Determinants of Farm Size and Structure

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THE IMPACTS OF STRUCTURAL CHANGE AND THE FUTURE OF AMERICAN AGRICULTURE

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In this chapter, we estimate what the future structure of U.S. farms will be. We do this in three stages. First, past projections and methods are reviewed. Second, based on recently available 1987 Agricultural Census, we make a new set of projections. Finally, we discuss the potential impacts of changes in the underlying structural forces which may cause the future to be different from the projection of historical trends.

Past Projections and Methods

Concern and interest in the future have caused many projections of the future size and structure of U.S. agriculture to be made. There were several studies and discussions of size and structure issues in the late 1970s during the Carter-Bergland era. The ESCS published "Structure Issues of American Agriculture" which provides a good background in a set of papers by many authors. The GAO also added its interpretation in its study "Changing Character and Structure of American Agriculture: An Overview." In 1979, then Secretary Bergland held a series of discussions with farmers and others interested in structural issues across the country (USDA, 1980). These and other reports and discussions were summarized by the USDA (1981) and a set of recommended actions put forward. However, with the change in administrations (from Carter to Reagan) the progress on these recommendations and concern on the structure of agriculture cooled.

Various methods have been used to study structural issues. The one point that ties these studies together is the continuance of current trends. That is, the historical trend of declining number of farms is always projected to continue; the future rate of decline and the change in that rate and how to estimate that rate and change is what differentiates these studies. The studies by Lin, Coffman, and Penn (1980) and the Office of Technology Assessment (U.S. Congress) are examples of these studies. A few studies have attempted to understand why past trends happened and what that means for the future. Reimund, Martin, and Moore is a very good example of a study examining the underlying structural issues of change. In this section, a selection of these studies are reviewed for their methods, projections, and any criticisms or suggestions which may help guide projections made in the future. Due to space limitations, the selection is very small compared to the potential list of publications covering size and structure issues. The discussion is arranged by method.

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Markov Chains

Several studies have used Markov chains to describe the process of farms moving from one size class to another, remaining in the same class, or exiting from farming. In one of the earlier studies, Krenz used census data from 1935 through 1960 to estimate the Markov transition matrix to project the trend in the number of farms in North Dakota. To estimate this matrix of probabilities, Krenz had to make several restrictive assumptions due to the lack of data on individual farms: (1) operators will expand, if possible, (2) farmers who do expand are those initially larger than the average in that size category, (3) increases are gradual, and (4) decreases are not likely to occur. These assumptions can be summarized into these conditions: the largest farms will remain in farming, increases in sizes will be to the next class only, and farms will either grow, remain the same size, or exit; they will not shrink. Krenz projected a continuing decline to 46,814 farms in 1975 and 41,247 farms in 2000 (p.81). However, Krenz found two absorbing states: "no farms" and "1000 acres or more" which meant that, in the final equilibrium state, all farms would either cease to exist or increase to 1000 acres of more. Since this is not very likely to occur, the more interesting prediction is the surviving number of farms in North Dakota which he projected to be 37,500 farms using the 1935 to 1960 base and 32,400 farms using a 1955 to 1960 base (p. 82).

The Markov process used by Lin, Coffman and Penn required that farms be classified into distinct classes or states in each year and a transition matrix be developed to describe the probability of moving (or not moving) from one class or state in one period to another state or class. Usually this was done with census data without worrying about price increases pushing too many farms into larger classes without an actual, real increase. However, between 1969 and 1974 there was nearly an 80% increase in prices received. So Lin, Coffman, and Penn devised a method to attempt to correct for this price increase so that only "real" changes would be left.

They estimated two transition matrices using 1964 and 1969 census data and using 1969 and 1974 (price adjusted) data. The two matrices were very similar. Using acreage classes, the number of farms was projected to decline to 2.1 million in 1990 and 1.7 in 2000 (Table 1).

Using the sales classes, the number of farms is projected to decline to 2.2 million in 1990 and 1.86 million in 2000 (Table 1). This estimate was made using a price inflation of 7.5% per year (p. 43); using a lower inflation estimate results in a projection of 1.85 million in 2000 (p. 44). The assumed price inflation was figured back into the projections after it was taken out to estimate the transition matrices.

Stavins and Stanton improved the Markov process in their study of the New York dairy industry. First, they started with a sample of dairy farms in which they could follow size changes over time. This sample data allowed them to obtain the transition probabilities without using the restrictions required by census data. Second, they regressed the estimated probabilities on a structural variable (i.e., the milk-feed price ratio) and not time. Third, by using a structural variable rather than time, they could project the structural variable and a new set of probabilities under different scenarios of the future. As a final step, they took the projections based on the sample and extrapolated the results to the entire New York dairy industry.

Kaiser and Hammond used Markov chains to predict Minnesota farms by herd size to 1990. Their data source was the Minnesota State Federal Crop Livestock Reporting Service for 1966-1980.

In a more recent analysis of the size and structure issues at the national level, the Office of Technology Assessment (U.S. Congress) used the Markov process to project farm distributions to 2000 (Table 2). Using data from 1969 through 1982, this study concludes that "farm numbers are likely to decline from 2.2 million in 1982 to 1.8 million in 1990 and 1.2 million in 2000" (p. 96). The study also concludes that the future distribution of farms will be a bimodal or bipolar distribution; that is, there will be a large proportion of small and part-time farms, an increasing proportion of large farms, but a decreasing proportion of mid-sized farms (p. 96). Another measure of structural change is the concentration of sales in the larger farms; the OTA study projects that approximately 50,000 of the largest farms in 2000 will account for 75 percent of the agricultural production by year 2000 (p. 9). Similar trends were projected for individual commodities and regions with some differences in the details.

