Cost and Production Efficiency Dispersions in the Ontario Dairy Farms

Getu Hailu,

Professor, Department of Food, Agricultural and Resource Economics, University of Guelph

EXECUTIVE SUMMARY

This report measures the productive efficiency of Ontario dairy farmers and provides evidence on the correlation between capital structure and vintage, production efficiency and productivity in Ontario dairy using the Ontario Dairy Farm Accounting Project (ODFAP) data. Results show that there is non-trivial heterogeneity in efficiency and productivity across the sample farms. The results also show that capital structure has a positive effect on farms' productivity and efficiency. The level of barn equipment has a positive correlation with productivity and a negative correlation with production efficiency.

1. WHAT IS THE ISSUE?

An interesting feature of firm-level production efficiency studies is the considerable and persistent differences in efficiency between firms that operate in the same industry (Syverson 2011). For example, Hailu and Poon (2017) find that farms at the 90 percentile are 10.39 percent more efficient than those in the 10th percentile for the feedlot, 16.45 percent cow-calf and 18.43 percent for background in Ontario. Some of the explanation for the efficiency or productivity dispersion is capital vintage effects and lacking or imperfect competition in an industry (i.e., if the competition is not very strong, then lagging farms which, otherwise would be forced to exit, continue to stay in the market thereby increasing efficiency dispersion). In this research, first, I use the ODFAP data to measure production efficiency, second, I use the estimated production efficiency to examine production efficiency dispersion across dairy farms in Ontario, and third, I will examine if there is a link between dispersion and capital structure and vintage. The information generated in this study provides insights for governments and producer group decision-makers that are interested in the long-term competitiveness and sustainability of the dairy industry. The recent USMCA, TPP and CETA agreements have opened a significant percentage of the industry to imports and further underscore the long-term challenges facing Ontario's dairy industry.

In the previous DFO funded project results, I show that the top 10% of low-cost farms produce a hectolitre of milk at nearly half the cost (i.e., 55%) of the lowest 10% of high-cost producers. This cost dispersion result holds significant policy relevance because it demonstrates that a bob-trivial level of cost savings is obtainable for a large percentage of dairy farms.

2. WHAT DID THE STUDY FIND?

2.1. Productivity and Capital Structure and Vintage

We estimated productivity by milk per cow per year in litres. We find the average productivity is 9,050 litres per cow over the study period, 8,560 for 2011, and 9,937 for 2017. Productivity has been increasing over the study period at an average rate of 2.8% per year. The gains in productivity can be attributed to the adoption of technologies (*e.g.,* genetics, robotics) and better managerial practices. Figure 1 provides the distribution of milk yield over the study period.

