; (3) the younger man has fewer

sentimental ties to the farm. According to a study by Brian

Perkins, farmers 15-24 have more mobility than farmers 25-34;

farmers 25-34 have more mobility than farmers 35-44; and after

age 45 mobility is insignificant.[16] Perkins found that farm

operators took jobs primarily in non-farm agriculture,

forestry, fisheries, construction, wholesale and retail trades[17]

trades.[17] These occupations are similar to farming in that

the work is done outside for the most part.

The effect of age and how it affects mobility out of

agriculture were studied by Perkins. Don Kanel got similar

results when he used age cohort analysis to study labor

mobility over a thirteen state region.[18] One of the purposes

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[16]Ibid., p. 22.

[17]Ibid., p. 27.

[18]Kanel, "Age Components of Decrease in the Number of
Farmers," p. 247.

of this paper is to see if age cohort analysis can be applied to smaller regions (Iowa) and still give us the same mobility age effects that Perkins found for larger regions. If this is not true, then this fact must be accounted for in future planning.

Simultaneous Equation Model

The simultaneous equation model developed here was used by Robert Crown in his study of Ontario[19] to test the hypothesis that the decision to leave agriculture is based on opportunity costs to the farmer and to estimate farm labor requirements in the future. This model provides a means to check the results of the cohort model and can be used in conjunction with cohort analysis. By estimating the coefficients and solving for values at particular time periods, a set of estimates for labor needs can be found and then these could be compared to the cohort model. I started to estimate these coefficients, but found it difficult to get enough data in the same series to successfully estimate the coefficients. Around the period of World War II the data was not always consistent. Thus when the coefficients were estimated, some of the variables were not significant. This is a result of the data used and not of the model. Therefore, the results of the estimates I made for Iowa are not presented.

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[19]Crown, "Forecasting Farm Labor," pp. 32-45.

The Model

Persons employed in agriculture are either farm operators, hired labor, or unpaid family labor. Each type of labor decides to work or not work for different reasons. For example, a decrease in the price of agricultural products might cause a farm laborer to be laid-off entirely, while the farmer might work off the farm part of the time. Generally the farm operator will remain in agriculture as long as the opportunity costs of staying are less than his income. If there is a small decrease in income, the farmer will tend to remain in agriculture since his assets have little value outside the farm sector. If a farmer moves he does so with the expectation of increasing his current and his long run or "permanent" income. A farmer's expectations of employment in the non-farm sector will be based on his experience in the non-farm labor market and upon what other people tell him about it. As a short-run adjustment, a farmer will try to increase his income by multiple-job holding. Multiple-job holding increases the farmer's knowledge of the job market, increases his experience in the non-farm labor market, and somewhat reduces the psychic costs of migration.[20] Multiple-job holding and off-the-farm

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[20]Brian B. Perkins, "Labor Mobility between the Farm and Non-farm Sector" (unpublished Ph.D. dissertation, University of Michigan, 1964), p. 64.

migration can be accounted for in this model by converting actual employment of farm operators to man-year equivalents. This removes seasonal fluctuations, and shows the year to year changes in employment levels.

Returns from farming in the model are assumed to be reflected in real, realized net income, while implicit rent, value of home-grown food consumed, and returns to owner's equity are included in the net cash receipts from farming. Inventory changes are excluded due to lack of effect over discretionary spending. The income figures are divided by the number of man-years of family labor employed in the year to measure the average revenue productivity of family labor (operator labor and unpaid family labor). A three-year moving average of these statistics was calculated and lagged one year in regression. The lagged response allows for the slow reaction of family members to be reflected.

The real non-farm laborer's wage should be used to calculate the operator's off-farm labor expectations. This conclusion was based on the type of off-the-farm employment found by farmers. Construction, trucking, and unskilled factory employment provided about half of the off-farm employment. The farmer will calculate his future earning as the product of the probability of obtaining the job, and the wage rate. The best indicator of this uncertainty might be the unemployment rate among laborers. The probability of getting the

laborer's wage was calculated by one minus the unemployment rate among laborers in the state.

Operators' non-farm income expectations were calculated as the product of laborers' real wage rate, and the probability of getting the wage lagged one year. This reflects the known differences between farm returns and non-farm returns for some earlier period. It is also assumed that the farmer will continue to farm as a response to prevailing economic conditions.

Unpaid family labor

The amount of labor provided by the family depends on the number of farm families and off-the-farm returns to labor. The number of man-years of operator labor is used as a proxy for the number of farm families.

The calculation of farm returns to family labor is explained in relation to the farm operator. Since rural youth have growing aspirations and capabilities to compete for non-farm jobs, the hourly wage rate in manufacturing was used for calculating non-farm expectations. Expected income was calculated by multiplying the real hourly wage rate by the probability of getting that wage, that is by the employment rate of workers in manufacturing.

The demand for unpaid family labor is perfectly elastic. The supply of family labor depends on alternative opportunity and what can be done on the farm.

Hired labor

In the case of hired labor there are distinct supply and demand functions. The supply of labor is based on returns to labor in a given market. The demand for labor depends on the cost of relative factors of production and their substituti- bility. The main substitute for hired labor is machinery. This is measured by farm expenditures for machinery in a given year.

Non-farm expectations of hired labor are the same as operator labor because they have similar skills. However, these are not lagged a year since hired labor is not closely bound to the farm.

The Model

Equation five determines the number of man-years of farm operator labor that will be produced.

$$F_{o(t)} = a_1 + b_1 \overline{Y}_{(t-2)} + c_1 W'_{L(t-1)} + U_1 \tag{5}$$

$F_{o(t)}$ = 000's of man-years of farm operator labor employed in year t

$\overline{Y}_{(t-2)}$ = is a three year moving average of family income where

$$\overline{Y}_{(t-2)} = \frac{Y_{(t-1)} + Y_{(t-2)} + Y_{(t-3)}}{3}$$

where $Y_{(t)}$ = real realized net farm income of the farm operator and his family

$$W'_{L(t-1)} = W_{g(t)} \cdot (1 - w)$$

where $W_{g(t)}$ = hourly wage rate of laborers in Iowa

where W is the unemployment rate of laborers

U_1 = error term

Equation 6 predicts the amount of unpaid family labor that will be needed.

$$F_{u(t)} = a_2 + b_2 \bar{Y}_{(t-2)} + d_2 W'_{g(t-1)} + u_2 \qquad (6)$$

$F_{u(t)}$ = 000's of man-years of unpaid family labor employed in year t

$\bar{Y}_{(t-2)}$ = is the same as in Equation 5, where it is a three year moving average of family income

$$W'_{g(t-1)} = W_{g(t)} \cdot (1 - w)$$

where $W_{g(t)}$ = hourly manufacturing wage rate in Iowa,

where w is the unemployment rate in manufacturing

and 1 - w is the probability of getting the job

u_2 = error term

Equation 7 is the demand for hired workers which is based on the cost of relative factors and their substitutibility

$$W_{f(t)} = a_3 + b_3 \bar{Y}_{(t-2)} + c_3 f_{h(t)} + d_3 M_{(t)} + u_3 \qquad (7)$$

$\bar{Y}_{(t-2)}$ = is the same as in Equation 5, a three year moving average of the family income

$f_{h(t)}$ = 000's of man-years of hired labor employed in year t

$M_{(t)}$ = thousands of $ of farm expenditures for machinery

u_3 = the error term

$W_{f(t)}$ = the average daily wage in January, May and October

for agriculture.

Equation 8 is the supply equation for hired labor.

$$W_{f(t)} = a_4 + b_4 f_{h(t)} + c_4 W'_{L(t)} + u_4 \qquad (8)$$

$W_{f(t)}$ = the same as in Equation 7, the average daily wage in January, May and October for agriculture

$f_{h(t)}$ = the same as in Equation 7, 000's of man-hours hired in year t

$W'_{L(t)}$ = the same as in Equation 6, $W_{L(t)} \cdot (1 - w)$

u_4 = error term.