Statistical Models

Two of the four methods used by Lin, Coffman, and Penn were trend extrapolation and negative exponential functions. For trend extrapolation, they evaluated four types of regressions: linear, polynomial, semi-log, and log-linear. They chose to use the semi-log and log-linear functional forms for theoretical and empirical reasons. The resulting projections for the year 2000 were for 1.7 million farms using the acreage distribution and 2.1 million farms using the sales class distribution (Tables 1 and 2). They noted that the projection by sales class was larger than the projection by acreage and reasoned that this was due to a statistical misreading of the direction in the $20,000 to $39,999 class between 1969 and 1974.

To use negative exponential functions, Lin, Coffman and Penn assumed a fixed amount of total land, so that once the average size was determined, the number of farms was known also. That is, they assumed an inverse relation between size and number of firms. Once the functions were estimated, the number of farms were projected, based upon the exogenous projection of land in farms and of average farm size. This projection also requires the distribution over size classes to be stable over time. Lin, Coffman, and Penn's test for structural change indicated that the hypothesis of no structural change could not be rejected (p. 28). Using the negative exponential functions and the acreage classes, farm numbers were projected to decline from 2.9 million in 1974 to 1.8 million in 2000 (Table

1). Except for a slowing in the rate of decline after 1980, the negative exponential function projected a pattern of decline similar to historical trends (p. 29). Projections for sales size classes were done also, but the results departed from current trends in several important ways and were rejected (p. 31 and 32).

Econometric Models

Schatzer, et al. used an econometric simulation model to estimate the potential impacts of changes in average farm size. Their analysis showed that society's goals and policies will affect whether average U.S. farm size will grow. They state that if the goal is to increase farm income, current trends should continue (p. 7). However, if the goal is a larger supply of cheaper food, they find that larger farms will be needed but at a large cost to U.S. farmers.

Teigen analyzed size and structure issues by developing a model to analyze the linkages between farm policy instruments, technological introduction and adoption, and the structure of agriculture. Teigen's model was of an artificial farm industry which utilizes one technology with three inputs (hired labor, fertilizer, and land) to produce one output. Within this model, a new technology was introduced which decreased the marginal productivity of labor and increased the marginal productivity of fertilizer and land by changing only the linear parameters of the production function. Farms changed technologies due to greater profits and the input and output markets adjusted to changes in input use and output production. Farms exited as profits fall below other, non-farm opportunities. Teigen estimated that, without government intervention, some "old-technology" farms would exit directly while a few farms would first switch to the new technology and later exit. Per farm income was estimated to drop slightly in the new equilibrium compared to the initial equilibrium.

The impacts of alternative government policies were analyzed within Tiegen's model. Government programs of acreage diversion, price supports, and parity income slowed the change to a new equilibrium and increased slightly the number of farms in the new equilibrium compared to no government intervention. Net farm income under these programs were slightly higher than without government intervention but still below the initial level.[1] Instituting a new government program of exit annuities paid to farmers who leave farming and not to farmers who remain farming speeded adjustment to the new

[1] One exception to the impact of these traditional programs is the impact of using the acreage diversion program only. This program did not slow the adjustment process and ended with per farm income slightly higher than the initial, pre-new technology level. Teigen contributes this to a numerical coincidence due to the discreteness of the model and hence not a significant difference. The number of farms in the new equilibrium was slightly less than without government intervention.

equilibrium. This program also resulted in farm incomes being higher than the free-market adjustment levels. Government costs were estimated to be less than half the level involved in any price support program. A marketing quota system was estimated to raise per farm income but it also lengthened the adjustment process, and raised government costs to the highest levels of any program considered. However, the resulting number of farms was estimated to increase due to entrants. When an exit annuity was added to the market quota system, several "old" farmers exited and several new farmers entered. The new farmers were not under the quota system, had higher production levels, and had higher incomes per farm than the quota farmers.

Age Cohort Analysis

The fourth projection method used by Lin, Coffman, and Penn was age cohort[2] analysis. This method revolves around (1) the demographics of population dynamics causing changes in the number of potential farmers and (2) the life cycle of farmers. Projections are made by assuming that historical patterns of changes in the number of farmers by age cohort will continue into the future. Entries of younger farmers were assumed to replace parents. Thus, as farmers are projected to quit farming (allowing farm size to increase), there are fewer farmers to be replaced by children. Using age cohort analysis, the total number of farms is projected to be 1.61 million in 2004 (p. 49). Using the distribution of farms by acreage and sales class results in projections of 1.61 million and 1.65 million farms in 2000, respectively (Table 1 and 2).

Programming Models

Sonka and Heady used a linear programming model of U.S. agriculture to estimate the impact of four farm size scenarios: small, medium, large and mixed sizes. They evaluated the impacts, prices, location, income, numbers, labor, food costs, and income generated in the rural nonfarm and agribusiness sectors. They found that none of the four scenarios were clearly superior. Their analysis showed that small farms would provide greater total net farm income, more agricultural and off-farm employment, and more income generated in off-farm sectors. Large farms were shown to have larger net income per farm, lower commodity prices, lower consumer prices, and some incentives for exports.

