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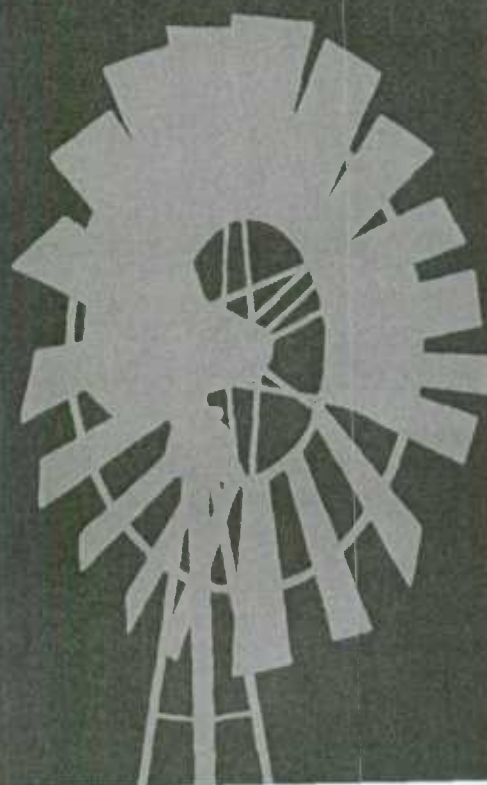
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Microdynamics of Farm Size Growth and Decline:

A Canada-United States Comparison

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Microdynamics of Farm Size Growth and Decline:

A Canada-United States Comparison

Introduction

The evolution of the farm size distribution is complex. Previous studies have shown trends toward increased average size and concentration in North American farming (e.g. Peterson and Brooks). However, we have less understanding about the underlying patterns of farm growth, decline, entry and exit that bring about aggregate trends.

Earlier studies of farm microdynamics in the United States and in Canada revealed high rates of turnover among farms and considerable heterogeneity in farm growth rates (Edwards, Smith, and Peterson; Ehrensaft, et al; Shapiro, et al). The current study compares farm size, growth, entry, and exit for a selected group of farms in the United States and Canada using longitudinal census data. We attempt to maintain homogeneity by comparing farms producing the same primary product (wheat) in a fairly homogeneous region: the Prairie-Northern Plains. The results illustrate the microdynamics that shape the aggregate farm size distribution and reveal differences between the United States and Canada. However, the results may not apply to farms in other regions or farms that produce other commodities besides wheat.

Our analysis compares life cycle patterns of farm entry, exit and growth for three age cohorts in the United States and Canada. Boehlje has described how farm management decisions, including entry, exit, size, and growth can depend on the life cycle of the proprietor. Young farmers often enter with farms of modest size, due to constraints on credit and limited personal wealth. As successful young farmers become established in farming, they often grow rapidly. At later stages of a farmer's life cycle the size of his/her farm may stabilize, and possibly decline as the farmer approaches retirement age. Several studies have shown that farm size, investment, and growth are related to the age of the farm operator (Gale; LaDue, et al.; Sumner and Leiby). These influences are often ignored in economic models and empirical analysis of farm size, entry, and exit decisions.

Methodology

The data used are Canadian and U.S. longitudinal data files created by matching Census of Agriculture records for individual farms from different years. The Canadian longitudinal data are available from 1966-91, but the U.S. data are available only from 1978-87. We chose to use Canadian data from years 1976 and 1986 because they cover a period close to the 1978-87 years available from the U.S. data.

The U.S. longitudinal data was created by matching records using the Census File Number assigned to each farm. The U.S. database was originally designed for administrative use, not for analysis. Consequently, it has only a limited number of variables, and some farms classified as entries and exits may actually be continuing farms that inadvertently had a change in CFN between years or failed to respond to the Census. The Canadian database has all the Census of Agriculture variables available, but we only used variables which were also available on the U.S. database.

An important difference between the two databases is in the frequency of nonresponse to the Census survey. Nonresponse in Canada is very low, under 1 percent, but was about 17 percent for North and South Dakota and 11 percent for Montana in 1987.¹ We analyzed unweighted individual Census records. Nonresponse is related to farm size, and possibly other characteristics, so the U.S. data may exclude small nonrespondents more frequently than the Canadian data. Higher nonresponse rates for the U.S. data also means that fewer records will match across Census years, if some farms respond in one year, but not in a later year, or vice versa.

