Off-Farm Work, Scale and Scope Economies, and Efficiency

The importance of off-farm income to all U.S. farmers is widely acknowledged, and the relative dedication to off-farm work is related to farm size, location, specialty, and operator characteristics. However, is off-farm work actually helping farm households in general, and those operating small farms in particular, to improve their economic performance? Since scale and scope economies, as well as economic efficiency, are key concepts used by economists to examine economic performance, this section introduces those concepts as they relate to off-farm work.

A farm is said to have economies of scale (or increasing returns to scale) if the average cost of production declines as output (scale of production) increases (see box, p. 4). This decline in per-unit costs as output increases suggests that smaller farms can achieve cost advantages by becoming larger. The concept of economies of scale is an important one. For example, farms with lower average costs are better able to cope with higher input prices (Kumbhakar, 1993). On the other hand, increasing returns to scale in production may lead to consolidation of firms with potential effects on competition (Hallam, 1991).

With multiple outputs, the measurement of scale economies becomes more complicated. In addition to changes in costs that occur as output expands, there are also changes in costs due to the product mix (Hallam, 1991). If it is cheaper to produce several outputs in one operation than it is to produce them in separate operations, economies of scope are said to occur (see box, p. 14).

Off-Farm Work and Scale Economies

We estimated the scale economies for corn and soybean farms for 1996-2000, from an input perspective. Scale economies both at the farm level (the measure traditionally reported) and at the household level (including off-farm income-generating activities as an output) are considered. At the farm level, the elasticity of scale ranges from about 0.56 for smaller farms (gross sales less than $100,000), to about 0.8 for the larger farms (sales greater than $500,000) (table 5). This means that to support a 10-percent increase in outputs, smaller farms would require a 5.6-percent increase in all inputs, while larger farms would require an 8-percent increase in inputs. Thus, the greater scale economies available for smaller operations provide a major inducement to increase farm size (compared with the larger farms whose scale elasticities are closer to 1).

However, at the household level, with off-farm income-generating activities included, the scale economies available are lower (scale elasticity is closer to 1; that is, closer to constant returns to scale). Thus, the scale elasticity is higher for all sizes, ranging from 0.73 to 0.96 (table 5). So for smaller farms, a 10-percent increase in all outputs requires a 7.3-percent increase in inputs, while larger farms require a 9.6-percent increase in inputs.[12] More importantly, the difference between the scale elasticities at the household and farm levels is larger for the smaller farms (30 percent)

[12]The scale elasticity increases (moves closer to constant returns to scale) when off-farm income is included because of the theoretical relationship between scale and scope economies in multiproduct firms: "the presence of scope economies 'magnifies' the extent of overall economies of scale beyond what would result from a simple weight sum of product specific economies of scale" (Baumol et al., 1982).

Table 5
Scale economies for corn/soybean farms, 1996-2000

Farm type[1]	Gross sales	Elasticity of scale: Farm level (Excluding off-farm income)	Elasticity of scale: Household level (Including off-farm income)
Farming occupation/ lower sales	< $100,000	0.56	0.73
Farming occupation/ medium sales	$100,000-$249,999	0.74	0.88
Large family farms	$250,000-$499,999	0.77	0.94
Vary large family farms	>$500,000	0.80	0.96
All farms		0.66	0.83

[1]Excluding limited-resource farms and retirement/residential farms. Limited-resource farms are small farms with gross sales less than $100,000, total farm assets less than $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. Retirement/residential farms are small farms whose operators report they are retired or engaged in a major occupation other than farming) (Hoppe et al., 1999)

Source: Nehring et al., 2005.

than for the larger farms (around 20 percent). Thus, households operating smaller farms may compensate for the scale disadvantages of their farm business activities with the advantages of off-farm income-generating activities. This advantage may also support the notion that integrated farm and nonfarm labor markets are enabling many small farms to survive and flourish to an extent not thought possible three decades ago (Gardner, 2005).

Off-Farm Work and Economies of Scope

Scope economies measure the cost savings due to simultaneous production of outputs relative to the cost of separate production (see box, p. 14). The concept of economies of scope is useful in assessing the advantages of output diversification. Given the importance of off-farm income to U.S. farm households, scope economies may be expanded to include as output any income-generating activities on or off the farm (household-level scope economies) (see appendix 1).[13] Our estimates for corn and soybean farms show substantial household-level scope economies, 0.24 on average. This means that farm households engaged in off-farm income-generating activities together with the production of traditional farm outputs have cost savings of 24 percent relative to carrying out those activities separately.[14] The cost savings are likely to arise from the sharing of managerial expertise (of the operator and spouse) between onfarm and off-farm activities. Economic evaluations of the farm business alone, then, provide an incomplete view because they exclude off-farm activities, which are an important means of output diversification.