Linked Census Data

The experience in Canada was analyzed by Ehrensaft, et al. In their analysis of linked census data from 1966 to 1981, they divided the farms into size classes, not by sales

[2] An age cohort are all the people born in the same decade.

volume, but by percentiles formed by ranking all farms in each year. Thus, they avoided the problem of deciding whether the growth in size was due to inflation or real growth. They found a much higher rate of exit and entry than expected. Indeed, after reviewing the length of life for new entrants, they commented, "life in the farm sector ... appears to be distinctly Hobbesian: nasty, brutish, and short" (p. 824). The turnover rate was much higher for the smaller classes than for the larger classes. In the midst of this turnover, the upward mobility was "stately rather than bustling" (p. 826). They also found very few farms decreasing in size; most farms were either staying the same size or exiting with a few growing. All rates (exit, entry, and growth) decreased in the larger size classes. Farms which started in the smaller sizes rarely grew into the larger classes. "The most viable path to the upper ranks of the size scale over the 1966-81 period, then, was to start out among the biggest third of the 1956 farm operators in the first place" (p.827). They found that entry rates varied by commodity and did not conform to preset ideas that supply management hindered entry. When compared to the whole of the U.S. (including the large-farm areas in the Sunbelt), the Canadian changes were slower than the U.S. experience as often said. But they found that the experience in the northern U.S. states was similar to the Canadian experience of change.

Compilation of Methods

Upon comparing their four methods, Lin, Coffman, and Penn note that all "the projections point to a continuous decline in farm numbers, to about 1.75 million farms by 2000" (p. 54). In testing the projection of 1974 using a Thiel-U test statistic, the Markov processes perform the best.

Their most likely projections of farm numbers and size distributions were developed in two steps. First, the total number of farms were estimated based on the acreage distribution using the trend extrapolation and the Markov process. Second, projections by acreage class were computed by multiplying the most likely total number of farms by a synthesized distribution which they obtained from trend extrapolation and Markov process projections (Table 1). Also as part of the second step, projections by sales class were computed by multiplying the most likely total number of farms by a synthesized distribution of farm numbers obtained from Markov process and age cohort analysis (Table 2)[3].

After comparing their four methods, Lin, Coffman, and Penn projected that "farm numbers are likely to decline from 2.87 million in 1974 to 2.32 million in 1985, 2.09 million in 1990, 1.89 million in 1995, and 1.75 million in 2000" (p. 10). Using the new definition of a farm which requires minimum sales of $1,000, they stated that "farm numbers are likely to decline from the 2.37 million in 1978 to 2.05 million in 1985, 1.85 million in 1990, 1.66

[3]See Lin, Coffman, and Penn's Tables 5 and 6 for a more detailed reporting of these projections (p. 11).

million in 1995, and 1.54 million in 2000" (p. 10). (The 1987 Agricultural Census counted 2.09 million farms.)

Using both acreage and sales class distributions, they also projected that the trends towards both larger and smaller farms would continue. However, they said that most of the increase in large farms as measured by sales class would be due to "the expected rise in the index of prices received by farmers rather than a rise in the real output per farm" (p. iii). Related to the growth in size is the concentration of farmland ownership, farm production, and farm wealth. They predicted that the percent of sales from farms with sales of $100,000 and up would increase from 53.7% in 1974 to 95.8% in 2000; the percent share of the largest 50,000 farms was predicted to increase from 31% to 63% (p. 13). These trends were also expected to continue: (1) farm operators renting more of their farmland and (2) the increasing importance of contractual arrangements between farmers and food processors. Their estimates of changes in financial structure may be biased by the upturn in asset values in the 1970s yet not affected by the yet unseen declines in the 1980s.

Structural Change Model

In the second of the Carter-Bergland era reports which we look at more closely, Reimund, Martin, and Moore evaluated the conditions, forces, and processes of structural change in the broiler, fed cattle, and processing vegetable subsectors since World War II. Out of this analysis, they concluded that forces or factors outside farming trigger structural change to exploit new or changed conditions and then to manage new risks. Their list of external forces or factors included: new mechanical, biological, or organizational technology; shifting market forces and demand; and new Government policies and programs. They develop these observations into what they call a preliminary model of the agricultural change process which they divide into four parts or stages:

1. Technological change

   New technology is adopted by the innovators (including input suppliers, processors, and distributors, as well as farmers). The innovators were often new entrants.

2. Shift in location of production

   New areas have resources which are more amenable resources to the new technologies.

3. Growth and development

   Output increases due to new efficiencies. Farms and firms become larger. Specialization and concentration occur. Market economies develop in the new areas. Risks are altered due to these changes.

4. Adjustment to risk

New risk aversion strategies are developed. These include the increased use of forward sales and production contracts and other forms of increased coordination between suppliers, producers, and processors. More of the control over the product shifts from the farmer to the stages closer to the consumer. The subsector becomes more industrialized.

Reimund, Martin, and Moore examine three subsectors in detail: broilers, fed cattle, and processing vegetables. In each they identify the preconditions to structural change (i.e., technological factors, resource and product market factors, and policy factors) and then describe how the structural change process fits the agricultural change model just described.

They also studied the conditions and trends in the hog, feed grain, dairy, and fruit subsectors and found the model able to explain the structural change which has occurred in these subsectors. There are differences in how these other subsectors have changed structurally, but the basic process described in the change model is followed. For instance, in the feed grain subsector, new technologies have been adopted, farms have increased in size and specialization, and new areas have been developed. However, these changes have not occurred rapidly due to the older production areas still producing which have established tenure and ownership patterns. Government commodity programs have also helped slow some of the rapidity of change found in other subsectors.

Reimund, Martin, and Moore conclude that "it would be difficult if not impossible to control structural change in agriculture solely through manipulation of existing policy variables" (p. 65). This difficulty is apparently due to policy variables exerting their influence primarily through their interaction with technological development and market forces. "Policies could, however, provide a basis for influencing the structural basis through their impacts on such structural dimensions as adoption of technology, geographic relocation, and producer risks" (p.65).