Farms were included in the study if classified as a wheat farm and as a "family" farm (nonfamily corporations and institutional farms were excluded) in either the initial or final year of the study. Census data classify farms as wheat farms if more than half of sales are from wheat. Since wheat accounts for less than half of sales for many farms that grow wheat, our data include only a fraction of the farms that grow wheat in these regions. The study was limited to major wheat-producing States of Montana, North and South Dakota, and the Provinces of Alberta, Saskatchewan, and Manitoba on the Canadian side of the border. Comparison of U.S. and Canadian farm statistics is often hindered by the differing commodity mix and diversity of topography and climate between the two nations. However, comparison of similar farms on either side of the border can potentially reveal differences due to policy or cultural differences.

The region studied is characterized by relatively flat prairies-plains, low population density, and relatively large grain farms. Wheat is the primary product of over half of Saskatchewan farms in 1986, and over one-third of North Dakota farms in 1987. In the region, about 20 percent of the 96,000 farms on the United States side, and 30 percent of the 148,000 farms on the Canadian side of the border, were classified as wheat farms in 1986 and 1987, respectively. Although this is a major wheat-growing region, the results are not representative of all wheat farms, especially in the United States, where over 70 percent of wheat is grown outside of this three state region.

We observed farm sizes of three age groups of farmers at two points in time: 1976 and 1986 for Canada, 1978 and 1987 for the United States. We defined "continuing farms" as those having data for each of the two years.² The size and growth of continuing farms were analyzed for three age groups, based on the operator's age in the initial year: ages 18-34 (new entrants), 35-44 (established), and 45 and older (peak age).

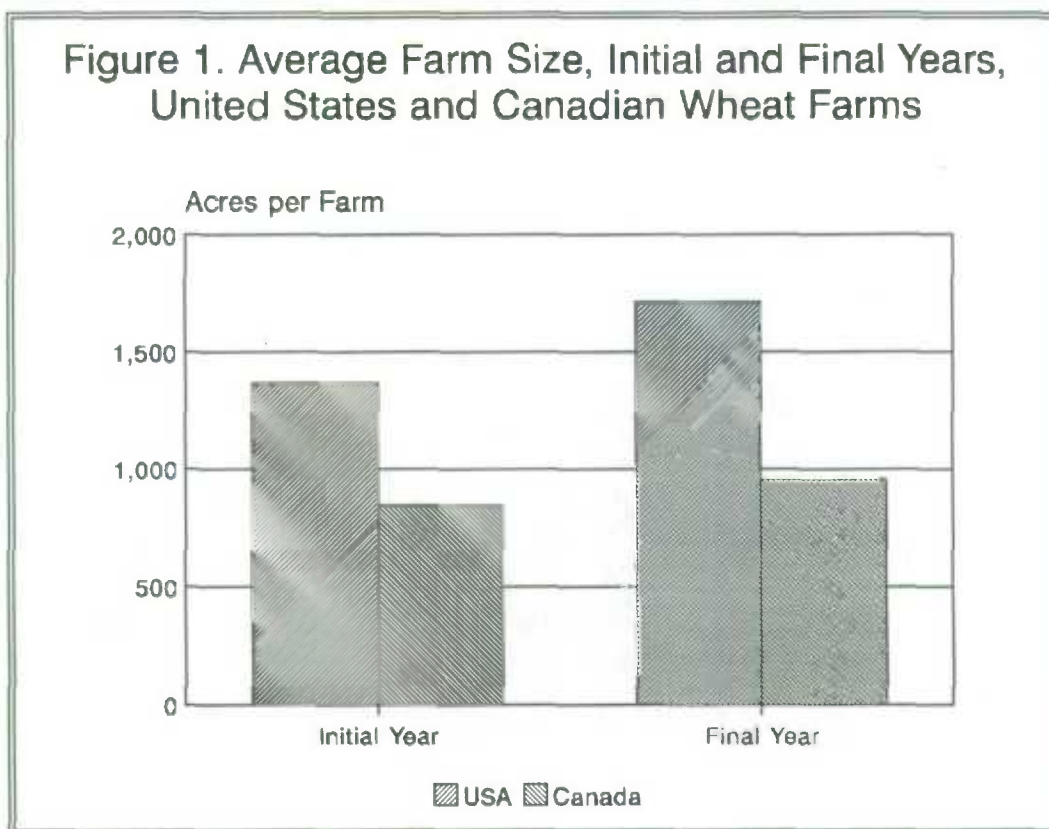
"Exiting farms" were those present in the initial year (1976/1978), but not in the final year (1986/1987). We assumed that these farms ceased operation over the time period. For this study, exiting means leaving farming, rather than leaving the wheat industry or becoming a "non-family farm".³ Size of exiting farms was observed for each of the three age groups. "Entering farms" were those which did not appear in the initial year data, but were present in the final year and were classified as a wheat farm and a "family" farm.

