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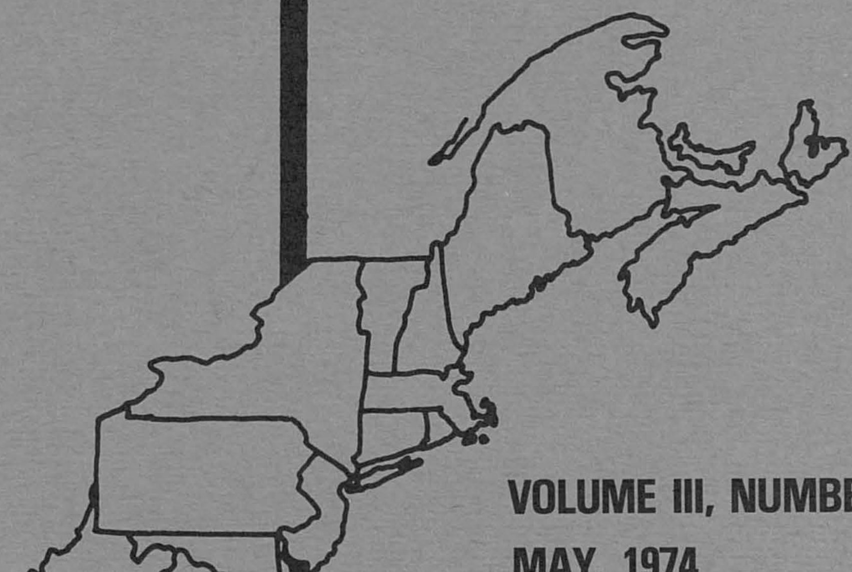

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AN EVALUATION OF DIFFERENT WAYS OF PROJECTING FARM SIZE DISTRIBUTIONS

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Introduction

Farris and Padberg [4], Krenz [5], and Boxley [1] have discussed different ways of projecting the distribution of firm sizes. Farris and Padberg utilize Markov chain analysis where transition probabilities were derived from observed changes in firm size for Florida citrus packing firms over a five-year period. Krenz, recognizing the difficulty of securing data with which to estimate transition probabilities, developed rules which could be used to derive transition probabilities from census data. Krenz applied this technique to the size distributions of North Dakota farms. Finally, Boxley applied a completely different technique to estimating farm size distributions in the United States. Boxley's technique involved fitting negative exponential functions to firm size distributions observed from census data. According to Boxley, these functions were sufficiently stable to permit estimation of future firm size distributions.

The purpose of this paper is to compare these three techniques of projecting farm size distributions with respect to their accuracy of projections in a specific situation. The specific example to be investigated is the size distribution of dairy farms in New Hampshire. The State Veterinarian in the New Hampshire Department of Agriculture makes an annual brucellosis ring test of all cows in the State which are 30 months or more of age. These tests provide an annual record of all milk cows in New Hampshire.

Records for the years 1961, 1966 and 1971 were the data used in comparing the three techniques of projecting farm size distributions. The data for 1961 and 1966 were used to develop transition probabilities for both the Farris and Padberg and the Krenz techniques. Similarly, these data were used in fitting negative exponential functions and testing for stability over time. Estimated farm size distributions for 1971, using

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all three methods were then compared with the actual distribution for that year.

Results

"Ordinary" Markov projections (the type used by Farris and Padberg and hereafter referred to simply as Markov projections) and Krenz type projections were based on farm size distributions in 1961 and 1966. The Markov projections include information on observed farm movements between size classes while the Krenz approach is based on transition probabilities developed according to the following rules [5, p.78]:

1. Farms in largest size class remain in their size class.
2. Increases in farm numbers in any size class come from the next smaller size class.
3. Any decrease in farm numbers in any size class, except those resulting from rule 2, above, result in a movement to the zero or "out of business" size class. In other words, they are assumed to go out of business rather than move to the next smaller size class.

Actual movements of farms between size classes, from 1961 to 1966, are presented in Table 1. Estimated movements, knowing only the distribution in 1961 and 1966 and using the rules noted above, are presented in Table 2. These data were used to compute transition probabilities for the Markov and Krenz approaches.