Regional and Commodity Studies

Several regional and commodity specific studies of size and structure have also been undertaken in the past (and continue to be analyzed currently). Among these past studies is a California specific study (Carter and Johnston) which surveyed the literature, reviewed the historical data, and then drew out implications for the future of California's agriculture industry. They covered topics included policy, taxation, economies of size, product marketing, risk, labor, energy use, mechanization, and the rural community. Moore, Wilson, and Hatch addressed the size and structural issues in context of federal irrigation projects and the acreage limitation policy. As part of their study, they estimated the economies of size for farms in irrigation project. An example of a sector-specific study is Hayenga, et al., which studied the U.S. pork sector for its organizational structure, historical trends, coordination systems, performance, and policy options.

Current Projections of Structural Change

The structure of American agriculture in future decades will necessarily be influenced by its current structure and the way it has evolved through time. One approach to making projections of likely change to the year 2000 is to extend trends based on changes over recent time spans. An examination of changes in the distributions of farm numbers by standard size classes using census data makes use of a widely recognized data base.

One of the problems when comparing changes in size distributions based on sales through time is that both price levels and technology change. Thus, the size class, $10,000-20,000 of sales, in 1969 is roughly equivalent to $20,000-40,000 of sales in 1978 because prices approximately doubled in that period (Table 3). But this adjustment for inflation by itself does not take into account how much more output one worker produced because of changes in technology. Unadjusted data for the three most recent census periods, when price changes were relatively small, are summarized in Table 3 along with the size distribution for 1969 adjusted to 1978 prices. Observations with nominal sales of $500 or less in 1969 were omitted because of the change in definition of a farm.

Changes in farm numbers over this span of 18 years are relatively small considering that in the previous 20 years, 1950 to 1969, farm numbers in the United States had been cut in half, from 5.4 to 2.7 million, with no change in the definition. The reduction of 300,000 farms between 1969 and 1987 is still important with 50 percent of the total occurring between the 1982 and 1987 censuses. A few important points can be made when looking at this basic table:

(1) The group of residential and part-time farms with sales of less than $20,000 accounted for about 60 percent of the total number in each census period, when 1969 is adjusted to a 1978 base.

(2) Reductions in numbers occurred mainly among the part-time and small commercial farms with sales of $20,000-39,999 and $40,000-99,999.

(3) The number of farms with sales of $100,000 or more increased with the rates of increase less between 1982 and 1987 than in earlier years.

Adjustments of 1978 Census Data to a 1987 Base

While the changes in prices received by farmers between 1978 and 1987 are modest compared to the doubling of prices between 1969 and 1978, it is important to recognize these differences as well and their effects on the distributions. Farm prices rose modestly between 1978 and 1982, by 15.65 percent; they fell on average between 1982 and 1987 by 5.3 percent. The net change over the nine years was 9.1 percent (Table 4).

In order to examine the overall change in the size distribution between 1978 and 1987, adjustments were made in each of the size classes for 1978 to reflect numbers in the class if the prices of 1987 had been effective, 9.1 percent higher, in establishing the class interval in each case (Table 4). Numbers in each size class were rounded to the nearest thousand to facilitate comparisons.

Reductions in numbers were largest in the part-time and small commercial farm groups with sales of $20,000-39,999 and $40,000-99,999. The large class which includes 60 percent of farm numbers, sales of less than $20,000, also reflect a small percentage reduction, but accounted for about one-third of the absolute decrease in numbers in the first three classes in Table 4. In contrast, numbers increased in each of the three largest classes; half of these were in the $100,000-249,999 group.

Percentage changes in each of the size classes were calculated as one basis for extending trend from the 1987 distribution to the year 2000. Here, the assumption would be that the change over in that nine-year period might well be repeated in the next 13 years.

Value of Sales by Size Class

While it is both interesting and instructive to examine the changes over time in numbers of farms in each size class, it is also important to recognize what is implied in terms of the shares of total production from agriculture that comes from each of these classes. The unadjusted data for the three most recent census years are provided in Table 5.

The changes in the shares of total value of production that have occurred between each of these census periods is more striking than the changes in numbers. In 1978, if output from all farms with sales of less than $40,000 was treated as one group, it accounted for a larger share of the total than that produced by farms with sales of $250,000-499,999, 15.7 percent compared to 12.0 percent. The three groups including the largest farms made up 62.9 percent of the total; those with sales of $500,000 or more made up 27.7 percent.

In contrast, by 1987 the smallest farms (less than $40,000 of sales) accounted for about 10 percent of the total. The three largest categories were now 76.3 percent and those with sales of $500,000 or more, 38.2 percent. The small commercial farms (sales of $40,000-

99,999), still a very important part of the numbers of units where farm income was the primary source of family income, had decreased to only 13.8 percent of the total. Important changes occurred in the decade in the proportions of total sales coming from the farms in the largest size category.

Projections of Farm Numbers Based on Trend 1978-87

Most projections are based on some kind of historical trend, whether it be quite simple explanations or more sophisticated calculations like Markov processes. As first approximations of what might occur in the year 2000, the percentage changes which occurred in each of six size categories for the period 1978-87 was examined after corrections were made to place the 1978 data on a 1987 base for prices received (Table 4). The percentage changes observed were rounded and a set of "conservative" estimates based on trend were developed for the year 2000 in Table 6.

A continuation of the loss in farm numbers in the three smallest size classes is projected. In the group with sales of less than $20,000, the reduction is 77,000 farms, a relatively small number. Most of this decrease is likely on the farms with sales between $10,000 and $20,000 based on historical experience. In a similar fashion, there are important reductions of 68,000 part-time farms with sales between $20,000 and $40,000. There is a sizable decrease of 25 percent in numbers for the small commercial category, sales of $40,000-99,999. A total of 203,000 farms are projected to drop out of these three smaller size groups.

The three larger size groups are all assumed to increase by 15, 20 and 40 percent, respectively. The increases in numbers are more modest; a total of 56,000 is added. The net decrease considering all six classes is 147,000 farms or about 7 percent in total.