The measure of farm size is acres of farmland. Other possible size measures include quantity or value of output or assets. Output or asset value measures are preferred when comparing farms of different types, but land is suitable for comparing wheat farms in a homogeneous region. The use of land as the size measure allows us to focus on the acquisition of land as the means of increasing farm size. The land measure includes all land in farms. The data for U.S. farms do not include the components of farmland by use, e.g. cropland, pasture, and woodland.

Analysis

Just over 11,000 farms were identified as continuing from 1978 to 1987 in the U.S. database, and over 43,000 in the Canadian database. In the U.S. database nearly 9,400 farms were present in 1978, but not in 1987, and 7,300 were present in 1987, but not in 1978. The totals for the Canadian database were 26,000 present in 1976, not in 1986, and 16,000 present in 1986, but not in 1976. Farms meeting the criteria for the study, and present in 1986/87, represented 19 percent of total farm numbers in the three states reported in 1987, and 29 percent of all farms in the three Canadian provinces in 1986.⁴

The average size of U.S. wheat farms in the sample in 1978 was 1,514 acres, 669 acres larger than the Canadian average of 845 acres in 1976 (Figure 1). By the final year of the study (1987/86), average acres per farm had increased in both countries, but the difference in average size between U.S. and Canadian farms grew to 876 acres. There appears to be a greater propensity for growth and larger farm size in the United States compared with Canada.



In the sections that follow, we examine the various components of growth in the two nations. We consider growth of continuing farms for different operator age groups, the size of entering and exiting farms, and ability of continuing farms to improve their rank in the size distribution.

Size and Growth of Continuing Farms

We begin by observing the size of continuing farms in the initial and final years of the study, as well as average annual growth in acres, defined as: $(A_{t+n} - A_t)/n$. Table 1 shows median and mean values of acres and growth. Medians are generally much lower than means, because the distributions of farm size and farm growth are skewed to the right. There was a high degree of variation in farm size and in growth, as standard deviations (not reported) were in most cases larger than mean values. The wide variation in farm size and growth results from the high degree of skewness in the distributions, with quite a few extremely large values in both size and change in size.

For both United States and Canadian continuing farms, mean farm size in the initial year is smallest for the under-35 age group, and largest for the 35-44 year old age group. The 45 and older age group has larger mean farm size than the under-35 group, but smaller than the 35-44 age group. The difference in mean farm size between the under-35 and 35-44 groups is 649 acres for the U.S. group, but is less than 200 acres for Canadian farms. A similar pattern holds for median farm size in the United States, but the median size in Canada is 880 acres for both the under-35 and 35-44 age groups, compared with 800 acres for the 45 and older group.

Differences in average size by age group can reflect life cycle influences, as well as differences between cohorts who entered farming at different times. The relatively small farm size of the youngest age group could reflect limited resources available to new young farmers, while the smaller farm size of the 45 and older age group compared with the 35-44 age group could partly reflect smaller farm sizes that prevailed when the older operators entered farming, or transfer of farmland to younger family members at advanced age.

Life cycle effects are more clearly seen by examining farm growth. In both nations, the youngest age group had the most rapid growth, but U.S. farms grew faster than Canadian farms and older Canadian farmers appear more inclined to reduce acreage than their U.S. counterparts. The mean number of acres added per year by farms in the under-35 age group was 68 in the U.S. and 40 in Canada. For the 35-44 year-old group U.S. farms grew an average of 30 acres per year, compared with 11 for Canadian farms. The mean growth falls to 1 acre for the United States and -9 for the Canadian 45 and older age group. The pattern of median growth rates is similar for the U.S. farms, but for Canadian farms the median is 0 for both the 35-44 and 45 and older age groups. When growth is computed as a percentage of initial-year acreage, the difference between U.S. and Canadian farm growth is smaller, but U.S. farms still show faster growth.