Both Markov and Krenz projections were based on the assumption that the number of potential entrants to the industry is equal to one. This assumption was chosen to reflect the nearly non-existent potential entrants to dairy farming in New Hampshire. Further, in both cases, the percentage farm size distribution in 1971 was used for projection purposes. These were used in place of the size distribution expressed in number of farms which results from the product of the initial distribution of farms and selected powers of the transition probability matrix [6]. The percentage distribution, applied to an estimate of the number of farms in 1971, yielded estimates of the number of farms in each size class for that year. The procedure of using percentage distribution and applying them to independent estimates of total farm numbers was chosen to minimize the effect of the potential entrants cell on projections [7]. The number of firms in 1971 was estimated to be 690 farms which was based on a trend analysis of farm numbers in 1964, 1965 and 1966.

Boxley type distribution equations for 1961 and 1966 were as follows:

(1) $Y = 105.897\ e^{-1.24550X}$ $\quad R^2 = 0.99$, $\quad t = 22.63$

(2) $Y = 103.683\ e^{-1.29169X}$ $\quad R^2 = 0.96$, $\quad t = 10.24$

Table 1. Distribution of Farm Sizes and Actual Movement Between Size Classes--Used In Markov Analysis

Size Classes-Number of Cows 1961	Size Classes - Number of Cows - 1966							Total
	0	1-19	20-29	30-49	50-74	75-99	100+	
	(Number of Farms)							
0	1	0	0	0	0	0	0	1
1-19	1135	153	61	35	2	2	2	1390
20-29	220	62	147	86	14	0	1	530
30-49	151	10	45	179	68	2	3	458
50-74	35	2	0	21	48	13	7	126
75-99	8	0	1	0	5	12	8	34
100+	3	0	0	0	0	0	5	8
Total	1553	227	254	321	137	29	26	2547

Table 2. Distribution of Farm Sizes and Estimated Movement Between Size Classes--Used In Krenz Analysis

Size Classes-Number of Cows 1961	Size Classes - Number of Cows - 1966							Total
	0	1-19	20-29	30-49	50-74	75-99	100+	
	(Number of Farms)							
0	1	0	0	0	0	0	0	1
1-19	1163	227	0	0	0	0	0	1390
20-29	276	0	254	0	0	0	0	530
30-49	113	0	0	321	24	0	0	458
50-74	0	0	0	0	113	13	0	126
75-99	0	0	0	0	0	16	18	34
100+	0	0	0	0	0	0	8	8
Total	1553	227	254	321	137	29	26	2547

Where: Y = percent of farms above a certain size class
X = relative farm size defined as lower limit of size class divided by average firm size.

The equations for 1961 and 1966 were good fits relative to the usual statistical criteria. In both cases the coefficient of determination was greater than 0.96 with the coefficients to relative farm size being statistically different from zero at the ninety-nine percent level of confidence. These equations were estimated by least squares subject to the restriction that the function passes through the point (0.046, 100)--that is, the function is such that at relative size 0.046 (i.e., lower limit of first size class divided by average firm size) the percent of firms above this lower limit is 100 percent.[1/]

Parameters of both equations were tested for equality using the procedure developed by Chow [3]. The F statistic was 0.06 which indicates that there were no statistical differences between the parameters estimated with the 1961 and 1966 data. This result suggests that over a five year period the estimated parameters are sufficiently stable to permit their use in projection. The use of Boxley type distribution equations are appropriate for situations where past trends have been fairly stable and transitions that occur in farm size distributions are controlled by the empirical past rather than by new events [2]. The Chow test employed suggests a "statistical" stability.

Using the 1966 equation, and an estimate of the average farm size in 1971 (46 cows) which was also derived from a trend analysis of average firm size in 1964, 1965 and 1966, the farm size distribution for 1971 was estimated. Again, the percentage distribution was computed and applied to the estimated number of farms, 690, in 1971.

As indicated in Table 3, the Markov and Krenz projections both under-estimate the actual number of farms in most size classes. The Boxley estimates are also generally lower than the actual number of farms in each size class. In the first size class, however, the Boxley estimate is substantially larger than the actual number of farms.