Projections of Farm Numbers Based on 1982-87 Trend

Another approach to projecting trend is to consider the rate of change in the most recent five-year census period (Table 7). This is the recent period when the farm debt crisis was at its peak and when many considered the rate of exodus from commercial farming to be larger than normal. One then could consider projections on this kind of basis to emphasize a continuing rapid rate of exodus and change for the future.

The projections made in Table 7 are rough approximations of the rates of change observed for a five-year period expanded to cover the 13 years between 1987 and 2000. Technically, rates of decline for the smaller size groups should reflect the smaller base in each successive year just as the increases are built on a successively larger base. The percentages are reflections of this process calculated as a period average with rounding and personal judgment included.

In this projection, four of the size intervals show decreases in numbers. There is a small increase of 5,000 farms in the next to largest category and an increase of 10,000 in the largest. The net decrease in farm numbers projected is 295,000. Again, the bulk of the decrease is observed in the two smallest categories, 198,000 or approximately two-thirds of the numbers. But there is a decrease of 86,000 in the small, commercial category and 26,000 in the $100,000 to $250,000 size class.

Projections of Farm Numbers Compared to OTA Projections

A summary of the two trend-based projections compared with the OTA (U.S. Congress) estimates published in 1986 using Markov processes methodology is presented in Table 8. The OTA projections did not adjust for changes in prices over this period; hence, the numbers assume similar rates of changes in prices in succeeding years. The projections made in Tables 6 and 7 are based on 1987 prices.

The most striking difference among the projections is that reported for farm numbers with sales of less than $20,000. Actual reductions in numbers between 1978 and 1987 were less than 100,000 as reported by the census (Table 3). It seems unlikely that the exodus projected in residential and small, part-time units will be as large as that suggested in the OTA report. In terms of total numbers of farms, the difference in the projections for this class alone accounts for all but 54,000 of the total difference in one projection and for all but 126,000 in the other.

A comparison of the projections when the two classes with sales between $20,000 and $100,000 are combined is interesting as well. The totals in each of the three cases are quite similar falling in a quite narrow range, from 363,000 to 388,000 farms. All three projections suggest a decrease from the 1987 totals of more than 125,000 farms, based on the large reductions that have occurred in the 1970s and 1980s.

Comparisons for Farms with $40,000 of Sales or More

Much of the interest in changes in the structure of agriculture is centered on what is happening in the commercial sector ($40,000 of sales or more), where more than 90 percent of total sales were obtained in 1987. One of the areas of greatest interest has been rates of change in the numbers of "small, family" farms, often associated with those selling between $40,000 and $100,000 annually. In 1987, it accounted for nearly half of these farms, while in 1978, corrected to a 1987 price base, it amounted to 58 percent of the total (Table 4). Alternative projections for changes in numbers are provided in Table 9.

The projections based on the 1978-87 trend suggest the smallest deviations from the 1987 census distributions. A very small change in the total is projected. Much of the decrease in the smallest category is seen moving into the next largest class, $100,000-249,999.

There are important increases in each of the three largest size categories. A separate class for farms with sales of $1,000,000 is added to insure consideration of the impact of this relatively small number of farms, which in 1987, accounted for 30.9 percent of all sales (Table 10).

The projections based on trends between 1982-87 are more nearly like those developed by OTA than those based on 1978-87 changes. The numbers in the smallest commercial class are essentially the same. OTA projects a much larger proportion moving into the $250,000-499,999 class than does the trend between 1982-87. One of the difficulties in making these comparisons is the slightly different class intervals used by OTA and the need to arbitrarily divide those projections into the current sales categories established by OMB for such distributions.

Projections Assuming More Rapid Reductions in Percentage Terms

Two other distributions were developed on the assumption that very rapid reductions in farm numbers might come about as a result of changes in technology, relatively low prices for agricultural products, and agricultural supply outrunning effective demand. The distribution of expected increases and decreases for each size class reflects changes observed in the recent past but are "intuitive" rather than "objective" determinations.

A reduction of 25 percent in total commercial operations in a span of 13 years is much greater than the annual rates experienced between 1982 and 1987. This could be looked at as a "worst case scenario" of rapid exodus from agriculture. About 165,000 farms are forced out of the two smallest categories so that 17,000 can be added to numbers in the three largest size groups. The projected increases in the two largest classes, $500,000 and over, still only yield 40,000 farms compared to the OTA estimate of 50,000. It took a reduction of about 40 percent in farm numbers to bring the number of farms in these two largest size categories up to 50,000.

Total Value of Sales Associated with Different Projections

One additional way to examine what is implied by different projections is to study total sales associated with the numbers assigned to each class. The assumption of average sales for each class is basic to this process. Because all of the projections make use of the Census distributions, the average for each class in 1987 was used to make the calculations summarized in Table 10.

The percentage distribution of total sales from all farms with sales over $40,000 in 1987 is provided as a basis for comparison. For the $40,000-99,999 group of small commercial farms, each of the projections except the last in Table 10 indicates about 9 or 10 percent of total sales to come from this group but still includes no less than 40 percent of "commercial" farm numbers. There is much greater variation in the percentages attributed to farms with $100,000-249,999 of sales. In all cases, more of total sales comes from this group than from the smallest commercial class. In all of the projections of farm numbers, 65 to 80 percent of the total are included in these two classes. But they account for only 20 to 35 percent of total sales, again excluding the projection of a 40 percent reduction in numbers as extreme.

