Chapter 4

Farm Size, Efficiency, and Off-Farm Work

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Very large commercial farms have important cost advantages over smaller farms in the major corn and soybean producing States. Those advantages, however, do not appear to promote further expansion of the largest farms—scale economies (the decline in cost per unit of output as output increases) appear to be fully realized by the largest current farms. Off-farm earnings opportunities may affect how we view both scale economies and farm technical efficiency (how effectively inputs are used in producing output). When the off-farm income that an operator foregoes by expanding is taken into account, the gains from expanding are lower.

Introduction

This chapter examines how two measures of farm production efficiency vary across farms in 10 States (Illinois, Indiana, Iowa, Michigan, Minnesota, Minnesota, Nebraska, Ohio, South Dakota, and Wisconsin) that account for most U.S. corn and soybean production, and shows how these measures vary with farm size and across farms of a given size.

The influence of off-farm work is explicitly included in these measures of performance.[1] Off-farm income and nonfarm business opportunities have become increasingly important in many agricultural areas in recent years. Off-farm income accounts for almost all household income (see Appendix II, "Measuring Farm Operator Household Income") among households with less than $100,000 in farm sales, and smaller but still important shares of income among most households with more than $100,000 in farm sales. The analysis views the farm household as a business that combines both farm outputs and off-farm work. For example, when the household plans an expansion of the farm business, it explicitly takes into account the effect of that expansion, which would require more onfarm work by household members, thereby reducing off-farm earnings opportunities.

Two measures of relative efficiency (stated in terms of inefficiency) are used (Nehring et al., 2002). The first measures scale inefficiency. Frequently, production is subject to economies of scale, in which costs per unit of output decline as output grows. When there are potential economies of scale, they should be most noticeable and have greater impacts on costs among smaller operations—that is, at least some farms would be expected to get big enough to realize available economies of scale. The growth in the number of very large farms and the decline in the number of small commercial farms is likely due in part to these economies.

[1] Chapter 3 examines the characteristics of "top" and "bottom" performing farms based on a financial measure of farm business performance, the returns to operator labor, and management income.

The scale inefficiency measure reported here indicates the percentage decline in unit costs for every 1-percent increase in farm output. Hence, a value of 0.2 indicates that unit costs would decline by 0.2 percent for a 1-percent increase in output. A value of 0.0 indicates that unit costs would not change as farm size increased.

The second measure of inefficiency is technical inefficiency. Among farms of a given size, it is not uncommon to see a noticeable variation in costs. Some farms follow "best practices." They realize much lower costs than other operators by using technologies and techniques that best fit the farm's outputs and resource base. The technique used here isolates the best-practice farms within any size class, and measures technical inefficiency by how far other farms fell, on average, below best-practice farms. Specifically, an index of technical inefficiency is defined and set equal to 0 for best-practice farms. For other farms, the index measures the extent to which costs exceed a best-practice farm of the same size. For example, a farm with a technical inefficiency index of 10 realizes costs that are 10 percent greater than a best-practice farm with the same level of output.

Data from ARMS (see Appendix I) for 5 years (1996, 1997, 1998, 1999, and 2000) were used to analyze these measures. Representative farms were defined by assigning sample farms in the 10 States to 1 of 13 groups, classified by the primary occupation of the farm operator and the gross sales of the farm (table 4-1). Data for the representative farms were then developed by calculating mean data values for all the sample farms within each group. A total of 650 representative farms were used in the analysis (13 representative farms in each of 10 States for each of 5 years). Assigning farms to

Table 4-1—Defining farm groups

Farm group	Farm typology category	Gross value of sales
	Rural residence farms	
1	Limited-resource, Retirement, & Residential/lifestyle	$2,499 or less
2	Limited-resource, Retirement, & Residential/lifestyle	$2,500-$29,999
3	Limited-resource, Retirement, & Residential/lifestyle	$30,000-$249,999
	Intermediate farms	
4	Farming occupation-Low Sales	$9,999 or less
5	Farming occupation-Low Sales	$10,000-$29,999
6	Farming occupation-Low Sales	$30,000-$99,999
7	Farming occupation-High Sales	$100,000-$175,000
8	Farming occupation-High Sales	$175,000-$249,999
	Commercial farms	
9	Large family farms	$250,000-$330,000
10	Large family farms	$333,001-$410,000
11	Large family farms	$410,001-$499,999
12	Very large family farms and Nonfamily farms	$500,000-$999,999
13	Very large family farms and Nonfamily farms	$1,000,000 or more

Source: USDA, Economic Research Service farm typology categories (see "Introduction" for further discussion).

groups and then developing a representative farm for each group greatly simplifies the task of statistical estimation.