Land Consolidation

Along with changes in the use of labor there are also changes in the use of land. One of these changes in the use of land has been consolidation of land to make farming more profitable by extending production so that the marginal product of factors is equal. (This relationship is expressed in Equation 2). While farmers do not consider each decision in marginal terms, we shall assume that they act as if they do because each farmer will try to produce the most possible output given his resources. As technologies have changed, the

farmer has used more land, more equipment and more capital to maximize his output. The farmer has been replacing labor with land and capital to increase his profits. One reason for the change from labor to capital is that the relative cost of farm labor has risen faster than the relative cost of capital goods.[21] As output has increased, the relative costs of resources have changed, and the relationship between farm consolidation and farm employment has moved in opposite directions. During the period after World War II, the number of farms being consolidated increased at the same time that the number of farmers decreased.

In Iowa, existing farms are being enlarged and consolidated, thus decreasing the amount of farm employment. Moreover, the decrease in the number of farms and farm opportunities is taking place at an increasing rate.[22] Eber Eldridge says that "the number of farm jobs will decrease more in the next ten years than the last ten."[23]

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[21]Kaldor, "Occupational Plans of Iowa Farm Boys," p. 614.

[22]Eber Eldridge, "Trends Related to Agricultural Employment," in Human Resource Development, ed. by Edward Jakubauskas and Phillip Baumel (Ames, Iowa: Iowa State University Press, 1967), p. 63.

[23]Ibid., p. 74.

Table 1. Changes in the number of Iowa farms by five year
          periods, 1945-1965[a]

Year	Number change	Percent change
1945-50	-5,795	-2.8
1950-54	-10,226	-5.0
1955-59	-18,226	-9.4
1960-64	-16,797	-11.8

[a]Source: Eber Eldridge. "Trends Related to Agricultural
Employment," Human Resource Development. (Ames, Iowa, Iowa
State University Press, 1967) p. 63.

The technology which changed the mix of resources also
changed the entrance requirements into agriculture. Formerly
a boy could enter farming with a small piece of land and a cow.
The technology changes that have taken place in agriculture
require that relatively less labor and relatively more capital
and land are needed to start farming profitably today. This
change in the entrance requirements is one reason why there are
fewer new entrants into agriculture today.

Trends in farm employment in Iowa for the most part
follow those of the nation. The number of Iowa farm workers
(including all types of workers) decreased nearly twenty-two

percent between 1940 and 1954.[24] Iowa farm operators, however, have left farming at a slower rate than farm operators in the nation. This is the main difference between Iowa and national statistics and can be explained by the large number of Iowa farm operators who have well organized farms since this type of farmer does not leave agriculture. Iowa farm operators on average spend as much time working off the farm as do farm operators in the rest of the nation.

The decrease in farm labor between 1940 and 1954 is indicative of the change in the mix of inputs in agriculture. Another reason for this decrease is that the demand for farm labor is derived from the demand for agricultural output. Studies relating the consumption of food products and income indicate that Engel curves for food products are relatively inelastic, i.e., they tend to be concave upward, which means that changes in money income will not have much effect on consumption. This has meant that while income in the United States has increased, the demand for agricultural products has remained about the same, holding population constant. At the same time, technology is increasing per capita productivity so that each farmer is producing more and thus decreasing the amount of labor required for a given volume of output. Since the demand for agricultural products is

[24]M. W. Trautwein, "Differential Rates of Resource Adjustment within Iowa Agriculture" (unpublished M.S. thesis, Iowa State University, 1958), p. 6.

about constant, farmers cannot produce more and more output
without causing the price to fall. This implies that some
farmers must either leave agriculture or the entrance rate of
younger people into agriculture must be lowered for farm
income to remain constant. In short, the opportunities for
employment in agriculture are limited since the market for
agricultural products does not expand as much as income
increases while concomitantly new technologies are increasing
productivity thereby decreasing the amount of labor inputs
needed. The occupational outlook in agriculture can be
summed up by the following occupational outlook:

> The United States is in the midst of an agri-
> cultural revolution that is having a tremendous impact
> on the employment outlook in agriculture.
> In brief, fewer and fewer farmers are producing
> more and more of America's farm products. Employment
> on U.S. farms has declined from 9.9 million in 1950
> to 4.9 million in 1967. Agricultural economists
> predict that by 1980, U.S. farms will employ only 3
> million to 3-1/2 million persons.[25]

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[25]U.S. Department of Labor, Bureau of Labor Statistics,
Occupational Handbook, 1970-71 edition, Bulletin No. 1650
(1971), p. 569.

CHAPTER II.   CROSS SECTIONAL MODEL

Structural Trends

If the aforementioned structural trends continue, then future farm employment can be predicted. As new labor-saving technologies are introduced capital will continue to be substituted for labor, thus further limiting the number of farm opportunities.

Another structural trend causing decreasing farm opportunities is the factor-product relationship or the way in which factors are related to products. Equation 1 showed that the ratio between the prices of factors and the prices of a product must equal the marginal product of the factors. If too much of a product is produced then revenue will fall because the demand for agricultural products is relatively inelastic. Some farmers will not be able to adapt to changing production technologies and will eventually be forced to leave agriculture. The decision to leave agriculture is difficult since the alternative uses for agricultural resources are low. This decision, being a difficult one, is often not made directly by the farmer but rather indirectly by the market. As revenue begins to decline, the farmer will try to produce more. This causes his costs to increase. As more and more is produced, the revenue of the farmer decreases. With increasing costs and decreasing revenue the farmer is caught in a profit-

squeeze. After this happens for a number of years, the farmer will decide to leave agriculture.

A third structural trend which has limited entrance to agriculture and has also in some cases hastened exit is the scarcity of credit. New technologies require more capital both for established farmers and for new entrants into agriculture. Capital is needed to buy new inputs and land to maintain a combination of factors that produce the most output for the least cost. New entrants into agriculture often cannot get enough credit to begin farming (without the aid of their families) because the scale of operation needed for efficient production is very large. The per acre costs of farming decrease substantially as the number of acres increases.[26] Credit is also needed by the established farmer to buy new technologies in the forms of new equipment and to increase the size of his farm. Farmers who are producing at or near the marginal conditions are more likely to get credit because they are a better risk, while farmers who are not maximizing profit are not as likely to get credit. Consequently they are going to become worse off as more and more new technologies are introduced. The farms that grow and have increasing incomes are run by farm operators who are efficient managers and who are willing to take some risks.

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[26]Eldridge, "Trends Related to Agricultural Employment," p. 71.

The farm operator must be able to foresee a need for new investment and provide the managerial and technical skills to use the investment profitably. In the writer's opinion, younger farmers are more likely to take risks. They will be more flexible and have a longer time to realize the returns from investments. As a farmer gets older he will reduce his work load and not look for new investments. Also older farmers are less likely to take risks.

Forecasting Procedure

Age cohort analysis is used to forecast future farm employment by disaggregating census data into age classes. Cohort analysis is an improvement over single observations of the total number of farmers. In the next section the number of farm operators are divided into age classes according to census data. Each census shows a change in the number of farmers entering and leaving agriculture within the same age group or cohort. Net changes in census data are disaggregated into the net changes of age classes. Studying age classes shows how each age class over time increases and decreases. In the next section a model to predict farm employment using these age classes will be presented.

The Theory

Age is a major factor in mobility in agriculture. Many people attempt to move but the most successful are the young. Both economically and psychologically the young have the greatest chance in the non-farm sector. There are several reasons for this result.

The young out-mover has fewer ties to bind him to the farm and a longer time to spread the cost of moving. A young person will have a better chance to obtain a desirable steady job. He is able to fit into a pension plan easier than an older person. A young man can be trained more easily and expected to use his skills over a greater period of time. He is probably better educated and has a wider market for his skills.