The midpoint of the three largest classes, particularly that for farms with $1,000,000 or more of sales, has an important effect on the percentages. The 1987 census indicated an average of $3.4 million per farm. No doubt, those units moving into this class from the $500,000-999,999 class would initially help to move that average down if the number moving in were large. On the other hand, the continuing units also have the capacity and management to continue to grow. The projections all suggest increasing proportions of total sales to come from this relatively small number of farms, from 14,000 to 17,000 in number.

The amount of historical data available concerning this class of largest farms and its changes through time is meager at best. The census provided summary data nationally for the first time in 1987. USDA has not yet published such annual estimates in its Economic Indicators of the Farm Sector. Nevertheless, it is one of the more important classes in terms of the future structure of American agriculture. Some special tabulations from past censuses on an aggregate basis could be useful in trying to improve estimates of likely change in this increasingly important component of the agricultural production.

Farms with $500,000 or More of Sales by State, 1987

Information about the distribution of farms with sales of $1,000,000 or more by state was not released in the 1987 census but compilations were made for farms with $500,000 of sales or more. The largest farms are quite widely distributed across the United States but 36 percent of the numbers and 49 percent of total sales are associated with farms in five states (Table 11). If one divides the number of farms in each of these states into the total value of sales, it is quite clear that an important number of farms with $1.0 million or more of sales are located in Colorado and Arizona as well from among the next five states. The top ten states include 51 percent of the farms and nearly 64 percent of these sales.

In contrast, the 35 states with the smaller numbers of large farms make up 35 percent of the total number and 27 percent of sales for this size class. The largest farms in the United States are in the irrigated West, the Great Plains, the Western Corn Belt and parts of the South. One can assume that an important part of future increases are likely to occur in these locations, although the adoption of new technology may well change the incidence of change in some agricultural sectors.

Impact of Changes in the Economic Environment on Structure

Movement Toward Free Trade in the International Economy

The GATT negotiations are giving agriculture major attention with some prospect that a shift toward less distortions in trade and a move away from protectionism could occur in stages during the 1990s. The rate at which markets will be opened is likely to be slow and deliberate. Nevertheless, such a step internationally should encourage production of crops and livestock in those locations around the world where there is the greatest comparative advantage.

Such a movement should generally speed up the rate of structural change in the United States as market prices play a more important role in allocating agricultural resources. The impact is likely to be modest in total, however. The rate of change internationally will be slow. In many sectors, the primary market of agricultural producers is domestic. There will continue to be some kind of governmental support structure underlying most of the export crops both here and in the EC in the 1990s. While the direction of change seems clear, this influence by itself will not be easy to recognize in the next decade. Perhaps the most important effect will be in the atmosphere in which decisions are made. A shift to more open economies and less government intervention will encourage successful managers to invest in agriculture where they feel profitable opportunities exist.

Movement Toward Protectionism and Closed Economies

Alternatively, an accommodation with the EC, Japan, and many countries with protected domestic agriculture to move toward more open economies may not be accomplished. In this setting, the export-based parts of our agricultural economy must operate in a less favorable economic environment. This should have some tendency to slow down the rate of change especially if it entails some kind of government production controls on key commodities. Any programs that establish production quotas will slow down structural change. Farms with sales of $40,000-99,999 (1987 prices) will have greater viability. Quotas will take on value as capital assets. The projections based on trends between 1978-87 will be more credible than those based on the 1982-87 period.

Impact of Food Safety and Environmental Concerns

It is difficult to establish clearly how concerns about food safety and environmental protection will be reflected in the rates at which farm numbers in the different size classes change. It seems likely that some of the advantages of monoculture and specialization will be reduced. Contract arrangements for marketing may become more important as stricter standards for product quality and pesticide use are enforced. Expansion of livestock enterprises at single locations may be slowed because of point pollution problems, restrictions established by local governments, and ground water concerns. Overall, this set of issues may slow expansion of the largest farms and at the same time speed the exit of some part-time operations. Low input sustainable agriculture will also tend to allow smaller commercial enterprises (sales of $50,000 to $150,000) to compete; hence, the declines in numbers for those size classes might be slowed.

The Possibility of Chronic World Food Shortages

In a period when chronic surplus problems have been the rule in North America, it may seem strange to consider the possibility of food shortages by the year 2000. As world populations continue to increase at constant percentage rates, it is conceivable that the ability to expand production will not keep up with food needs particularly if there is a sustained period of unfavorable weather in major producing regions. Price variability would clearly increase. The grains sector and livestock farms would be strongly affected with enhanced expectations of profitability in crop production. The short run effects in the decade of the 1990s would be to keep more farms in agriculture; in succeeding decades into the next century, the decline in numbers and shift to ever larger units of operation would likely accelerate. This commentary, from the perspective of the beginning of the 1990s, is more academic than the other scenarios.

Concluding Comments

The process of making specific projections of farm numbers by size classes is more useful in thinking about the forces that have led to changes in the recent past and those that are likely to prevail than in the projected numbers themselves. A few central points stand out from this exercise:

1. Historically, about 60 percent of all the producing units defined as farms sell less than $20,000 of agricultural product (1987 prices). Unless the definition of a farm is changed and that seems unlikely, this proportion is likely to continue or might even grow a little larger. It is here that this trend-based analysis is most divergent from the OTA projections.

2. The number of part-time farms with sales of $20,000-39,999, have declined in importance in terms of both numbers and the total value of sales in the past 20 years. It seems most likely that this trend will continue under nearly any scenario projected, particularly if environmental regulation and requirements increase in the 1990s.

3. The much talked about decline in the number of small, family farms, where farming provides the major source of family income (sales of $40,000-99,999), is likely to continue as it has in the past 20 years. The importance of this group as a proportion of the total number of "commercial" farms is also decreased somewhat. Nevertheless, this group will continue to be the most important in terms of total numbers among all farms with sales of $40,000 or more in any serious projection developed. The rapid disappearance of this group and the demise of family farms does not emerge from any of the projections considered likely by 2000.