[13]Farms that produce the two output groups separately are those that either produce conventional outputs and no off-farm income or else generate off-farm income but no conventional outputs. While our sample includes farm households that produce conventional outputs with no off-farm activities, it technically does not include households with zero traditional outputs. However, the sample does include many farm households with very small revenues from traditional outputs because, for statistical purposes, in the U.S., a farm is currently defined "as any place from which $1,000 or more of agricultural products were sold or normally would have been sold during the year under consideration" (USDA, 2005). We consider five outputs (corn, soybeans, other crops, livestock, and operator/spouse off-farm labor) and five inputs (hired labor, operator labor, spouse labor, miscellaneous inputs, and pesticides). The method of calculating scope economies, as well as the underlying cost function, is shown in appendix 1.

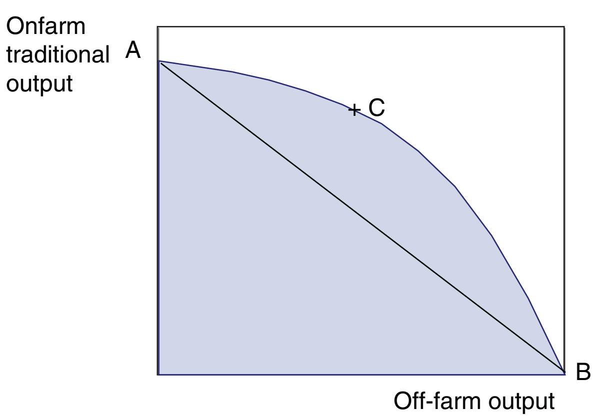
[14]This result is valid on the average, not necessarily for all the corn/soybean farms studied. For example, it is not likely to be valid for the largest farms in the sample (whose operators are less likely to work off the farm, table 4). As shown in appendix 1, the underlying cost function is a function of the output quantities (and, thus, gross sales), and so are scope economies. The values reported here are calculated at the means of the sample.

Scope Economies

Scope economies measure the total cost savings due to simultaneous production of outputs relative to the costs of separate production (appendix 1). Given scope economies, it is less costly to produce several outputs in one operation than to produce each output in separate operations (or joint production in one operation generates more output than separate production in two different operations using the same resources). An often-cited example of scope economies is fast food outlets, where savings are obtained by sharing storage, cooking facilities, and customer service in the production of many food products. In general, scope economies may arise from the presence of public inputs or from sharing of imperfectly divisible quasi-fixed inputs in the production of different goods (Fernandez-Cornejo et al., 1992). In our context, farm households achieve scope economies by diversifying or pursuing off-farm activities in addition to the onfarm production of traditional commodities.

To illustrate the possible advantages of "producing" onfarm and off-farm outputs in a farm household, we may use the example of a production possibilities curve (often used in economics). When the production possibilities curve (ACB) is shaped as in the figure, it is advantageous to produce onfarm and off-farm outputs together. As the figure shows, total output produced by a farm household at point C (a combination of onfarm and off-farm outputs) is higher than output produced either at A or B (or a linear combination of both, line AB) while using the same amount of resources.

Diagram of a production possibilities curve



Scope economies for farm households are likely to arise from the sharing of managerial expertise (and its many components, such as accounting and information processing skills, sales expertise, administrative and technical know-how, etc.) between onfarm and off-farm activities.[15] The expertise of many farm operators and/or their spouses is used in off-farm jobs in private businesses and Government, and in self-employment (Mishra et al., 2002). A USDA survey shows that the largest share of off-farm work done by operators and their spouses is accounted by work in executive, administrative, and managerial positions, service occupations, administrative support, and sales (Covey et al., 2004).

[15]As is well known, diminishing marginal labor productivity is a determinant in the allocation of labor between onfarm and off-farm activities. In addition, labor requirements for crop production are often concentrated in very few months of the year. Thus, the marginal productivity of managerial labor for the rest of the year is often very low or negligible (Olfert, 1984).

Off-Farm Work and Efficiency

Technical efficiency measures how well a farm transforms inputs into outputs given the technology at its disposal (Kumbhakar and Lovell, 2000). Efficiency is of great importance to prevent the waste of resources. Technically inefficient farmers fail to produce the maximum attainable output with the amount of inputs used, and therefore can increase output with the existing level of inputs and available technology.

Two types of technical efficiency are examined here: traditional (farm-level) technical efficiency of the farm business in the production of commodities; and technical efficiency at the household level, which considers both on- and off-farm activities.[16]

[16]We have adopted the terminology of "farm-level" and "household-level" efficiency following a recent publication by Chavas et al. (2005). Our earlier terminology (as used in Nehring et al., 2005) was less transparent.