The young in-mover in agriculture will also have a greater chance of being successful. A young man has more years to spread the cost of entry and to realize returns from the farm. Therefore, the investment he makes in the farm is more likely to be large enough to be efficient. Also a young farmer is apt to have scientific skills and a good attitude toward taking risks. As a result of these factors, a younger person's farm is more likely to be in the highest economic class, but the entry rate into agriculture is declining. Large amounts of capital are needed to enter agriculture. Competition for land is increasing. New farm opportunities

are decreasing since there is a limited supply of land and farms are being consolidated. As a result, entry in farming is in effect limited to persons who will inherit large amounts of assets or to persons who can go into a partnership.

At the same time that the entry rate is declining, we find that older farmers are retiring from agriculture faster than before. One possible reason for farmers retiring earlier is that farmers are eligible for Social Security. Also, as a farmer gets older he either farms part time or decreases his work load. Reasons for this might be the highly technical nature of machinery now used in farming and the level of physical conditioning needed to run the machinery.

The Cohort Pattern Model Applied to Iowa

The study of cohort pattern and size can lead to a simple estimate of the number of new farmers who are replacing the older generation. The procedure for finding the number of new entrants into agriculture is as follows. First, one must know the number of farm boys who are born into a cohort. (See Table 2 next page) To allow for infant mortality rates, the first measure of the cohort is made in the next census by counting the total number of all rural farm boys age 5-14; this number is taken as the potential number of farmers in the cohort. For example, in Table 2, we see that the census of 1910 showed that 115,531 rural farm boys were 5-14 years old at the time

Table 2. New entrants into agriculture[a]

Cohort	Potential no. of farmers	No. of farmers 15-24 as a % of potential no. of farmers	No. of farmers 25-34 as a % of potential no. of farmers	No. of farmers 35-44 as a % of potential no. of farmers
1895-1904	115,531[c]	42%[ac]	42%[ac]	45%[ac]
1905-1914	97,812[c]	44%[ac]	50%[ac]	47%[ac]
1915-1924	112,298[c]	32%[ac]	43%[ac]	36%[ad]
1925-1934	89,073[d]	45%[ac]	45%[ad]	
1935-1944	158,390[a]	16%[bd]		
1945-1954	140,241[a]			

[a]Source: Calculated from the following: U.S. Department of Agriculture, Bureau of The Census, U.S. Census of Agriculture: 1959, Vol. 1, pt. 16, Iowa.

[b]U.S. Department of Agriculture, Bureau of The Census, U.S. Census of Agriculture: 1964, Vol. 1, pt. 16, Iowa.

[c]U.S. Department of Commerce. Bureau of the Census. Fifteenth Census of the United States, 1930: Population, Vol. III.

[d]U.S. Department of Commerce. Bureau of the Census. Sixteenth Census of the United States, 1940: Population, Vol. IV.

of the census. This means that 115,531 boys survived until 1910 out of the total number of boys born between 1895-1904. From the 1920 census (which provides the next available cohort information, we take the number of farm operators age 15-24 as the numerator in a ratio to determine the entrance rate into farming. The denominator is the potential number of farmers in the cohort 1895-1904 which was mentioned above.

In the 1930 census, the people born into cohort 1895-1904 are now in the 25-34 age group. The number of people 25-34 years of age, who are farming divided by the potential number of farmers gives us the percent of potential farmers who were engaged in farm work at the time of the 1930 census. In the 1940 census our cohort 1895-1904 was in the 35-44 age class. The number in this age class is again divided by the potential number of farmers to give us the percent of potential farmers engaged in agriculture in 1940. This ratio of actual to potential farmers reaches a maximum at ages 35-44.[27] For example, for the cohort born 1895-1904, in 1920 42 percent of the cohort had entered farming; in 1930 42 percent were in farming; and in 1940 45 percent were in farming. The cohort born in 1905-1914 contained 97,812 rural farm boys in 1920.

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[27]Kanel, "Age Components of Decrease in the Number of Farmers," p. 247. Kanel states that cohort size reaches its maximum at 35-44 years of age. However, I have found that this is not always true in Iowa since some cohorts reach maximum size at 25-34 years of age as seen in Table 2.

In 1930, when the rural farm boys were 15-24 years old, 44 per-
cent had entered farming; in 1940, 50 percent had entered
farming; and in 1950, 47 percent had entered farming.

This ratio of actual to potential farmers is computed for
each cohort up to the cohort 1945-1954. The 1960 Census shows
140,241 potential farmers in the 1945-1954 cohort. To find
out how many of them will enter farming we assume that the new
farmers will enter farming at the same rate as the cohort
before them. In 1960, sixteen percent of the potential farmers
in the 1935-44 cohort became farmers. We assume therefore that
sixteen percent of the boys born in the 1945-54 cohort will
enter agriculture. This would mean there were 22,439 new
entrants into agriculture in 1970. This figure, however, will
not be completely accurate because of the following reasons.
First, the entry rate into agriculture is decreasing, but the
model assumes that the entry rate will remain constant. Second,
the definition of a farm changed between censuses. This model
will be modified later in this chapter to allow for these
changes.

The procedure to estimate the number of agricultural
leavers is similar to the procedure presented above to estimate
the number of new entrants. At the point 35-44, each cohort
contains the maximum number of farmers. After this point, the
number of farmers decreases. In 1920, when the farmers from
the 1885-1894 cohort were 35-44, the cohort reached a size of

56,282 farmers. This will be the denominator in the ratio of leavers while the number of farmers aged 45-54 belonging to the 1885-1894 cohort in 1930 will be the numerator of this ratio. When converted to a percentage, this ratio gives us the percent of farmers who were still farming at ages 45-54 of those farmers who were farming at ages 35-44. As the members of the cohort get older, the number still farming will decrease. For example, in 1930, 87 percent of the 1885-1894 cohort were still farming; in 1940 67 percent of the 1885-1894 cohort were still farming, and in 1950, 36 percent of the 1885-1894 cohort were still farming.

The same method was used on the cohorts born 1895-1904, 1905-1914 and 1915-1924. We assume that farm operators leave agriculture at the same rate as the cohort before them. The cohort 1915-24 reached a size of 49,286 in 1950. In 1960, 82 percent of the farmers remained in agriculture. Thus the withdrawal rate was 18 percent. In 1960, there were 39,805 farmers with ages 35-44. If by 1970, 18 percent of these farmers will have stopped farming, there will be 7,165 less farmers. Similarly, between 1950 and 1960, the cohort 1905-1914 decreased by 26 percent, implying that the cohort 1915-1924 in 1970 would decrease by 26 percent or 12,814 farmers, while the cohort 1905-1914 in 1970 would decrease by 23 percent or 11,281 farmers. This means a total decrease in the number of farmers of 31,260. The difference in the actual rates of

Table 3. Agricultural leavers[a]

Cohort	No. of farmers 35-44 yrs. of age. (Max. size of cohort)	No. of farmers 45-54 as a % of the no. of farmers 35-44	No. of farmers 55-64 as a % of the no. of farmers 35-44	No. of farmers 65 yrs. and over as a % of no. of farmers 35-44
1885-1894	56,282[c]	87%[ac]	67%[ac]	36%[ac]
1895-1904	56,801[c]	92%[ac]	61%[ac]	38%[bd]
1905-1914	49,049[c]	91%[ac]	65%[bd]	
1915-1924	49,286[d]	82%[cd]		

[a]Source: U.S. Department of Agriculture, Bureau of the Census, U.S. Census of Agriculture: 1959, Vol. 1, pt. 16, Iowa.

[b]U.S. Department of Agriculture, Bureau of the Census, U.S. Census of Agriculture: 1964, Vol. 1, pt. 16, Iowa.

[c]U.S. Department of Commerce. Bureau of the Census. Fifteenth Census of the United States, 1930: Population, Vol. III.