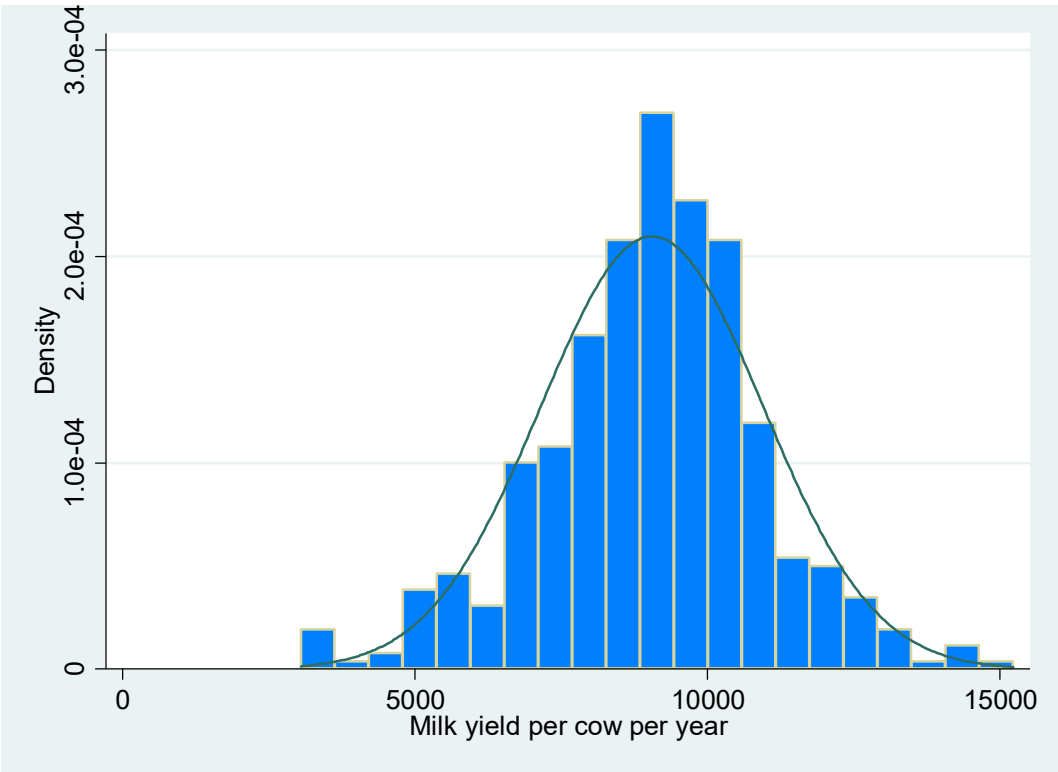

Figure 1 Distribution of milk yield per cow per year

We also find a positive correlation between debt to asset ratio and productivity. Farms with higher debt to asset to ration to be more productive. This could be because of investment in productivity capitals. To further explore the correlation between capital and productivity, we assessed the relationship between the value of barn equipment (as a proxy for capital vintage). We find a positive correlation between the level of barn equipment and productivity. A one percent increase in the value of barn equipment increases productivity by 0.05% percent (approximately 5 litres higher). We, however, find a nonlinear relationship between capital vintage and productivity – i.e., there is considerable heterogeneity in terms of the effect of capital vintage across farms (Figure 2). The effect of capital vintage at the lower quartile (0.02%) is lower than at the upper quartile (0.08%).

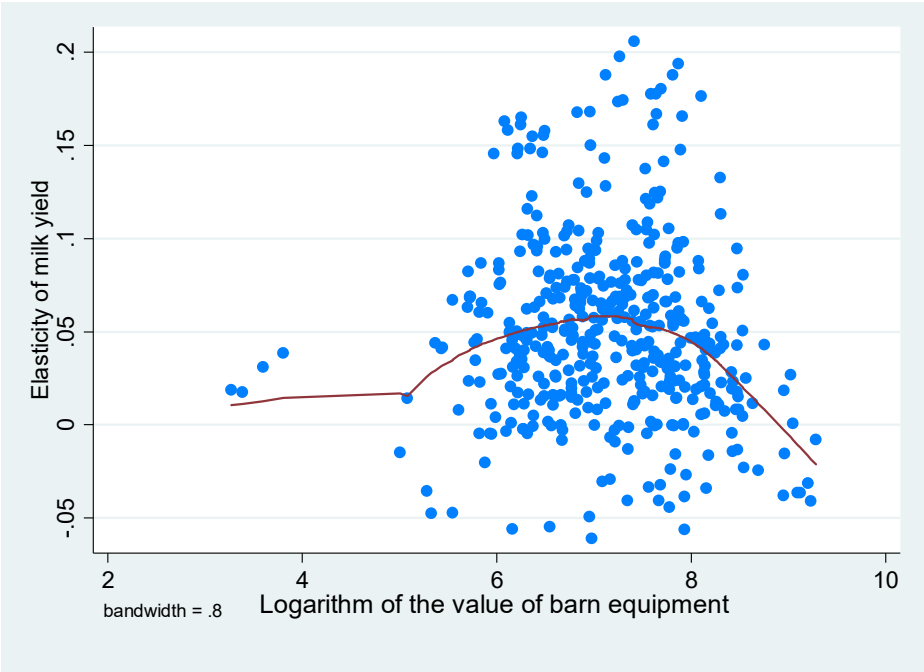

Figure 2 Relationship between milk yield and capital vintage

We also used barn condition as a proxy for capital vintage (1=poor; 2=average; 3=good; 4=excellet). On average, 13% of the observations reported average barn condition, 65% good, and 24% excellent. Though there are some shifts in distribution, the distribution of barn

