Scale, Diversification and Economic Performance of Agricultural Producers

by

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Various factors, including production scale and diversification, off-farm employment, innovative adoption and other farm and farmer characteristics, determine farmers' economic welfare. A recent study analyzes the impact of such factors on the performance, and thus the potential competitiveness, of different types of U.S. farms. Ê

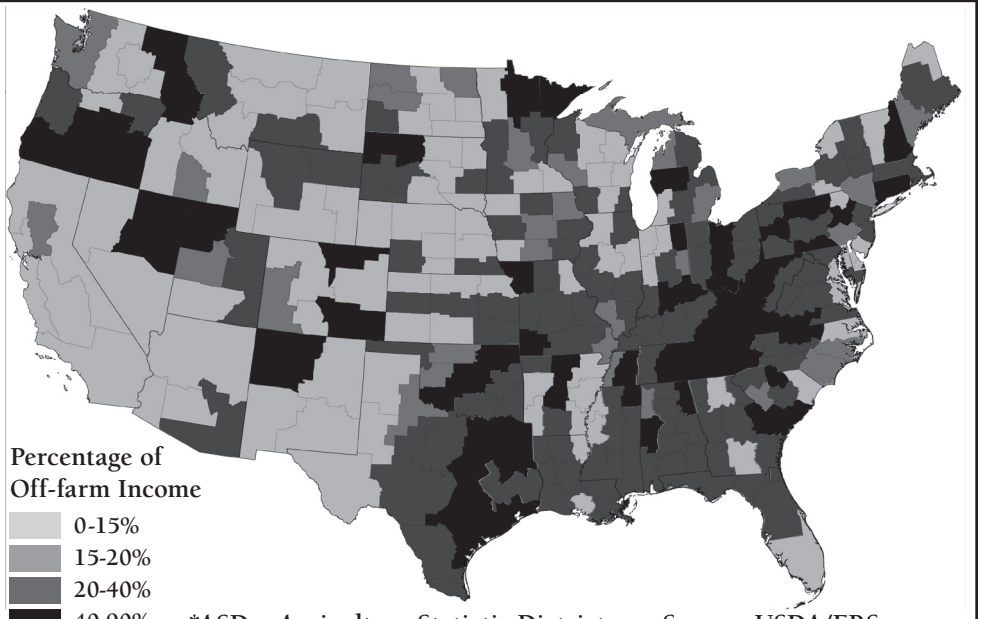
U.S. farm size in acres has been increasing in the past two decades; farms in major agricultural regions grew by about 17 percent between 1980 and 2000. Agricultural production is also highly and increasingly concentrated in large farms, with "large" and "very large" family farms (see Table 1 for a definition of terms) making up only eight percent of all farms in 1998, but accounting for 53 percent of agricultural production. The USDA documents that these large farms were profitable in 1998, although farms in most smaller typology groups reported insufficient income to cover expenses. Such patterns suggest that significant scale economies exist in modern agriculture, and that this technological reality is putting critical pressure on the small family farm.

In addition to the apparent importance of scale economies, product diversity (scope economies) seems to contribute considerably to farms' economic performance. *The Family Farm Report,* for example, states that: "…diversification is a significant factor explaining differences in the level and variability of income between higher and lower performing small farms. Financially successful small farms tend to be more diversified." The report also documents that production of multiple outputs is most prevalent for high-sales farms, and that diversification affects input mix as well as economic performance. The largest farms, however, tend to specialize in livestock.

Off-farm employment is another form of expansion in the scope of revenue-producing farm operations that is especially feasible in urban-influenced areas. The USDA reports that non-farm income sources now dominate net farm income in the U.S., and also finds that "farm households relied heavily on off-farm jobs," with 55 percent of all farm households reporting that either the operator, spouse or both worked off-farm to increase "total operator household income." Nationwide patterns in off-farm employment (the ratio of off-farm income/total income) are shown in Figure 1.

Economic performance of U.S. farms has also been increasingly influenced by technical change. In particular, enhanced cost effectiveness from the adoption of inputs such as genetically modified (GM) seed may improve farms' competitiveness. Rapid adoption of transgenic crops suggests that this innovation has been beneficial to farmers. But

Figure 1. The Importance of Off-farm Income by ASD*: 2001 (Off-farm Income/Total Income)



*ASD = Agriculture Statistic District Source: USDA/ERS

Table 1: Definition of Terms

Farm Typologies

Small Family Farms (sales less than $250,000):

1. Limited-resource. Any small farm with: gross sales less than $100,000, total farm assets less $150,000, and total operator household income less than $20,000. Limited-resource farmers may report farming, a nonfarm occupation, or retirement as their major occupation.

2. Retirement. Small farms whose operators report they are retired (excludes limited-resource farms operated by retired farmers).

3. Residential/lifestyle. Small farms whose operators report a major occupation other than farming (excludes limited-resource farms with operators reporting a nonfarm major occupation).

4. Farming occupation/lower-sales. Small farms with sales less than $100,000 whose operators report farming as their major occupation (excludes limited-resource farms whose operators report farming as their major occupation).