4. In nearly all of the projections, the number of farms with sales of $100,000-249,999 is substantially smaller than those with $40,000-99,999 but larger than the next three size categories. While it is possible that the number of these farms in the year 2000 will be larger than 1987 as smaller family farms expand modestly, most projections suggest somewhat smaller numbers.

5. The rate at which there are increases in numbers in each of the three largest size classes based on sales is most difficult to project given the limited historical bases, especially for farms with sales of $1,000,000 or more. This largest size category deserves more attention than it has received. All of the projections indicate that a small absolute increase in the number of these farms is associated with a substantial increase in the proportion of total sales arising from this size group. The impact of these farms on other commercial farms in the area, on input supply and on markets for agricultural output deserves increased attention.

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Table 1. PROJECTIONS OF FARM NUMBERS TO THE YEAR 2000 BY SIZE OF FARM

Study & Method	1-99	100-219	220-499	500-999	1000-1999	2000 & up	All Farms
	Size by Acreage						
	(1,000 farms)						
<u>Lin, Coffman, and Penn</u>:							
Most likely:	827	302	264	183	102	71	1,750
Trend Extrapolation:	751	300	286	205	108	61	1,711
Negative Exponential:	320	313	501	430	224	37	1,826
Markov Process:	865	290	230	153	92	77	1,705
Age Cohort:[4]	934	301	220	156	98	54	1,772

[4]For the Age Cohort analysis, the projection reported in this table is for the year 2004.

Table 2. PROJECTIONS OF FARM NUMBERS TO THE YEAR 2000 BY SALES CLASS

	Sales Class (1000 $)								
Study & Method	from: 0- up to: 2.5	2.5- 10	10- 20	20- 40	40- 100	100- 200	200- 500	500 & up	All Farms
	(1,000 farms)								
<u>Lin, Coffman, and Penn</u>:									
Most likely:	604	186	100	88	214	161	183	217	1,750
Trend Extrapolation:	456	201	164	443	539	188	81	27	2,109
Negative Exponential:	13	42	53	102	271	354	606	417	1,857
Markov Process:	640	180	108	88	262	168	190	226	1,862
Age Cohort:[5]	655	219	100	100	190	---->	600	<----	1,864
<u>U.S. Congress, OTA</u>:	-------	->	638	--->	363	75	125	50	1,250

[5]For the Age Cohort analysis, the projection reported in this table is for the year 2004.

Table 3. FARM NUMBERS BY SALES CLASS
Census, United States, 1969, 1978, 1982, 1987

Sales Class	1969 in 1978 prices	1978	1982	1987
Index of prices received by farmers, 1977=100	(59) 118	115	133	126
		- number of farms -		
Under $5,000	686,176	761,234	814,535	753,214
$ 5,000 - 19,999	748,347	613,303	540,809	525,566
Subtotal	1,434,523 (60.2%)	1,374,537 (60.9%)	1,355,344 (60.5%)	1,278,788 (61.3%)
$ 20,000 - 39,999	395,472 (16.6%)	299,175 (13.3%)	248,825 (11.1%)	225,671 (10.8%)
40,000 - 99,999	396,697 (16.6%)	360,093 (16.0%)	332,751 (14.9%)	287,587 (13.8%)
$100,000 - 249,999	103,990	165,493	215,912	202,550
250,000 - 499,999	40,460	38,202	58,668	61,148
500,000 and over	11,535	17,973	27,800	32,023
Subtotal	155,985 (6.6%)	221,668 (9.8%)	302,380 (13.5%)	295,721 (14.2%)
Total	2,384,788**	2,255,473*	2,239,300*	2,087,759

* Totals adjusted downward by unclassified abnormal farms.
**Reduced from 2,730,250 to account for all farms with sales of $500 or less in 1989 because of definition change.

Table 4. NUMBER OF FARMS BY SALES CLASS
1987 Base, United States, 1978 and 1987 Census

Sales Class	Actual 1978	Net adjustments for prices 9.1%	1978 Census on 1987 base	Actual 1987	Percentage change
			- number of farms -		
Residential and Part-time:					
Under $20,000	1,375,000	-27,000	1,348,000	1,279,000	-5.4%
$ 20,000 - 39,999	299,000	-3,000	296,000	226,000	-31.0%
Small Commercial:					
$ 40,000 - 99,999	360,000	-5,000	355,000	288,000	-23.3%
Large Commercial:					
$100,000 - 249,999	165,000	+17,000	182,000	202,000	+11.0%
250,000 - 499,999	38,000	+13,000	51,000	61,000	+19.6%
500,000 and over	18,000	+5,000	23,000	32,000	+39.1%
Total	2,255,000*		2,255,000	2,088,000*	-9.1%

*Reduced by number of unclassified "abnormal" farms.

Table 5. TOTAL VALUE OF SALES BY SIZE CLASS
Census, United States, 1978, 1982, 1987

Sales class	1978	1982	1987
		- millions -	
Under $20,000	$ 8,181	$ 7,260	$ 6,967
$ 20,000 - 39,999	8,599	7,142	6,448
Subtotal	$ 16,780 (15.7%)	$ 14,402 (10.9%)	$ 13,415 (9.9%)
$ 40,000 - 99,999	$ 22,869 (21.4%)	$ 21,642 (16.4%)	$ 18,764 (13.8%)
$100,000 - 249,999	$ 24,772	$ 32,930	$ 31,178
250,000 - 499,999	12,848	19,851	20,740
500,000 and over	29,559	42,764	51,952
Subtotal	67,179 (62.9%)	$ 95,545 (72.7%)	$103,870 (76.3%)
Total	$106,828*	$131,589*	$136,049

*Reduced by aggregate sales from "abnormal" farms.