[d]U.S. Department of Commerce. Bureau of the Census. Sixteenth Census of the United States, 1940: Population, Vol. IV.

entry and withdrawal would then be 7,821. This number represents the number of farms we would expect to be consolidated.

This estimate of the decrease in the number of farmers is too low. Among the reasons why it is too low are the following:

1. There have been changes in the census definition of what is a farm;

2. there have been changes in the Social Security laws to include farmers;

3. we have assumed farmers leave agriculture in the same manner as farmers in previous cohorts. This may not be true. To avoid these problems an alternate model is formulated.

An Alternate Model

This analysis of age cohorts of Iowa farmers was done using a variation of the method Robert Crown used in his study of Ontario. First, 1940 data and 1950 data are used to predict 1959 and 1969 farm employment.[28] Next the predictions for 1959 are compared with the actual data for 1959. The 1959 estimates are poor due to the effect of the war years and the high income expectations generated by the Korean conflict in the early fifties.

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[28]The Census of Agriculture was taken for 1940, 1950, 1959, and 1969. Since this is the best information available, I used it even though in some cases it makes the time period only 9 years.

The employment of farm operators can be explained in the following manner. Let C_{ij} represent a cohort where i represents the cohort and j represents the census year. "i" goes from 1, ... 6.

1 = the cohort 15-24 years of age

2 = the cohort 25-34 years of age

3 = the cohort 35-44 years of age

4 = the cohort 45-54 years of age

5 = the cohort 55-64 years of age

6 = the cohort 65 years old and older.

If the census year is 1940 then $C_{1(40)}$ represents the cohort that was 15-24 years of age in 1940. Following this pattern $C_{i(50)}$ and $C_{(i-1)(40)}$ are individuals in the same cohort, while $C_{i(40)}$ and $C_{i(50)}$ are individuals in different cohorts. The forecast number of farm operators in 1959 and 1969 are given by the following relationships:

$$C_{i(59)} = C_{(i-1)(50)} \cdot \frac{C_{i(50)}}{C_{(i-1)(40)}} \cdot \tag{9}$$

$$C_{i(69)} = C_{(i-1)(59)} \cdot \frac{C_{i(59)}}{C_{(i-1)(50)}} \cdot \tag{10}$$

This method allows us to estimate how many farmers in each cohort will remain in farming at the time of the next census. This relationship can be used to find the number of 25-34 year-old farmers in 1960 from the number of 15-24 year-

old farmers in 1950 as shown below.

$$7194 \cdot \frac{39191}{6520} = 43{,}242 \text{ farmers age } 25\text{-}34 \text{ in } 1959.$$

This procedure is illustrated by the following diagram. A and B are two different cohorts of the same age at different points in time. Y and Z are cohorts A and B respectively, ten years later. The same rule that maps A into Y also maps B to Z.
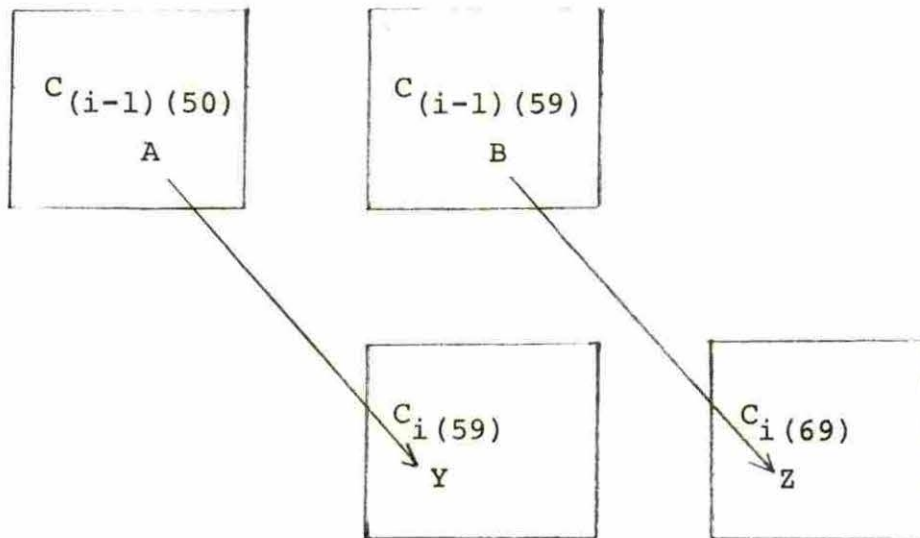

Diagram 1. Diagramatic determination

This method is used in Table 4 for each cohort, C_i, (i = 1,2, ..., 6). Columns 1, 2, and 3 are the actual data as given by the U.S. Census of Agriculture. Columns 4 and 5 are computed by our relationship (9). Inspection of column 3 reveals that in 1959 the actual number of farmers in $C_{2(59)}$ was

Table 4. Future estimates of farm operators in Iowa for 1960 and 1970

Cohort/year	1[a] 1940	2[a] 1950	3[b] 1959	4[c] 1959	5[c] 1969	6[d] 1969
1 (15-24)	6,520	7,194	3,680	----	----	
2 (25-34)	36,140	39,191	25,987	43,242	13,293	
3 (35-44)	49,049	47,893	39,805	51,936	26,394	
4 (45-54)	52,669	45,002	40,547	43,941	33,699	
5 (55-64)	38,155	35,029	32,259	29,929	29,065	
6 (65 and older)	23,575	20,486	11,019	18,807	10,147	
Total					112,598	136,604

[a]Source: U.S. Department of Agriculture, Bureau of the Census, U.S. Census of Agriculture: 1950, Vol. VI, pt. 9, Iowa.

[b]Source: U.S. Department of Agriculture, Bureau of the Census, U.S. Census of Agriculture: 1959, Vol. 1, pt. 16, Iowa.

[c]Source: Calculated from columns 1, 2 and 3.

[d]Source: Iowa Department of Agriculture, U.S. Department of Agricultural Statistical Reporting Service, Iowa Annual Farm Census, 1969.

25,987. Our predicted $\hat{C}_{2(59)}$ was 43,242, thus our relationship overestimated the actual figure by 17,255 farmers. $\hat{C}_{3(59)}$ overestimates $C_{3(59)}$ by 12,131 farmers. $\hat{C}_{4(59)}$ and $\hat{C}_{6(59)}$ both overestimate the actual values and $\hat{C}_{5(59)}$ underestimates the actual value by 2,330 farmers. It is obvious that there is no $\hat{C}_{1(59)}$ since we would need a $C_{0(50)}$ to calculate it which is non-existent. Thus we see that our relationship does not do a very good job of predicting. One explanation for the poor predictions is to look at the political and economical conditions of the 1940's and the 1950's. In the 1940's there was a major war with price controls. After the War, America helped Europe rebuild by providing supplies and food stuffs which increased the demand for farm products in the 1940's. The Korean War again raised agricultural prices. In the late 50's there was a recession. Thus the economic and political conditions were very different over these periods. During the wars more people remained in agriculture since prices were higher than would be expected if there was no war. Since more people were in farming in the base years, the predictions for 1959 were high. This is especially true in younger cohorts, where high expectations of income caused more young farmers to enter. The predictions for 1969 will be better since the decade beginning in 1950 is more like the decade beginning in 1960.

Since relationship 9 does not estimate $C_{1(69)}$ (because of the need for the non-existent $C_{0(59)}$, another relationship must be used to find the predicted number of farmers in 1969 who are 15-24 years old. The relationship which was used to do this follows.