Life cycle patterns of farm growth can be expected only when the same operator manages the farm in the initial and final years. We examined operator ages in the initial and final years, and found about 10-15 percent of farms reported ages that differed by more or less than 10 years (9 years for the U.S. data), indicating a change in operator, more than one operator, or an error. About 15 percent of Canadian farms and 10 percent of U.S. farms in the 45 and older age group in the initial year reported an operator age in the final year that was at least 20 years less than the initial year age. In many cases, this may indicate a transfer to a younger operator. These farms showed increases in farm size between the initial and final years, while other farms in the 45 and older age group showed decreases.⁵

In both the United States and Canada, the faster growth by younger farm operators results in a narrowing of the difference in farm size between age cohorts by the final year. The difference between the mean size of the youngest cohort and the middle cohort narrows from 649 acres in 1978 to 307 acres in 1987 for the U.S. farmers. The Canadian farmers under 35 years old had an average farm size 187 acres less than 35-44 year olds in 1976, but by 1986 the youngest group had the highest mean acreage of the three age groups. In both the U.S. and Canada, the youngest age group had a larger mean and median size than the oldest age group in the final year.

Exit and Entry

In all age groups, exit rates were lower for Canadian farms than for U.S. farms (Table 2). U.S. exit rates are 7 percentage points higher than Canadian exit rates in the 45 and older group. The difference increases to 13 points for the 35-44 age group and 15 points for the under-35 age group. It is not clear whether this actually represents higher exit rates for U.S. farms. Entry rates for the U.S. were also higher than for Canadian farms, but the net percentage change in farm numbers for the two groups was comparable. The apparently higher U.S. exit rates could be due to shortcomings in the construction of the U.S. database that failed to match records of some continuing farms across years.

In both countries, farmers in the 45 and older group were the most likely to exit: 46 percent exited in Canada and 51 percent exited in the United States. The exit rates for the 18-34 year old group were slightly higher than the exit rates for the 35-44 year olds. In the United States, 37 percent of the youngest farmers exited, compared with 32 percent of U.S. farmers 35-44 years old. These percentages were 28 percent and 24 percent for Canadian farms. High exit rates for young farmers may reflect high job turnover among young persons as they switch jobs and careers to find the right match for their skills, abilities and interests. High rates of job change are common among young persons in all occupations.

Most exiting farms were in the 45 and older age group (Table 3). Entering farms were spread more evenly across the three age groups in the United States. In the United States 45 percent of all entrants were in the 45 and older age group, and about one-third were in the 18-34 age group. Entrants tended to be younger in Canada, where about half of entrants were in the 18-34 age group.

In the U.S., farms in the youngest age group had the smallest mean and median farm size among entering farms. This could again reflect relatively limited resources of younger farm entrants. U.S. farm entrants in all age groups, however, had much larger farms than their Canadian counterparts. In Canada, there was less difference in farm size of entrants across age groups.

The youngest entrants had only slightly smaller mean farm size than the middle age group, and their mean size was larger than the oldest age group. The youngest Canadian farm entrants had the largest median farm size, but it was much smaller than the median for their counterparts in the United States.

These data show that exiting farms tend to be smaller than farms that continue in operation. In Canada, exiting farms had fewer average acres than continuing farms in each age group. In the U.S. the overall mean acres of exiting farms was less than the mean acres of continuing farms, but exiting farms had slightly larger mean acres in the U.S. under-35 age group. The median acreage of exiting farms was less than the median acreage of continuing farms in each age group for U.S. farms.