Efficiency of the Farm Business

Kumbhakar et al. (1989) examined the effect of off-farm income on farm-level efficiency for dairy farmers. They reasoned that the larger the off-farm component of the operator's income, the less time the operator would spend managing the farm, eroding farm-level efficiency. Indeed, they found that farm-level efficiency of Utah dairy farmers in 1985 was negatively related to off-farm income and that the negative effect was strongest for the smallest farms, which had the largest off-farm incomes.[17] Fernandez-Cornejo (1992) calculated that the farm-level technical efficiency of vegetable farms in Florida was negatively related to off-farm work carried out by the operator. Similar results were obtained by Aigner et al. (2003) for the farm-level efficiency of U.S. corn farmers using 2001 data.

[17]In a subsequent article, Kumbhakar (1993) showed that lower efficiency is the main reason that small farms are less profitable than medium and large farms; another reason being their higher returns to scale (lower scale economies).

More recently, Goodwin and Mishra (2004) analyzed the relationship between farm-level efficiency and off-farm labor supply. With data collected from 7,699 farms in USDA's 2001 Agricultural Resource Management Survey (ARMS), they used gross cash income (appendix table 1) over total variable costs as an operational measure of farm-level economic efficiency. Greater participation in off-farm labor markets was shown to be significantly associated with lower farm-level efficiency. An additional 1,000 hours engaged in off-farm work would tend to lower the farm-level efficiency ratio by 0.17 with respect to the mean, which was $1.93 of cash farm income per dollar of variable cost. This effect, while not large, was statistically and economically significant. Such findings support the notion hypothesized by Smith (2002) that off-farm work may hinder "smart farming" and confirm a negative relationship between farming efficiency and the supply of labor to off-farm employment. As theory predicts, more efficient farmers are less likely to work off the farm, reflecting the higher opportunity cost for their labor. Furthermore, the statistical tests performed by Goodwin and Mishra suggest that off-farm labor supply and farm-level efficiency are jointly determined.[18]

[18]There is a two-way relationship between the two variables rather than a cause-and-effect relationship (in economic jargon, each variable is endogenous to the other).

Household-Level Efficiency

Rather than estimating the influence of off-farm work on the efficiency of the farm business, we estimated the household-level technical efficiency (including on- and off-farm activities), compared it with farm-level efficiency, and examined how those efficiencies vary with farm size. The technique used in this research isolates the best-practice farm within any size class, and measures technical efficiency by how close other farms are, on average, to the best-practice farms, which are assigned a technical efficiency equal to 1 and said to be on the "frontier." [19]

At the farm level, technical efficiencies of corn/soybean farms increase with size from 0.87 to 0.93 (table 6).[20] However, technical efficiencies at the household level (when off-farm income is included) are higher (around 0.95) and the measures of technical efficiency do not vary across size groups. Moreover, while the beneficial effect of off-farm income occurs at all sizes, it is stronger for smaller farms, whose household-level efficiency levels are comparable with the farm-level efficiencies of the larger farms. This suggests that small corn/soybean farmers have adapted to shortfalls in farm-level efficiency by increasing off-farm income.

Also, the higher household-level efficiencies are consistent with the positive scope economies found. Both findings reflect the more efficient use of resources at the household level, particularly the use of managerial labor (operator and spouse) shared between onfarm and off-farm activities.

Moreover, as Smith (2002) observes, as farm operators and other household members engage in off-farm activities, they have less time available for farm management. This may inhibit their adoption of management-intensive agricultural innovations and lead to less efficient farming.

Table 6
Technical efficiency of corn/soybean farms, 1996-2000

		Technical efficiency scores	
Farm type[1]	Gross sales ($)	Farm level (excluding off-farm income)	Household level (including off-farm income)
Farming occupation/ lower sales	< $100,000	0.87	0.95
Farming occupation/ medium sales	$100,000-$249,999	0.91	0.95
Large family farms	$250,000-$499,999	0.91	0.95
Very large family farms	> $500,000	0.93	0.95
All farms		0.91	0.95

[1]Excluding limited-resource and retirement/residential farms.

Source: Nehring et al., 2005

[19]The analysis uses several econometric techniques, including the estimation of an input distance function and stochastic frontier estimation (appendix 1; Nehring et al., 2005) to estimate technical efficiency at the farm (excluding off-farm income-generating activities) and at the household level (including off-farm income-generating activities). Data used were 1995-2003 survey data of corn/soybean farms from 10 States (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin), that account for most U.S corn and soybean production.

[20]A farm unit with an efficiency score of 0.8 is said to be 80 percent as efficient as the farms on the 'frontier," i.e., the best performing farms in the data set.