To estimate the number of new entrants into agriculture we assume that the entry rate is a declining proportion of all farmers. Let the proportion of new entrants into farming to all other farmers be R, so that in 1950 the entrance rate was $R_{(50)}$ and in 1959 it was $R_{(59)}$ where

$$R_{(59)} = \frac{C_{1\ (59)}}{\sum\limits_{i=2}^{6} C_i\ (59)} \ . \tag{11}$$

Once we know $R_{(50)}$ and $R_{(59)}$ we use them to predict $R_{(69)}$ by relationship 12

$$\hat{R}_{(69)} = R_{(59)} \cdot \frac{R_{(59)}}{R_{(50)}} \ . \tag{12}$$

This would imply that

$$\hat{R}_{(69)} = \frac{C_{1\ (69)}}{\sum\limits_{i=2}^{6} C_i\ (69)}$$

and

$$\hat{C}_{1(69)} = \hat{R}_{(69)} \cdot \sum\limits_{i=2}^{6} \hat{C}_i\ (69)$$

We now assume additionally that the ratio of new entrants to all farmers has a constant proportional decline such that $\hat{R}_{(69)}$ is better estimated by

$$\tilde{R}_{(69)} = \frac{\hat{R}_{(69)}}{1-\hat{R}_{(69)}} \tag{13}$$

Our estimate of $C_{1\ (69)}$ now becomes

$$\tilde{C}_{1\ (69)} = \tilde{R}_{(69)} \cdot \sum_{i=2}^{6} \hat{C}_i\ _{(69)} \tag{14}$$

When we calculate $\hat{C}_{1\ (69)}$ we find it is equal to 1,465 farmers. We now proceed to calculate estimates for $C_{i(69)}$ ($i = 2,3, \ldots,$ 6) using relationship (10). These estimates are presented in column 5 of Table 4. Since the 1969 Census of Agriculture is not yet available, we do not know how good our estimates are. The Iowa Census of Agriculture for 1969 is available, but it does not have farmers broken down into cohorts. Nevertheless, the total number of farmers given by the 1969 Iowa Census of Agriculture (See Table 4, column 6) is not too far from the total estimates given by our age-cohort relationships 9 and 14. (See Table 4, column 5). The age cohort estimates are 82% of the actual estimates. In an effort to improve my estimates, I next distributed the cohorts into economic classes. My reason for doing this was that large and prosperous farms are less likely to be consolidated than poor, inefficient farms. The technique employed was to estimate the distribution of economic

classes according to age. The distribution was estimated by extrapolating the change in the distribution from 1950-1959 to the period 1959-1969. This was done linearly to assure unity in the projected sums.

Let $P_{i(50)}$ be the ratio of farmers in economic class P for all farmers in $C_{i(50)}$. The proportion of farmers in an economic class in 1969 is then given by:

$$P_{i(69)} = P_{(i-1)(59)} + P_{i(59)} - P_{(i-1)(50)}. \quad (14)$$

This relationship will not hold, however for the $P_{1(69)}$ cohort as before there is no $P_{0(69)}$ cohort and so to estimate $P_{1(69)}$, I used:

$$P_{1(69)} = 2P_{1(59)} - P_{1(50)}.$$

The Census of Agriculture contains nine economic classes. The first six classes are based on value of products sold and have the following distribution:

The remaining three economic classes have the following definitions as stated in Table 5.

Part time: Farms with a value of $50 - $2,499 were classified as "part-time" if the operator was under 65 years of age and he either worked off the farm 100 or more days or the income he and the members of his household received from non-farm sources was greater than the total value of farm products sold.

Table 5. Economic classes according to the census of agricul-
          ture[a]

Economic class	Value of farm products sold
I	$ 40,000 and over
II	$ 20,000 to $ 39,999
III	$ 10,000 to $ 19,999
IV	$ 5,000 to $ 9,999
V	$ 2,500 to $ 4,999
VI[b]	$ 50 to $ 2,499

[a]Provided the farm operator was under 65 years old and
(1) he did not work off the farm 100 or more days, or (2) the
income he and his family received was less than the total value
of the products sold.

[b]Source: U.S. Department of Agriculture, Bureau of the
Census, U.S. Census of Agriculture: 1959, Vol. 1, pt. 16,
Appendix, Iowa.

Part retirement: Farms with a value of sales of farm

products of $ 50 to $ 2,499 were classified as "part-retirement"

the farm operator was 65 years old or older.

Abnormal: All institutional farms and Indian reservations

were classified as "abnormal" regardless of sales.

These last three census classes cannot be estimated since

there is no set pattern in their occurrence. Tables 4 and 6

are estimates for only the first six economic classes. To

obtain the total number of farm operators in Iowa we must find

the sum of all economic classes. We will assume the number of

Table 6. Estimates of future farm operators by economic class in Iowa, 1969

Cohorts/year	Economic class[a]	1[b]	2[b]	3[c]
1 (15-24)	Total farm operators	7,194	3,680	1,465
	I	233	114	34
	II	676	346	107
	III	2,199	1,125	348
	IV	2,688	1,375	425
	V	1,085	555	172
	VI	313	160	50
2 (25-34)	Total farm operators	39,191	25,987	13,293
	I	2,760	1,830	936
	II	7,201	4,775	2,443
	III	14,683	9,736	4,981
	IV	10,430	6,916	3,536
	V	3,514	2,330	1,192
	VI	603	400	204
3 (35-44)	Total farm operators	47,893	39,805	26,394
	I	3,415	2,838	1,881
	II	8,697	7,228	4,753
	III	17,538	14,576	9,665
	IV	13,039	10,837	7,186
	V	4,447	3,696	3,448
	VI	758	630	418

[a]The economic class distribution was extrapolated linearly from the 1959 information since this was not available for 1950.

[b]Source: Columns 1 and 2: U.S. Department of Agriculture Bureau of the Census, 1950, 1959.

[c]Source: Column 3 was calculated from the Census data.

Table 6 (Continued)

Cohorts/year	Economic class[a]	1[b]	2[b]	3[c]
4 (45-54)	Total farm operators	45,002	40,547	33,699
	I	2,284	2,058	1,710
	II	6,007	5,412	4,498
	III	15,254	13,744	11,421
	IV	14,414	12,987	10,794
	V	6,655	5,996	4,983
	VI	1,498	1,350	1,122
5 (55-64)	Total farm operators	35,029	32,259	29,065
	I	1,077	992	894
	II	3,096	2,851	2,568
	III	8,186	7,539	6,793
	IV	12,327	11,352	10,228
	V	7,129	6,565	5,915
	VI	3,225	2,970	2,676
6 (65 and older	Total farm operators	20,486	11,109	10,230
	I	463	251	231
	II	1,525	827	761
	III	3,845	2,085	1,920
	IV	6,742	3,656	3,367
	V	7,745	4,200	3,864
	Part retirement	15,898	8,621	

farms in the abnormal, part-time and part retirement classes remains the same as it was in 1964; i.e., equal to 16,625.[29] Adding this number to the sum of expected farmers in economic classes I - VI from Tables 4 and 6 (112,598 + 16,625 = 129,223), we find there are an expected 129,223 farmers in 1969. According to the Iowa Annual Farm Census of 1969, there were 136,604 farmers. Thus the predicted number of farm operators are 94.5% of the actual number of farm operators.

Prediction of Employment of Unpaid Family Labor

All members of the farm family share in the farm's income, even if they are not regularly paid. Both the sons of farmers and the wives of farmers make sufficiently large contributions to the labor force to warrant inclusion in this study.

Unpaid male employment has been and is expected to continue declining for the following reasons:

1. There are decreasing numbers of farm families:

2. higher rural educational levels have made farm youth more qualified for employment in the non-farm labor market;

3. today's farm youth leave home at an earlier age than farm youth did before World War II;

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[29] U.S. Department of Agriculture, Bureau of the Census, U.S. Census of Agriculture: 1964, Vol. 1, pt. 16, Iowa.

4. increased knowledge of non-farm life has tended to reduce the number of young people working on farms.

Another factor which might influence the decision to leave or stay on the farm is opportunity cost. On small farms, the opportunity cost of a boy's leaving the farm is quite low. On large farms, boys have high expectations about income that cannot be realized while on the farm. Thus, boys from both large and small farms are equally likely to leave agriculture.[30] The decline of male unpaid farm labor does not depend on economic class. The ratio of decline is estimated by assuming that the decline in the number of unpaid male laborers from 1959 to 1969 is the same as the rate of decline from 1950 to 1959.