Table 6. PROJECTED* NUMBER OF FARMS BY SALES CLASS
1987 Prices, United States, 1987 and 2000

Sales class	Actual distribution 1987	Trend percentage change (1978-87)	Projection for 2000
		- number of farms -	
Residential and part-time:			
Under $20,000	1,279,000	-6%	1,202,000
$20,000 - 39,999	226,000	-30%	158,000
Small commercial:			
$40,000 - 99,999	288,000	-20%	230,000
Large commercial:			
$100,000 - 249,999	202,000	+15%	233,000
250,000 - 499,999	61,000	+20%	73,000
500,000 and over	32,000	+40%	45,000
Total	2,088,000	-7%	1,941,000

*Projection based on trends between 1978 and 1987.

Table 7. TREND PROJECTED* NUMBER OF FARMS BY SALES CLASS
1987 Prices, United States, 1987 and 2000

Sales class	Actual distribution 1987	Percentage change based on 1982-87 rates	Projection for 2000
		- number of farms -	
Residential and part-time:			
Under $20,000	1,279,000	-12%	1,126,000
$20,000 - 39,999	226,000	-20%	181,000
Small commercial:			
$40,000 - 99,999	288,000	-30%	202,000
Large commercial:			
$100,000 - 249,999	202,000	-13%	176,000
250,000 - 499,999	61,000	+9%	66,000
500,000 and over	32,000	+30%	42,000
Total	2,088,000	-14%	1,793,000

*Trend based on annual rates of change between 1982 and 1987.

Table 8. ALTERNATIVE PROJECTIONS OF SIZE DISTRIBUTION OF FARMS United States, Year 2000

Size class	1987 Census	OTA projection 1982 base	Trend 1982-87 change	Trend 1978-87 change
Under $20,000	1,279,000	638,000	1,126,000	1,202,000
$20,000 - 39,999	226,000	363,000	181,000	158,000
40,000 - 99,999	288,000		202,000	230,000
$100,000 - 249,999	202,000	75,000*	176,000	233,000
250,000 - 499,999	61,000	125,000*	66,000	73,000
500,000 and over	32,000	50,000	42,000	45,000
Total	2,088,000	1,251,000	1,793,000	1,941,000

*OTA used $100,000-199,999 and s$200,000-499,999 as the size classifications; proportionately these could be reallocated to 100,000 farms in each of the Census classes.

Table 9. ALTERNATIVE PROJECTIONS OF SIZE DISTRIBUTION, COMMERCIAL FARMS
1987 Base, United States, Year 2000

Size class 1987 prices	1987 Census base	1978-87 trend base	1982-87 trend base	Adjusted OTA projection 1982	25% reduction in numbers	40% reduction in numbers
			- number of farms -			
$ 40,000 - 99,999	288,000	230,000	202,000	203,000	175,000	115,000
100,000 - 249,999	202,000	233,000	176,000	100,000	150,000	110,000
250,000 - 499,999	61,000	73,000	66,000	100,000	70,000	75,000
500,000 - 999,999	21,000	30,000	28,000	33,000	25,000	30,000
$1,000,000 and over	11,000	15,000	14,000	17,000	15,000	20,000
Total	583,000	581,000	486,000	453,000	435,000	350,000

Table 10. TOTAL VALUE OF SALES AND PROPORTIONS OF TOTAL BY SIZE CLASS
1987 Base, Projections for United States, Year 2000

Size class 1987 prices class midpoints	Actual 1987 census base	Projection 1978-87 trend	Projection 1982-87 trend	Adjusted* OTA projection 1982	25% reduction in numbers	40% reduction in numbers
			- percent of total sales -			
$ 40,000 - 99,999 (65,000)	15.3	10.2	10.2	9.2	9.0	5.4
100,000 - 249,999 (155,000)	25.4	24.5	21.1	10.9	18.4	12.3
250,000 - 499,999 (340,000)	16.9	16.9	17.3	23.8	18.8	18.5
500,000 - 999,999 (675,000)	11.5	13.8	14.6	15.6	13.4	14.6
1,000,000 and over (3,400,000)	30.9	34.6	36.8	40.5	40.4	49.2
Total sales, billions	$122.7	$147.1	$129.4	$142.8	$126.3	$138.3
Total farms	583,000	581,000	486,000	453,000	435,000	350,000

*Adjustments made to split classes proportionately from OTA distributions.

Table 11. FARMS WITH $500,000 OR MORE OF SALES
States by Rank, Census, 1987

State	Number of farms		Value of sales	Percent of total
			millions	
1. California	5,641		$10,313.8	19.9
2. Texas	2,142		5,573.4	10.7
3. Kansas	957		3,533.8	6.8
4. Florida	1,455		3,214.3	6.2
5. Nebraska	1,279		2,829.2	5.4
Subtotal	11,474	(35.8%)	$25,464.5	49.0
6. Colorado	688		$ 1,932.3	3.7
7. Iowa	1,630		1,643.4	3.2
8. Washington	962		1,460.7	2.8
9. North Carolina	1,084		1,287.8	2.5
10. Arizona	555		1,271.0	2.4
Subtotal, 10	16,393	(51.2%)	$33,059.7	63.6
11. Idaho	662		$ 1,077.1	2.1
12. Arkansas	903		1,005.0	1.9
13. Georgia	935		993.0	1.9
14. Illinois	1,059		978.0	1.9
15. Minnesota	860		952.1	1.8
Subtotal, 15	20,812	(65.0%)	$38,064.9	73.2
Other 35 states	11,211	(35.0%)	13,887.4	26.8
Total, United States	32,023		$51,952.3	100.0