To summarize these three types of projections, a "total deviation from actual" statistic was computed. This total deviation statistic is defined as the square root of the sum of squared deviation of each estimate from the actual number of farms. It is not surprising that the Markov projections are superior to the other two since there is more adequate information about the transition changes. The Krenz projection is quite similar to the Markov projection while the Boxley projections are substantially poorer. In short, the choice of the Boxley type technique is inappropriate because of the instability, or changes in structure that have occurred since 1966.

1/ More specifically, in the model $Y = \alpha e^{\beta x}$, where ε is the residual, $\Sigma\varepsilon^2$ is minimized with respect to β subject to the restriction $\alpha = 100/e^{\beta(0.046)}$.

Table 3. Projected Farm Size Distribution, 1971--Alternative Methods

Type of Projection	Size Classes--Number of Cows						Square Root of Sum of Squared Deviation From Actual
	1-19	20-29	30-49	50-74	75-99	100+	
	(Number of Farms)						
Markov	86	146	237	141	35	45	42.8
Krenz	43	142	263	163	32	47	66.5
Boxley	281	100	132	88	44	44	238.1
Actual	104	160	255	169	48	51	0.0

The Krenz projections appear, however, to be as good as the Markov projections, since in three of the size classes, the Krenz projections are closer to actual farm numbers than the Markov projections. In other words, while the total deviation statistic indicates that the Markov projections are more accurate than Krenz projections, the latter are closer to actual farm numbers than are the former. Since this total deviation statistic gives an equal weight to each size class and thereby ignores the importance of correct estimates for each method of projection. The rationale for such a procedure is that farms in the larger size categories deserve larger weights in the computation of a total deviation statistic.

Projected number of cows in each firm size class for each method of projection are presented in Table 4. As expected, the total deviation statistic is less for the Krenz than for the Markov or Boxley projections. Both the Krenz and the Markov projections are quite similar while the Boxley projections exhibit considerable deviations from actual number of cows in each size class.

Conclusions

Comparison of three methods of projecting farm size distribution indicated that the method requiring the most information provided the most precise estimates of the actual farm size distribution. In the specific situation studied, Markov projections were superior. This result is consistent with what one would expect and appears to be a logical conclusion. It should be emphasized, however, that the results presented relate to a single example and necessarily lack generality. The three techniques are different ways (not necessarily alternatives) of projecting farm size distribution. Each is suitable in certain situations; and, clearly, Boxley's method is inappropriate here.

Perhaps the most interesting implications of the results presented here is that the Krenz approach was not considerably more imprecise than the Markov method. In fact, if disproportionate rather than equal weights are assigned to each size class, the total deviation statistic for the Krenz approach is less than that of the Markov approach. This result occurred when size classes were adjusted to reflect the total number of cows in each class, i.e., farms in the larger size classes were given heavier weights than those in smaller size classes. These results suggest that for agricultural industries or industries experiencing increasing firm sizes and declining firm numbers, the Krenz approach may be the practical method partly in terms of precision of projections and also in terms of the ease with which the method can be implemented. The latter is especially important when it is recognized that detailed data needed to use the Markov approach are typically difficult to obtain.

Table 4. Projected Distribution of Cow Numbers By Farm Size, 1971--Alternative Methods[a]

Type of Projection	Size Classes--Number of Cows						Square Root of Sum of Squared Deviation From Actual
	1-19	20-29	30-49	50-74	75-99	100+	
	(Number of Cows)						
Markov	860	3,650	9,480	8,813	3,063	10,400	4,318
Krenz	430	3,550	10,520	10,188	2,800	8,778	2,689
Boxley	2,810	2,500	5,280	5,500	3,850	16,326	12,131
Actual	988	3,920	10,072	10,478	4,176	6,632	0

a The number of cows in each size class, except the largest size class, was estimated as the product of the number of farms in each class and the midpoint of each class. The number of cows in the largest size class was computed as the difference between the total number of cows (actual) and the sum of the estimated number of cows in the smaller size classes.

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