

What Do Econometric Estimates Tell Us?

COP accounting estimates clearly show that average costs decline as herd sizes increase, and they provide some useful information for assessing the sources of the cost advantage, but they also have limitations. Specifically:

- Because the estimates do not distinguish between input quantity and input price, we cannot determine whether a cost advantage derives from more efficient input use or from lower prices paid.
- COP estimates reflect the average performance of farms in each size class. Farms vary in efficiency—some are best-practice efficient operations, while others may be poor performers. Consequently, costs can fall as herd sizes increase, either because larger enterprises tend to be more efficient or because technology creates scale economies that allow large enterprises to realize lower costs than equally efficient smaller enterprises.

Two econometric analyses estimate scale economies in dairy production with data from the 2000 ARMS dairy version (Tauer and Mishra, 2006; and Mosheim and Lovell, 2006). The studies take different approaches to the issue (see box, “Herd Size and Production Costs: Scale Economies or Inefficiency?”). Each finds that average production costs fall as herd sizes increase, and each aims to identify the roles of scale economies and inefficiency.

Tauer and Mishra (T&M) argue that most of the observed cost advantage of large herds follows from a greater incidence of inefficient production among smaller dairies. Scale economies were found to be quite modest once they accounted for inefficiency. Costs at fully efficient large dairies (1,000 milk cows) were estimated to be only \$1.13 per cwt, or 11.3 percent, below those at fully efficient small (50 cow) dairies, in contrast to an \$8.10 difference (36.8 percent) using unadjusted 2000 data. They estimated that average costs at efficient dairies with 1,000 cows were 3 percent below those of efficient dairies with 500-cow herds, versus a 14.3-percent difference based on unadjusted data.

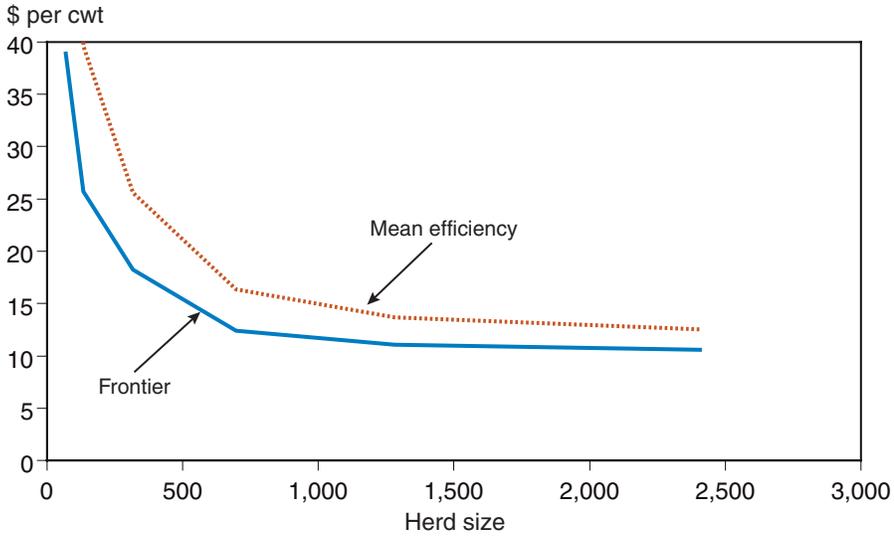
Mosheim and Lovell (M&L) found scale economies to be much more important. In M&L’s analysis, average costs among efficient producers decline sharply as herd size expands to 400 milk cows, and they continue to decline, but less rapidly, beyond that size (fig. 4). Among the most efficient operations, average costs fall to \$10.57 per cwt at 2,400 head, compared with estimates of \$11.05 at 1,300 head, \$12.43 at 700 head, and \$18.25 at 300 head. Furthermore, while the estimated cost advantages of further increases in herd size are modest at sizes above 1,000 head, M&L find that scale economies are not completely exhausted even among the largest operations in the sample (2,000-3,000 head).

M&L also found that inefficiency was an important source of cost differences. As in T&M, inefficiency was more prevalent among smaller operations. Costs for the average very large farm (2,400 head), at \$12.55 per cwt,

were 19 percent above frontier costs (fig. 4). Costs at average (mean efficiency) farms are 32 percent above frontier costs at 700 head, and 40 percent greater at 300 head.

Figure 4

Estimated scale economies in dairy production



Source: Data derived from Mosheim and Lovell (2006).