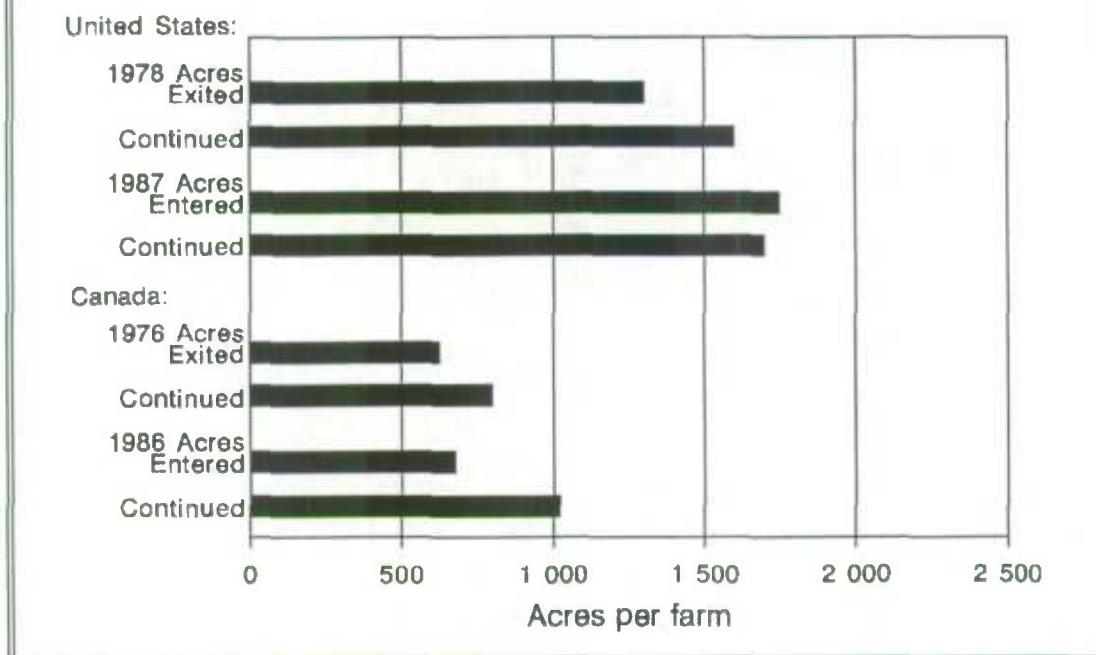
Entering farms tend to be larger than the exiting farms they replace, but entering farms are not necessarily larger than continuing farms in the same age group. In the U.S., new entrants had larger farms in 1987 than exiting farms in the same age group had in 1978. For example, new entrants under 35 years old had an average of 1,486 acres in 1987, compared with the average of 1,270 acres for under-35 continuing farms in 1978. The 35-44 year old entrants had an average of 2,078 acres in 1987, compared with 1,854 acres for 35-44 year old exiting farmers in 1978. In Canada, entering farms are larger than exiting farms in each age group, but the difference is smaller than that for U.S. farms.

A clear contrast appears between U.S. and Canadian farms when comparing the relative sizes of entering farms. In both countries exiting farms have smaller average size than continuing farms in the initial year (Figure 2). However, in the United States, entering farms are larger, on average, in 1987 than continuing farms, while in Canada new entrants are smaller than continuing farms in 1986. The relatively large size of entering farms in the United States reinforced the rapid growth of continuing farms to bring about the large increase in average size of U.S. wheat farms.

Components of Increase in Average Size

The above analysis established that growth of continuing farms and replacement of relatively small exiting farms with larger entrants contributed to

Figure 2. Average Farm Size, Entering, Exiting, and Continuing Farms, Initial and Final Years, U.S. and Canadian Wheat Farms



increased average farm size. In this section, we attempt to estimate the relative contributions of these two forces. Using the definition of the mean acres per farm and simple algebra, we can partition the change in average farm size into three components, due to:

1. increasing size of continuing farms,
2. replacement of smaller exiting farms with larger entrants,
3. change in the share of continuing farms.

Change in overall mean farm size, \bar{A} , between years t and t' ($t' > t$) can be expressed as,

$$(\bar{A}_{t'} - \bar{A}_t) = (\bar{A}_{ct'} - \bar{A}_{ct})s_{ct'} + (\bar{A}_{nt'} - \bar{A}_{xt})(1 - s_{ct'}) + (s_{ct'} - s_{ct})(\bar{A}_{ct} - \bar{A}_{xt})$$

where the subscripts c , n , and x represent the groups of continuing, entering, and exiting farms, respectively. The first component is the difference between

size of continuing farms in the final and initial years, weighted by s_{ct} , the share of farms in year t' that continued from year t (this component becomes bigger when continuing farms grow). The second component is the difference between size of new entrants and size of exiting farms, weighted by the share of farms in t' that were entrants (this component becomes bigger when new entrants are larger than exiting farms). The third component is the change in the percentage of continuing farms between years t and t' , multiplied by the difference in size between continuing and exiting farms in year t (note this part will be zero if the number of entrants equals the number of exits, or if exits have the same mean size as continuing farms).