5. Farming occupation/higher-sales. Small farms with sales between $100,000 and $249,999 whose operators report farming as their major occupation.

Other Farms

6. Large family farms. Sales between $250,000 and $499,999.

7. Very large family farms. Sales of $500,000 or more.

8. Nonfamily farms. Farms organized as nonfamily corporations or cooperatives, as well as farms operated by hired managers.

Economic Terms

Scale economies: Given scale economies the average cost of production decreases as farm size increases. The existence of scale economies suggests that farms can achieve lower average costs by becoming larger.

Scope economies: Given scope economies it is cheaper to produce several outputs on one operation than it is to produce each output in separate operations. The existence of scope economies suggests that farm households can achieve cost savings by diversifying into production of multiple commodities or part time off-farm employment.

Input jointness or production systems: Input jointness suggests that the adoption of certain technologies, such as GM corn, requires the concomitant use of several inputs (i.e. GM seed, alternative pesticides, custom labor and specialized application machinery), rather than simply the purchase of new seeds.

Technical efficiency: The ratio of current to maximum possible or "best practice" production, the latter representing fully efficient production practices.

Cohort: Individual observations grouped on the basis of geographic location and type of agricultural activity.

Source: USDA, Economic Research Service

GM adoption may also augment the importance of production systems; i.e., there may be linkages (input jointness) between adoption of these seeds, and the use of particular pesticides, labor practices or machinery for tilling.

These production relationships largely determine how efficiently farms of different sizes and with different output and input mixes might be producing. However, specific farm/farmer characteristics may also affect performance. The USDA identifies key dissimilarities in hours worked, age, education, debt and management methods of farmers that affect overall agricultural productive performance and the benefits obtained from innovation, and thus are important to recognize for effective policy implementation. Some types of farmers may simply be producing in a technically inefficient manner, which will affect their competitiveness.

Data and Overall Findings

We used USDA farm-level survey data to quantify these kinds of factors underlying the economic performance of U.S. farms. The data include 20,810 observations, across 5 years (1996-2000), for farms in ten midwest states, on farm outputs, inputs and characteristics. Using such a detailed micro level dataset allows us to represent multiple revenue-generating activities (or "outputs"), a variety of inputs used for farm production, and specific farm household characteristics.

The outputs from the farms surveyed are corn, soybeans, other crops and animal products (dairy, livestock), as well as income generated from off-farm employment. The inputs are labor, fuel, fertilizer, seed, feed, capital (machinery and structures), land, other livestock-specific materials, other crop-specific materials and other general expenses. Farm and farmer characteristics include farmer age, education, debt/asset ratio and the proportions of land rented to others and devoted to GM (corn and soybean) crops.

These data are summarized in Table 2. They are grouped on the basis of farm typologies, which we have divided into four primary types or cohorts: residential farms (typologies 1-3), very small family farms (typology 4), higher sales small family farms and large family farms (typologies 5-6), and very large family and "corporate" farms (typologies 7-8). Operators of small farms tend to be the oldest, with the least education, but have the lowest debt-asset ratios and the least rented land. They also have the second highest (after residential) ratio of off-farm to farm business income,

and appear less likely to plant GM corn but about as likely to plant GM soybeans as farmers in other typologies.

For the outputs, our estimates show significant scale and scope economies. This supports the notion that not only the scale of production, but also output diversification (expanding the portfolio of commodities produced, and particularly increasing the amount of livestock production), contributes to performance. However, revenue from off-farm employment tends to combat the cost disadvantages of small-scale production, implying that the increasing prevalence of off-farm income for small farmers improves their competitiveness. Off-farm employment also significantly affects input use; it augments the productive role of labor by 21 percent and doubles the importance of fuel. Our measures also indicate that animal outputs require the largest input "share," with corn second, and soybeans third.

For the inputs, we find that input mix affects economic performance, and is more fixed within cohorts, and in the short run, than across cohorts, and in the long run. That is, in the short term input rigidities due to lack of mobility, or limited potential to adapt production systems because of past ("sunk") investments, may inhibit the performance of some types of farmers. Expansion in the scale of production combined with input mix adaptations, as well as output diversification, is most likely to enhance competitiveness.

The largest input share or contribution is that of labor when off-farm income is recognized; the value of labor on the farm in terms of its contribution to farm revenues is larger than its opportunity (market) cost. This is also true for seed, although not for land, capital (machinery) and livestock inputs. Overall, off-farm income is a key contributor to farm revenues. Seed, feed and specialized crop expenses (largely pesticides) seem the most important drivers of overall farm productivity, perhaps because they are the variable inputs that determine the productivity of the other more fixed inputs—particularly land.