Most unpaid female labor is provided by the farmer's wife. A wife's decision to work in the non-farm sector usually depends on the farmer's decision to leave agriculture. Thus, the forecast for female unpaid labor is the product of the projected number of farms times the 1959 figure for per farm employment of female labor. The predicted values for employment of unpaid female labor is given in Table 7.

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[30]Crown, "Forecasting Farm Labor Employment," p. 18.

Table 7. Unpaid female labor estimate for Iowa, 1969[a]

Farm operator's age cohorts	1969 estimate
15-24[b]	50,959
25-34[b]	24,698
35-44	96,547
45-54	33,185
55-64	12,760
65 years and older	4,306

[a]Source: U.S. Department of Agriculture, Bureau of the Census, 1959. U.S. Department of Agriculture, Bureau of the Census, 1964.

[b]The female population was extrapolated from a category of under 35 years of age (operator's age).

Employment of Hired Labor

Employment of hired labor depends on demand. Increases in the number of large farms should increase the demand for hired labor. The demand for hired labor should also increase as hired labor substitutes for unpaid family labor when more and more sons leave the farms. Against these demand-increasing factors is the fact that the increase in wages in agriculture will cause a decrease in the amount of hired labor because other factors are still relatively cheaper than labor. At the same time increases in education, communication, and mobility

encourage hired labor to demand increased wages. Thus capital will increasingly be substituted for labor.

Employment of hired labor is estimated by economic class of farm since the size of the farm is important. The product of expected numbers of farms and the change in the per farm employment of hired labor is the basis of future hired estimates.

The expected number of farms is the same as the expected number of farm operators. Let L be the ratio of the per farm rate of labor for 1959 to 1950. E is the expected number of farms and H is the amount of hired labor.

$$L_{(69)} = \frac{\dfrac{H_{(59)}}{\text{the number of farms in } (59)}}{\dfrac{H_{(50)}}{\text{the number of farms in } (50)}}$$

The hired labor would be determined by:

$$H_{(69)} = L_{(69)} E_{(69)}.$$

Hired labor estimates are presented in Table 8.

Table 8. Estimates of hired labor for 1969[a]

Economic class[b]	Hired labor estimate, 1969
I	3634
II	16542
III	37495
IV	37267
V	19540
VI	4994

[a]Source: U.S. Department of Agriculture, Bureau of the Census, 1959, 1950.

[b]The definition of the economic classes is listed on page 27.

CHAPTER III.   TECHNOLOGY AND SMALL GEOGRAPHICAL AREAS

Over the period 1940 to 1960, the job description of farm operator changed substantially.   Agricultural technology increased with new kinds of machines, herbicides, fertilizers and insecticides.   Much of this technology was labor saving, thus causing a decrease in the demand for farm laborers.   The farm operator estimates we found in Chapter II for 1959 based on 1940 and 1950 data violated the original assumption that technology should increase at a constant rate, because in point of fact, technology was increasing at an ever faster rate after the war.   The level of agricultural technology in the 1950's was more like that of the 1960's (along with other economic conditions) so that the predictions for 1969 were better than the 1959 predictions.   This can be further illustrated in the following series of graphs.
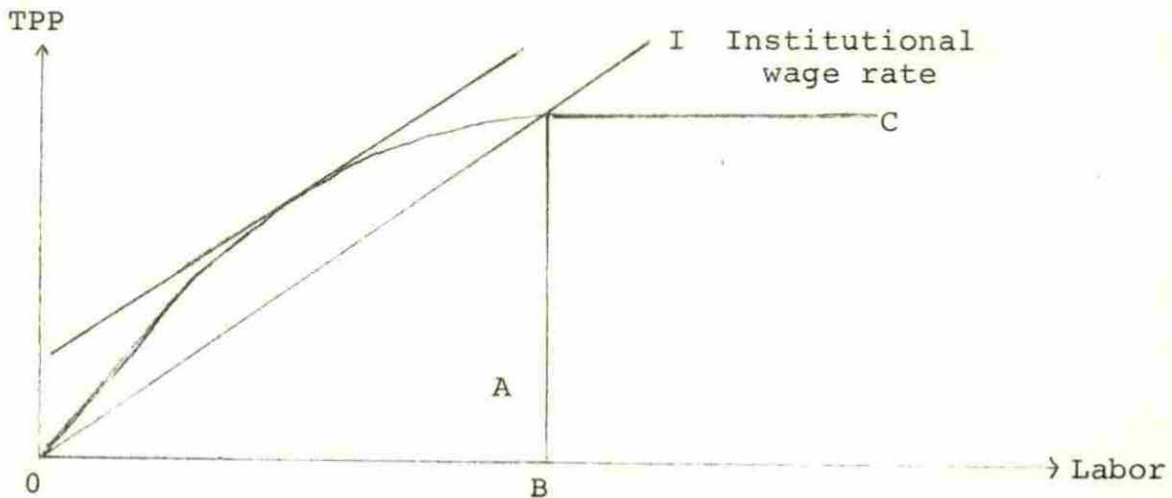
Graph 1.   Agricultural production

In graph 1, output is presented as a function of labor input. The wage rate is defined as a function of the marginal productivity of labor. This would mean that the wage rate would be zero for that part of the production curve that is parallel to the horizontal axis. This is impossible, so it is postulated that the wage rate is determined by an average wage rate or law or by some institution. Thus, it is called the institutional wage. The slope of OI, is the institutional wage rate while the slope of OC is the marginal productivity of labor in agriculture.

In the 1940's some Iowa farms were in part A of the graph. Here the MPP_L is less than the institutional wage rate. At this point some farmers will leave agriculture. As enough farmers leave, the marginal productivity of labor in dollars will equal the institutional wage rate ($MPP_L = I_w$). The farmers will leave agriculture in large numbers at first but as time passes fewer and fewer farmers leave agriculture until the marginal productivity of labor in dollars equals the institutional wage rate at which point no more will leave as shown by point B in Graph 2.