Using this method, we partitioned the increase in average size for U.S. and Canadian wheat farms (Table 4). The increase in mean size between 1978 and 1987 for U.S. farms in the group studied was quite large, 318 acres. Growth by continuing farms raised average size by 109 acres, large entry-small exit contributed an additional 194 acres, and the increased share of continuing farms contributed 15 acres. Entry-exit size differences accounted for over 60 percent of the increase in average size in the U.S. data, while growth of continuing farms contributed about one-third of the increase. Among Canadian farms, however, growth of continuing farms was the main contributor to increased average size. For Canadian farms average size increased 111 acres. Growth of continuing farms increased Canadian average size by 62 acres, accounting for 56 percent of the increase. Entry/exit contributed 19 acres of the increase, and increased share of continuing farms accounted for 30 acres.

Patterns of Mobility Among Quintiles

Finally, we investigated the degree to which farms were able to improve their relative position in the farm distribution over time. Having observed the rapid growth of young farmers, we expected young farmers to be the most likely to improve their position, i.e. move to a higher rank in the distribution. To do this, we ranked farms according to their acreage in the initial and final years and classified them into quintiles. We then sorted them to construct a 5x6 transition matrix that showed for each initial year quintile the number of farms that exited by the final year, and the number in each of the five final year quintiles. The transition matrices were computed separately for each of the three age groups.

We summarize the results in Figures 3 and 4. For each nation and age group there are five bars, each representing a quintile. Each bar shows the percent of farms in the quintile that exited by the final year, the percent that moved to a lower quintile, the percent that remained in the same quintile, and the percent that moved to a higher quintile. Each bar has a height of 100 percent.

The most noticeable pattern is that exit rates are highest for the smallest farms. This pattern is particularly evident in the Canadian data, where the exit rates of farms in the highest quintile are about half the exit rates of those in the smallest quintile. The relationship is weakest for the youngest U.S. farmers, where farms in all quintiles have similar chances of exiting. The 45 and older age group has the highest exit rates, reaching as high as 68 percent for those in the smallest quintile.

Figure 3. Wheat Farm Transitions by Age Group, United States, 1978-1987

Quintile Position in 1978:

Age 35 and under



Age 35 - 44



Age 45 and older



0 20 40 60 80 100

Percent of Farms

Position in 1987:

■ Exited ■ Lower quintile ■ Same quintile ■ Higher quintile

It is also apparent that younger farmers have a better chance of moving to a higher quintile than do older farmers. The chances of moving to a higher quintile are about 30 percent for the youngest Canadian farmers. For the youngest U.S. farmers, the share moving to a higher quintile ranges from 37.5 percent for the smallest farms to 15 percent for the upper middle quintile. Less than 10 percent of the oldest farmers move to a higher quintile.

Figure 4. Wheat Farm Transitions by Age Group, Canada, 1976-1986

Quintile Position in 1976:

Age 35 and under



Age 35 - 44



Age 45 and older



0 20 40 60 80 100

Percent of Farms

Position in 1986:

■ Exited ▨ Lower quintile ■ Same quintile ▩ Higher quintile

Conclusion

This study analyzed longitudinal farm data from a homogeneous region of the United States and Canada to highlight age-specific patterns of farm size, growth, entry, and exit. The analysis reveals the considerable dynamics that bring about changes in farm size distributions. At any time there are young farmers growing rapidly, while some older farmers are scaling back their operations. Older farmers are the most likely to exit, and young farmers are the most likely to improve their relative position in the farm size distribution.

The farm dynamics underlying changes in the size distribution of farms are considerably more complex than is often assumed. Analysis of changes in farm size should take into consideration the great diversity among farm firms, the large, steady flow of entry and exit, and the link between the life cycle of the farm firm and the life cycle of the farm operator. An increase in average farm size can come about through either or both of two mechanisms: growth of continuing farms, or selective entry/exit patterns, where small farms exit, to be replaced by relatively large farm entrants.