Herd Size and Production Costs: Scale Economies or Inefficiency?

The cost curve in figure 2 (p. 6) reflects how costs vary among producers who are choosing and using inputs in such a way as to minimize costs. Such producers are allocatively efficient in that they are choosing the combinations of inputs that will allow them to minimize the costs of producing a given level of output, and they are productively efficient in that they are getting the most out of the inputs that they've chosen. In that case, the declining cost curve represents scale economies that allow costs for efficient producers to decline as output expands. Scale economies are a technological concept, and in dairy production they may arise from several sources, including milking systems and milk storage, housing, feed storage and delivery systems, and manure handling equipment.

Inefficient operations would fall above the cost curve in figure 2, either because they are allocatively or productively inefficient. Operations can be inefficient because of events outside of the operator's control, such as bad weather; because the operation was originally designed and built to take advantage of input prices that no longer hold; or because of poor decisions made by the operator. The wide range of costs and returns exhibited by dairy farms in the COP estimates, as in other analyses of farm performance, strongly suggests that there may be important differences in efficiency among farms.

Analysts seeking to distinguish scale economies from inefficiency aim to identify the cost line depicted in figure 2. In principle, inefficient enterprises would have costs above the unit cost line, while efficient dairy enterprises would be on the line. Actual data points can fall above or below the line for other reasons, such as measurement errors in the data or an inability to control for other factors that affect costs. These are called random, or stochastic, errors. In trying to identify the unit cost line (scale economies) in the data, and to identify the extent of inefficient production, assumptions are made about the nature of the stochastic errors and about the nature of the technology that drives the shape of the line. The two analyses of the 2000 ARMS dairy data took different approaches to modeling and data development, and these differences affect their conclusions.

Tauer and Mishra (T&M) imposed two assumptions that are likely to reduce the estimate of scale economies in their analysis. First, they subtracted culled cattle revenues from the ERS cost-of-production estimates, on the grounds that those revenues represent the separable costs of livestock production and that they wanted to focus on the specific costs of milk production alone. But milk and cull cows are joint products, so costs cannot be meaningfully separated. Moreover, there is a strong inverse relationship between culled cattle revenues, per cwt of milk sold, and herd size in the sample. Thus, deletion of livestock sales from costs will reduce estimated production costs, and will reduce them more among smaller operations.

Continued on page 19

Continued from page 18

Second, T&M did not control for input prices in their analysis, but instead controlled for the locations (States) of farms (by inserting a dummy variable for each State). The practical impact of that approach is to limit the effective range of farm sizes considered to the range within a State—cross-State differences in farm size, which are large, were not used to assess scale effects. The adjustment for culled cow revenues and the imposition of State effects are each likely to reduce estimated scale economies.

Mosheim and Lovell (M&L) took a different conceptual approach to modeling costs. Costs at the level of the whole farm were analyzed, and the impact on costs of changes in all farm production (milk, but also crops and other livestock), as well as in input prices, was investigated. This approach is theoretically more appropriate than COP accounting, since it does not rely on potentially arbitrary rules for assigning joint or common costs to different farm enterprises, but it also presents significant technical and reporting challenges.

M&L developed an extensive set of input prices, and included those prices in their analytical model. The model allowed for a flexible specification of the relation between the scale of output and costs, and also accounted for inefficiency among producers. Cost data were drawn from ERS ARMS files, but two important expense categories were adjusted.

M&L used a different approach to estimating the implicit cost of capital equipment and structures used on the farm. The COP analyses build an estimate of capital stock by using detailed ARMS survey data on the structures and equipment used in the dairy enterprise, and estimating capital recovery costs from that information. M&L estimate costs for the whole farm, not just the dairy enterprise, in order to better model the impact of joint and common costs. The survey does not contain structures and equipment detail for the whole farm, so M&L estimate the farm's capital stock using data on estimated capital prices and a farm's financial flows.

M&L's estimates of the opportunity cost of unpaid farm labor exceed COP estimates. Since unpaid labor is more important on smaller operations, this approach raises estimated costs on small farms compared with COP and T&M's estimates, and raises the estimates of scale economies. The COP estimates are based only on off-farm wage earnings. M&L take the same regression-based approach that is used for the COP estimates, but they add earnings from operating another business to off-farm wage earnings. Since M&L include more sources of income in their analyses, their estimates of the costs of unpaid labor are higher.