In Graph 2, at point C a large number of farmers left agriculture. In the next time period at point D fewer farmers left agriculture. This pattern continues until the marginal productivity of labor in dollars is equal to the institutional wage rate or at B where people will stop leaving agriculture.
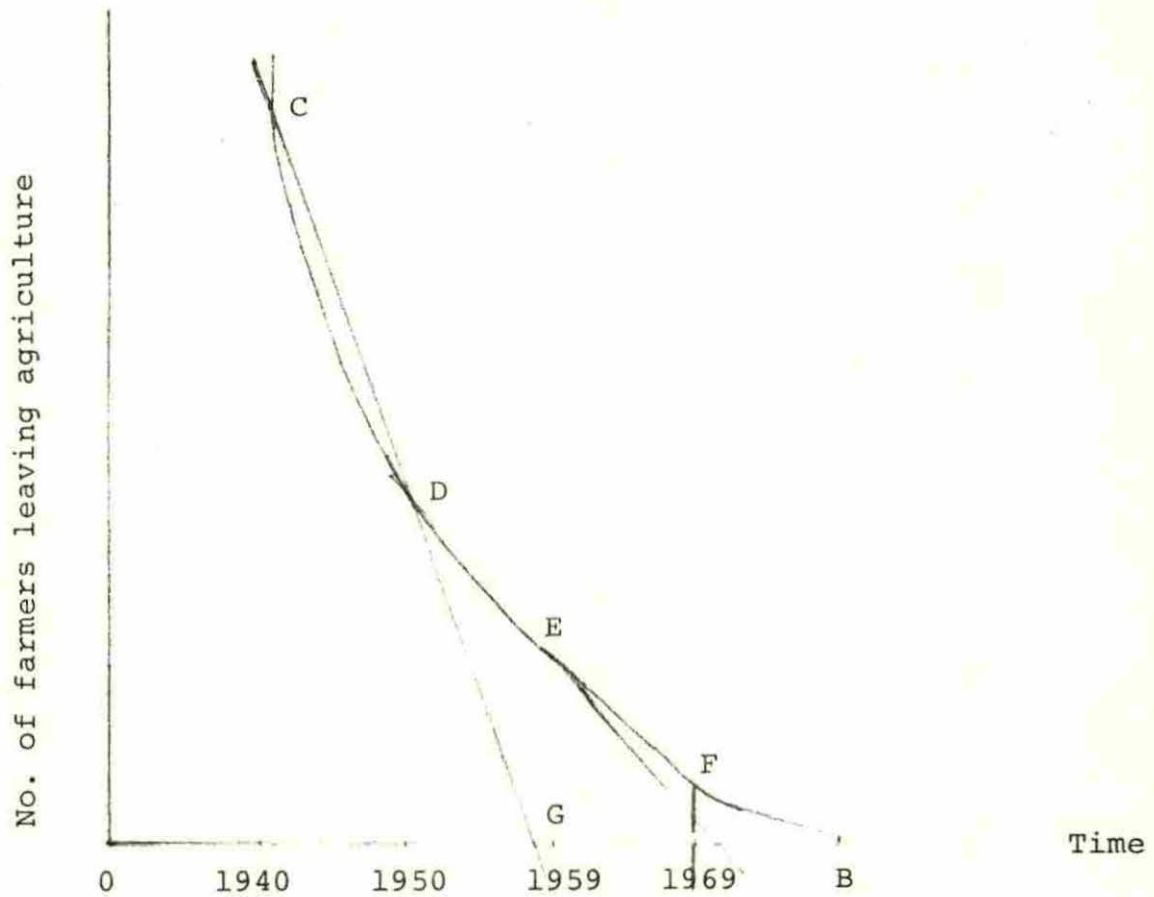
Graph 2.   The rate at which labor leaves agriculture

The rate at which farmers leave agriculture affects age cohort analysis in the following way: If points C and D on Graph 2 are the base years 1940 and 1950, and you try to estimate the number of farm leavers in 1959, then there would be a prediction of negative farmers leaving agriculture in 1960, as shown by the linear function CDG. If point E represents the actual number of farmers who left agriculture in 1959 then our linear trend prediction has not proved to be a very satisfactory prediction of farm leavers.

Now if points D and E are used to estimate F, the withdrawal rate in 1969, then the estimate is better. It is important to note that the level of technology employed becomes a problem for studies of small geographical areas because over large regions different levels of technology are averaged out and more evenly distributed.

The counties within Iowa have different levels of technology and thus they also have different rates of people leaving agriculture. Within a given county adoption of technology will vary with age and with economic class. Younger and newer farmers often have more education and skills than older farmers[31] and therefore have a different range of technologies open to them.

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[31]Perkins, "Movement of Labor between Farm and Non-farm Jobs," p. 17.

The economic class of a farm is an indication of the capital available to buy new technologies. Farms with high value of products sold are more likely to get credit to purchase new technologies. To show how economic class and the level of technology affect the linear estimates of withdrawal rates from farming; some examples for five counties will be presented.

We assume that there is a high correlation between high levels of technology and high gross sales per farm. Therefore, high gross sales per farm is used as a proxy for the level of technology. The counties in Iowa can be divided into three groups on the basis of average gross sales per farm.

Table 9. Average gross sales per farm in Iowa counties[a]

Average gross sales per farm	Number of counties
$ 6,000 - $10,999	17
$11,000 - $	60
- $20,999	
$21,000 and over	22

[a]Eber Eldridge, "Trends Related to Agriculture", p. 69.

Farms in the counties indicated hereafter were chosen to show the importance of economic class and the level of technology. (Farm and farm operator are used interchangeably since according to the census definition there is only one farm operator per farm.)

Monroe County has the lowest average gross sales per farm,[32] the highest percent of farms with less than $10,000 gross sales in Iowa,[33] and the lowest percent of farms with more than $20,000 gross sales in Iowa.[34]

Sac County has the highest average gross sales per farm,[35] is among the counties with the lowest percent of farms with less than $10,000 average gross sales per farm,[36] and it is among the counties with the highest percent of farms with more than $20,000 average gross sales per farm.[37]

Lee, Poweshiek, and Story Counties are in between these extremes of average gross sales per farm.[38]

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[32]Eldridge, "Trends Related to Agricultural Employment," p. 69.

[33]Ibid., p. 73.

[34]Ibid., p. 70.

[35]Ibid., p. 69.

[36]Ibid., p. 73.

[37]Ibid., p. 70.

[38]Ibid., p. 69.

To show how the combination of age and low levels of technology affects the county withdrawal rate from agriculture, Table 10 is presented. In Table 10, the rate of decline in the number of farms gets smaller as there are more farms with high average gross sales. This is true in most cases, but Lee County is an exception. Monroe County has the lowest average gross sales and Sac has the highest with Lee, Poweshiek and Story in between in ascending order. In Monroe County for 25-34 year olds there was a retention rate of .786 farmers or .786 farmers remained in agriculture while in Sac County for 25-34 year olds .88 farmers continued to farm. With present levels of farm technology one would expect Sac County to go through fewer adjustments than Monroe County in the future.

In the next section we will show how this improved method for predicting farm employment in small geographical areas can be useful in making policy decisions.

Table 10. A comparison of the ratio of the number of farm
operators: 1964 ÷ 1959[a]

	County				
Cohort	Monroe	Lee	Poweshiek	Story	Sac
15-24	.801	.839	.786	.839	.880
25-34	.786	.834	.789	.848	.880
35-44	.786	.835	.790	.846	.882
45-54	.785	.836	.792	.846	.881
55-65	.786	.837	.790	.846	.880
65 years of age and older	.787	.837	.790	.845	.881

[a]Source: Calculated from: U.S. Department of Agriculture,
Bureau of the Census, 1959. U.S. Department of Agriculture,
Bureau of the Census, 1964.

CHAPTER IV.   TWO USES FOR AGE COHORT ANALYSIS

The Planning of Vocational Education

With less and less rural youth entering agriculture, age
cohort analysis can provide a method to reorient the amount
and type of vocational agricultural education needed in rural
schools. The demand for agricultural vocational education is
decreasing, while the demand for new types of occupational
education is increasing. The Vocational Education Act of 1963[39]
can be described as the first reconsideration of vocational
education since 1917. However, it did not result in any basic
changes in vocational education.[40] The Act made Federal
matching grants available to the states to be spent in
specified amounts for training in agriculture, trades and
industrial skills, and home economics with a minimum of federal
direction or involvement.

The immediate motivation for the 1963 Act was the high
level of unemployment among untrained and inexperienced youth
in general. A more fundamental criticism was the alleged
failure to change occupational emphases to keep pace with an

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[39]Vocational Education Act of 1963, P.L. 88-210.

[40]Garth C. Margum and Sar A. Levitan, Federal Training
and Work Programs in the Sixties, (Michigan Institute of Labor
and Industrial Relations, 1969), p. 105.

increasingly sophisticated technical economy.[41] Investment in

vocational education was not deemed to be in keeping with the

national interest. There was little long-range planning.

Nevertheless, the Vocational Education Act of 1963 retained the

traditional occupational categories, although it expanded the

vocational agricultural education category by saying that

vocational education could--but need not--include training for

occupations related to, but outside of, commercial agriculture.

In 1968, the Vocational Education Act of 1963 was modified

by regulation of the U.S. Department of Health, Education and

Welfare Governing Administration of Vocational Education Pro-

grams by States, Codes of Federal Regulations Title 45, Part

102.

Section 102.53, entitled "Manpower needs and Job Opportuni-

ties", states the following:

> (a) In allocating funds among local educational
> agencies, the State board shall give due considera-
> tion to information regarding current and projected
> manpower needs and job opportunities, particularly
> new and emerging manpower needs and opportunities
> on local, State and national levels.