The results suggest a stronger trend toward increased farm size and concentration in the United States compared with Canada. The average size of farms in the group of U.S. farms studied rose faster than that of their Canadian counterparts, and the distribution of U.S. farms showed a greater degree of skewness resulting from the presence of a few very large farms. A variety of explanations for faster farm growth and concentration in the United States could be offered. Differences could be attributed to culture, management objectives, per-acre yields, credit availability, off-farm work opportunities, or incentives created by farm program or marketing board rules, tax codes, and other regulations. Future research should explore the differences in the social, economic and regulatory environments of the two nations that may produce differing propensities toward growth in the two countries.

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Table 1. Acres per Farm and Growth for Continuing farms, Selected U.S. and Canadian Wheat Farms, by Year and Operator Age^a

Age in Initial Year	United States				Canada			
	1978 Acres	1987 Acres	Change Acres /year	Obs.	1976 Acres	1986 Acres	Change Acres /year	Obs.
Means:								
18-34	1,218	1,831	68.1	2,284	870	1,272	40.2	11,548
35-44	1,867	2,138	30.2	2,113	1,057	1,171	11.4	9,795
45+	1,697	1,703	0.8	6,685	951	857	-9.3	22,037
All	1,631	1,812	20	11,082	953	1038	9	43,380
Medians ^b :								
18-34	900	1,540	47.4	2,284	880	960	30.3	11,548
35-44	1,375	1,692	13.3	2,113	880	960	0	9,795
45+	1,162	1,193	0	6,685	800	640	0	22,037

^aContinuing farms were present in initial (1976/78) and final (1986/87) years.

^bThe median change per year is the median increase in acres from initial to final year, divided by 9 (U.S.) and 10 (Canada).

Table 2. Exit Rates, Selected U.S. and Canadian Wheat Farms, by Age Group^a

Initial Year Age Group	U.S.	Canada
<i>Percent of Farms</i>		
18-34	37	28
35-44	32	24
45 and older	51	46

^a Exit rate is the percent of farms present in 1976/78 that were no longer present in 1986/87.

Table 3. Acres per Farm, Selected Exiting and Entering U.S. and Canadian Wheat Farms, by Operator Age Group^a

Age ^b	United States		Canada	
	Exited 1978-87	Entered 1978-87	Exited 1976-86	Entered 1976-86
Mean Acres:				
18-34	1,270	1,486	674	757
35-44	1,854	2,078	769	792
45+	1,334	2,023	652	682
All	1,380	1,863	670	739
Number of Farms:				
18-34	1,353	2,380	4,439	7,792
35-44	999	1,690	3,096	3,076
45+	7,008	3,317	18,621	5,328
All	9,360	7,387	26,156	16,196
Median Acres:				
18-34	800	1,100	480	640
35-44	1270	1,500	620	610
45+	920	1,400	480	480

^a Exiting farms were in operation in the initial year (1978/1976), but not in operation in the final year (1987/1986). Entering farms were in operation in the final year, but not in the initial year.

^b Age in initial year (1978/1976) for exiting farms, in final year (1987/86) for entering farms.

Table 4. Contribution of Farm Growth and Entry-exit Patterns to Increased Average Acres per Farm

	U.S.	Canada
Components of change:	<i>Acres (Percent)¹</i>	
Increased size of continuing farms	109 (34)	62 (56)
Replacement of smaller exits by larger entrants	194 (61)	19 (17)
Increased share of continuing farms	15 (5)	30 (27)
Total change in average farm size	318 (100)	111 (100)

¹Numbers in parentheses are percent of total change in farm size attributed to the category.

Endnotes

1. Published totals are computed by attaching nonresponse weights to each Census record. The procedure and nonresponse percentages by state are detailed in Appendix C of U.S. Department of Commerce.
2. To simplify the analysis, we ignored data from intervening years (1981/1982). We focused on the long-run 10-year changes.
3. If a farm changed its commodity type from wheat to some other commodity across years, we considered it to be a continuing farm. Many farms that grow wheat are not classified as wheat farms, thus a change in commodity type does not mean that a farm exited the wheat industry.
4. The higher percentage of published farm numbers for the Canadian data compared with the United States data is due to a higher proportion of non-wheat farms in the three U.S. states compared with the three Canadian provinces, and higher percentages of nonreporting farms in the United States (see footnote 1). Published estimates of farm numbers are weighted to capture nonreporting farms, but the data in this study are unweighted.
5. We checked changes in operator ages for different age groups, and found that large decreases between Censuses in operator age of 20 years or more for the same farm record were much more common for the older age group than for younger age groups.

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