Table 2: Summary Statistics, 2000, Averages

		All Farms	Residential	Small Family	Large Family	Very Large &Corp.
Revenues						
Farms		3,638	883	200	1,533	1,022
Corn	$[1]	24,765	4,202	2,665	52,819	143,391
Soybean	$	17,877	4,332	3,814	36,779	93,030
Other crop	$	29,855	3,476	5,106	40,456	303,127
Animal	$	43,683	5,428	6,100	50,811	483,217
Off-farm	$	26,941	36,742	13,510	14,133	9,540
Expenses						
Labor	$	24,481	29,597	17,213	30,080	83,716
Fuel	$	2,609	660	1,118	5,011	14,101
Fertilizer	$	10,775	2,367	2,303	21,850	60,135
Seed	$	4,840	955	1,380	9,333	30,025
Feed	$	14,609	2,120	1,816	15,548	165,875
Animal inputs	$	8,651	737	1,149	5,892	120,251
Crop inputs	$	6,245	1,416	1,290	12,220	36,769
Other inputs	$	12,694	4,317	5,237	21,564	71,158
Machinery/ Structures	$	12,547	3,878	5,565	23,383	63,513
Land	$	34,411	13,808	17,660	64,722	133,209
Age	Yr	53.7	53.7	61.41	51.99	48.65
Education	([2])	2.57	2.65	2.19	2.46	2.88
Debt/Asset	%	12	8	5	14	19
Rented land	%[3]	47	35	17	52	51
GM corn	%[4]	30	21	21	30	32
GM soy	%[5]	58	58	63	56	61

[1] inflation adjusted
[2] 1=no high school, 2=high school/equivalent 3=some college 4=4 year degree, 5=graduate school
[3] rented land as a % of acres operated
[4] biocorn acres as a % of total corn acres
[5] biosoy acres as a % of total soybean acres

Source: USDA, Economic Research Service

We also find farmers' measured technical efficiency to be high, at 93-94 percent of their "best practice" potential, and that this does not vary significantly by type of farm. The only significant performance impact of farm or farmer characteristics is that higher debt is counter-productive; a high debt/asset ratio implies reduced competitiveness. Generally, economic performance is more closely tied to output scale and

diversity and input mix than to technical inefficiency, or to farmer traits such as age or education.

Differences across Farm Typology and Time

If our economic performance measures are broken down by farm type, we find slightly larger potential scale and scope economies, and lower efficiency, for small family farms than for other farm types. Recognizing off-farm income increases measured scale and technical efficiency, especially for small family farms. In addition, scale economies appear to be decreasing, and efficiency increasing, over time. These results suggest that farmers are, as a group, taking advantage of the potential to reduce costs through expansion of scale, output diversification, substitution toward more cost-effective input mix and technical efficiency.

Distinguishing farm types provides few additional insights about differential performance. Farms in the upper level typologies (generally larger size) seem to require almost as many inputs for a given amount of output production as do family farms, when income from off-farm activities is recognized and all other factors are held constant. We also find falling input use for a given output level in some years, consistent with technical progress, although not in 1999 (and essentially constant in 2000). One interpretation of these patterns is that the mixes or values of outputs and inputs differ for farms in the larger typologies and over time—that larger farms produce higher-valued outputs and inputs, using higher-quality and higher cost inputs, including more livestock, less "other" crops and more machinery.

This seems consistent with the evidence. Input "shares" or contributions are notably higher for feed, capital, and animal and other specialized inputs, and lower for labor for farms in the larger typologies. This supports the notion of varying input mix across cohorts, even if inputs are quite fixed within cohorts. The contribution of labor seems also to be decreasing over time, along with that of seeds and specialized crop inputs, and the roles of energy, fertilizer, and capital seem to be increasing. These patterns suggest that movements toward greater capital-intensity, lower labor-intensity and more animal-output intensity enhance performance.

Output mix across cohorts does not appear as variable as for inputs, although corn and livestock proportions are higher and off-farm income lower for the larger farm typologies. Also, inputs devoted to soybean production are somewhat greater, and to "other" crops lower, for the large than small family farms. The output patterns over time are even less definitive, although input shares devoted to corn and animal production seem to be dropping slightly, and those to soybeans rising.

Finally, the (small positive) cost-savings impacts of planting GM corn are somewhat less substantive for farms in the larger as compared to the smaller typologies. The estimated impacts of planting GM soybeans are more variable across typology, year and specification, but all have a negligible (in magnitude) measured productivity effect.

In sum

Both scale and scope (diversification) economies appear to have central roles in explaining productivity patterns of U.S. agricultural producers. Inputs seem less joint across cohorts, but not within cohorts; input mix varies across cohorts, and somewhat over time. Although rigidities within cohorts may exist due to production systems, greater shares or intensity of capital and animal-oriented inputs, and animal output, seem related to greater economic performance.

Further, off-farm income appears empirically as well as anecdotally to be an important aspect of farm households' economic performance and economic viability, especially for small farms that are near urban areas. This seems the primary route to the success of small farm households in the future, given the cost-savings associated with growth in scale of production (consolidation) and diversity (especially large-scale livestock production) that reduce small farms' competitiveness.

The views presented here are those of the authors, and may not be attributed to the USDA.

For More Information the Authors Suggest:

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