Age cohort analysis could improve long-run planning of

vocational education. First, cohort analysis provides an

estimate of the number of farmers needed to maintain a constant

number of farms. Second, an estimate of the rural youth not

going into farming can be made.

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[41]Ibid.

By referring back to Table 4 we can see the predictions for new entrants into agriculture, agriculture leavers, and future estimates of farm operators. Our modified cohort model predicted 1,465 new farmers ages 15-24 in 1969 and 9,613 new farmers ages 25-34 in 1969. In 1959 there were 3,680 new farmers ages 15-24. Ten years later there was a total of 13,293 farmers ages 25-34. Therefore, 9,613 started farming between ages 25-34. This gives a total of 12,078 new farmers under the age of 35 in 1969. Agricultural leavers are computed as the number of farmers who age out of the 55-64 cohort. In 1959 there were 32,359 farmers in the 55-64 cohort and in 1969 there were 10,147 farmers 65 or older which gives a net withdrawal of 22,112 farmers. As the farmers 45-54 years old in 1959 become 55-64 years old there are 11,482 less farmers in the 55-64 cohort.

As the farmers 35-44 in 1959 become 45-54, in 1969, there are 6,106 fewer farmers. [Note: 1969 was used because the Census for 1969 was not yet available at the time this research was completed.] Thus we predict that 39,700 farmers left agriculture between 1959 and 1969. The difference between the entrances and withdrawals would be 27,622 farmers. Since there is one farm operator per farm, this would result in a decline of 27,622 farms during this period.

If only a small percentage of rural farm boys entered agriculture before they were 25 years of age, then different

types of vocational education should have been provided for
the other rural youth. Federal money given to the state of
Iowa can be distributed so that vocational agriculture accounts
for only the percentage of farm boys entering agriculture. It
would be in the national interest to increase gross national
product by providing more relevant vocational education pro-
grams based upon long-range planning. The question now is
where and how should money for vocational agriculture in Iowa
be distributed?

The estimates for future farm operators by economic class
now become important. Rural farm youth that do go into agri-
culture tend to do so because of the non-income characteristics,
the net worth of the family, and a favorable outlook of rela-
tive income. The net worth of the family is important in the
light of the increasing capital requirements. Where net worth
is very high, rural youth are more likely to enter agriculture.
Thus, money for vocational agriculture should be concentrated
in areas where there is a high net worth of farms.

Gross sales could serve as a proxy for net worth. Then,
areas with farms that have more than 30 percent of gross sales
over $20,000 should receive money for commercial agricultural
education. Other counties with low gross sales should receive
funds for other types of vocational education listed under the
act such as horticulture, landscaping, printing, office skills,
and trade and industrial skills. Counties with larger

percentages of farms in the lower economic classes need these other types of vocational education in proportion as the lower classes are declining. If in a county with low gross sales there is a projected decrease of 50 percent in these low economic classes, then there should be a corresponding increase in other types of vocational education.

The use of age cohorts for studying farm consolidation

Farm consolidation is a profitable change for the farmer who becomes more efficient, for the person who leaves agriculture and thereby increases his income, and for society because agriculture has freed some resources without decreasing production.

The rate of farm consolidation is increasing and the amount of farm employment is decreasing. The amount of hired labor is decreasing and total capital invested per farm is increasing. If a farmer is unable to have a large enough farm to utilize the cost advantages of large scale production then he will often find a non-farm job. Farmers near Des Moines, Waterloo, Ottumwa, and Burlington are especially prone to take advantage of these non-farm opportunities. The availability of non-farm jobs in a few Iowa cities has eased adjustments to the non-farm labor market. The decline in the demand for farm labor and the trend toward farm consolidation have led to a loss in population for rural communities and the incorporation of farms. These changes have threatened the "rural way of

life." Age cohort analysis can be useful in examining the problem.

Age cohort analysis shows the difference in the normal rate of replacement and the actual rate of replacement. If there is a normal rate of leavers from agriculture and a normal rate of new entrants, then the number of farmers will remain about the same, assuming the supply of land cannot be significantly changed. However, as the model predicts, the actual rate of replacement is not equal to the number of leavers. Iowa farmers are afraid that with fewer new entrants, farms will be bought in large quantities and incorporated. The large farms will become increasingly mechanized and the demand for labor will be further reduced. The number of people on the farms will decrease and the demand for other goods and services will decrease. As more and more people leave, rural communities will die.

By applying age cohort analysis to the county levels, the number of farms that will be consolidated in the county can be found. The farms with older operators and low efficiency are the farms that will be consolidated. This method of analysis gives an insight into the scope and extent of the problem in a particular county.

Age cohort analysis shows that a decreasing proportion of rural youth are entering agriculture. The youth who does enter agriculture is most likely to be 25 years old, has lived

on a farm, and has a high school education. About 45 percent
of those who enter farming have had vocational education. About
78 percent have had full-time non-farm jobs before starting to
farm.[42] The youth who do not enter agriculture, but who would
have liked to farm, were not able to acquire enough capital to
start. It is no longer possible (if it ever was) to buy a cow
and a few acres and work your way to a large profitable farm.

Knowing the amount and approximate locations of farms
that are about to be consolidated, possible solutions could be
worked out. The first solution would be to form an agency to
facilitate the mobility of labor and capital in rural areas to
the farms in question. A second solution would be the re-
organization of land toward alternative uses such as recreation.

Farmers fear that outside investment in corporation
farming will change their way of life. An agency could be
developed to use capital and labor from within the rural
community to form a corporation of consolidated farms. This
agency would encourage the following developments:

1) The forming of groups of rural youth who have had
   vocational education in agriculture for the purpose
   of consolidating their individual capital.

2) Provision of information to rural youth on farms that
   are being sold.

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[42]Eldridge, op. cit., p. 75.

3) Aid to rural youth in forming and operating corpora-
    tions.

4) Helping rural youth to acquire credit.

5) Provision of relocation allowances to foster mobility
    within the state.

This kind of relocation policy should help to increase
economic and social efficiency. Younger people will fit more
easily into a relocation program because it is relatively
easier for them to leave home to find jobs, marry, and set up
house. Lack of agricultural employment opportunities also
serves as a strong motivation to move. The cost of relocation
is an investment in human resources from which there are
economic and social returns. Age cohort analysis would limit
the dimensions of such a program. It can be used to define
problems in farm employment. Once this is done, policy and
administrative decisions can more easily be made.

CHAPTER V. SUMMARY

The objective of this study was to use age cohort analysis to predict future farm employment for small geographical areas (the state and county levels). Projections for the state and selected counties appear. Age cohort analysis can be used on small geographic areas provided there is some way to measure the state of technology.

This study provides information about cohort patterns that can be applied to the problems of training manpower, developing human resources, and farm consolidation. The cohort pattern analysis shows an estimate for the number of farmers who will leave agriculture and an estimate of those who will be replacing them. The difference between the number of farmers leaving and the number of new entrants is the number of farms that will be consolidated into other farms. Throughout Iowa there is a tendency to consolidate farms to increase efficiency.

There is another reason for farm consolidation. Only a few boys who want to go into agriculture have enough capital to start running an efficient farm operation. Thus as older farmers retire or die, rural youth who might want to replace them, cannot do so.

Manpower training is needed for rural youth who do not become farmers. The number of rural farm youth minus the number of new farmers represents those who will need some

kind of education to find jobs off the farm. The mix of agricultural and other training offered might in part be determined by studying cohort patterns. This implies that the manpower needs of Iowa suggest the desirability of turning away from vocational agriculture. As technology increases, the industrialized parts of the state might absorb the rural farm youth who are not going into agriculture.

Future research might be done in applying age cohort analysis to a general theory of labor mobility where often variables such as alternative job opportunities, geography, skills and education would be incorporated into the structure of the models.

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