Large Farms Have Important Cost Advantages

Statistical techniques were used to estimate measures of scale and technical inefficiency. The analysis controlled for other characteristics of the farm operation, such as the mix of commodities produced on the farm and input prices, and also controlled for characteristics of the farm operator and the operator's household, including age, education, experience, and off-farm work.

Based on the analysis, measures of scale inefficiency could be developed for farms in each group (these are mean estimates across years and States). Results (table 4-2) suggest that scale economies were pervasive and important. Among the smallest rural residence farms, the reported scale inefficiency measure is 0.43—costs per unit of output fall by 4.3 percent for every 10-percent increase in sales. This measure declines as rural residence farms get larger, as it should. But it is still quite large for farms with sales of $30,000-$249,999.

Groups 4 through 8 cover intermediate farms, small farms whose operators report farming as their major occupation. The number of these farms is

Table 4-2—Measures of efficiency for different farm types and sizes

Group number	Farm type and sales range[1]	Scale inefficiency[2]	Technical inefficiency[3]
		Measure	
	Rural residence		
1	$2,499 or less	0.43	5
2	$2,500-$29,999	0.33	4
3	$30,000-$249,999	0.22	5
	Intermediate		
4	$9,999 or less	0.32	5
5	$10,000-$29,999	0.28	5
6	$30,000-$99,999	0.19	5
7	$100,000-$175,000	0.13	5
8	$175,000-$249,999	0.11	5
	Commercial		
9	$250,000-$330,000	0.07	5
10	$333,001- $410,000	0.05	5
11	$410,001-$499,999	0.05	5
12	$500,000-$999,999	0.06	4
13	$1,000,000 or more	0.02	5

[1] Operators of rural residence farms do not report farming as their major occupation, while operators of intermediate farms do. Commercial farms include all farms with sales of at least $250,000, regardless of occupation reported by the operator.
[2] The percent by which average costs per unit of output would decrease if output increased by 1 percent . For example, for representative farms in group 8, average per unit costs would decrease by 0.11 percent for a 1-percent increase in output.
[3] The percent by which average costs for all representative farms in a group exceed those of the most efficient representative farm in that group for a fixed level of output. For example, in group 8, farms on average have costs that are 5 percent higher than the most efficient farm in the group.

Source: Estimates based on data obtained from the Agricultural Resource Management Survey, Phase III, USDA, Economic Research Service.

declining (table 1-1, p. 9)[2], and table 4-2 suggests one important reason for their decline—they can, on average, realize much lower costs by expanding output. Farms with sales between $10,000 and $30,000 have an average scale inefficiency of 0.28 (unit costs fall by 2.8 percent for every 10-percent increase in output), while farms with sales between $30,000 and $100,000 have a lower but still significant estimate of 0.19.

Estimates of scale inefficiency for commercial farms are much lower and approach zero among the largest farms, those with sales of $1 million or more. The number of farms with sales between $250,000 and $500,000 remained stable after 1992, while the number of farms with sales in excess of $1 million grew rapidly. Those largest farms have small but economically significant cost advantages over other commercial farms.

Measures of technical inefficiency are quite consistent across groups, and fall in a range of 4 to 5 percent. On average, the most efficient representative farms have unit costs that are about 5 percent lower than similarly sized farms in other States or years. However, much of the variation in technical inefficiency across individual farms was removed in the data development process, as individual farm data were averaged to create representative farms.

The analysis took explicit account of off-farm work in developing performance measures, and that decision had an important impact on the estimates. Inefficiency measures were much larger when off-farm work was excluded. For example, the scale inefficiency measure increased from 0.02 to 0.18 for the largest group, when off-farm work choices were excluded. That estimate would suggest that even some of the largest farm businesses were too small to fully realize all scale economies. But off-farm work options make farm expansion more costly, since expanding the size of the farm would require households to give up some off-farm work and its associated income. When these factors are properly taken into account in evaluating farm expansion, the gains to expansion of the largest farms become minimal, and the analysis provides a logical explanation for recent structural changes in farming.

[2] Correspondence between intermediate farms and farms with sales less than $250,000 in table 1-1 is not exact, because table 1-1 does not consider occupation.