conditions hasn't seen major structural change over the study period. For example, in 2011, 9.84% of the sample farms reported average barn condition, 67.21% good, and 23% excellent. In 2017, 15.27% reported average barn condition, 58.33% good, and 26.39% excellent. In terms of the relationship between productivity and barn conditions, we find that farms with excellent barn conditions are 4.5%, on average, more productive than those with average barn conditions - or their milk yield is higher by 4.5%. The effect of barn condition at the lower quartile (0.11%) is lower than at the upper quartile (8.8%) for excellent barn conditions compared to average barn conditions.

2.2.Production Efficiency and Capital Structure and Vintage

We estimated the production efficiency index using distance functions. We find that the average production efficiency is 68%, with the lowest being 35.10% and the highest being 97.63%. We also observed a considerable heterogeneity/dispersion in estimates of production efficiency (Figure 3). We also find that, on average, the sample farms operate in increasing returns to scale region. This finding is consistent with Moschini's (1988) finding of increasing returns to scale for Ontario dairy farms with larger levels of milk production but decreasing returns to scale for the very largest ones. For the U.S. dairy farms, Tauer and Mishra (2006) also find increasing returns to scale. The increasing returns to scale finding may explain why the average herd size has been increasing over time in Ontario, for example, from approximately 54 cows per farm in 2000 to 84 cows per farm in 2011, and 87 cows per farm in 2017.

High debt to asset ratio is positively correlated with production efficiency. We find that the correlation between the value of barn equipment and production efficiency is negative. Though this result is not expected, it may reflect adjustment cost, the learning curve in terms of highly specialized barn equipment. A one percent increase in barn equipment ($) will be associated with

a 0.096 percentage point decrease in production efficiency. As in the milk yield case, the relationship between production efficiency and the value of barn is also heterogeneous (Figure 4).

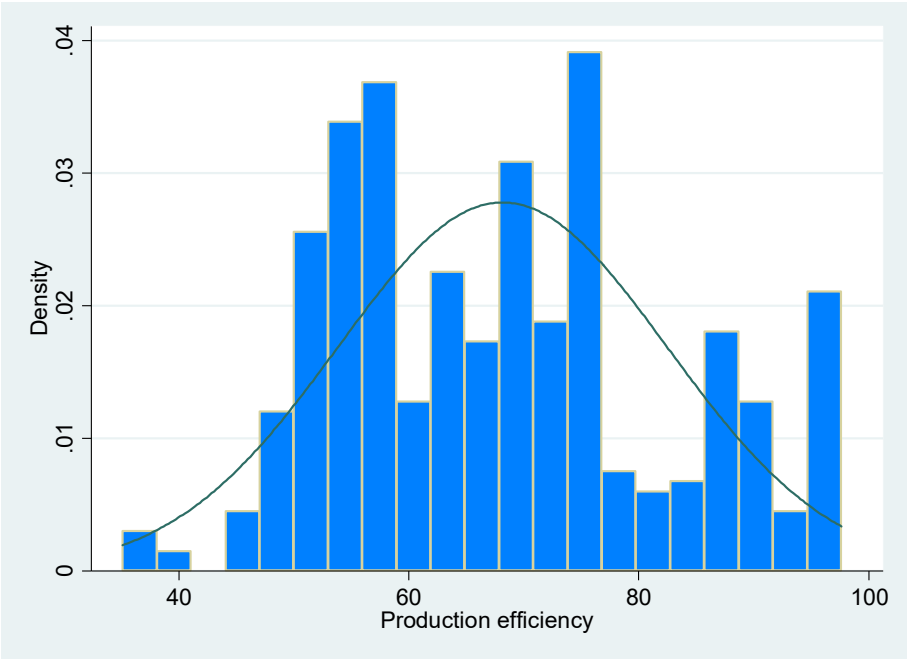

Figure 3 Distribution of production efficiency

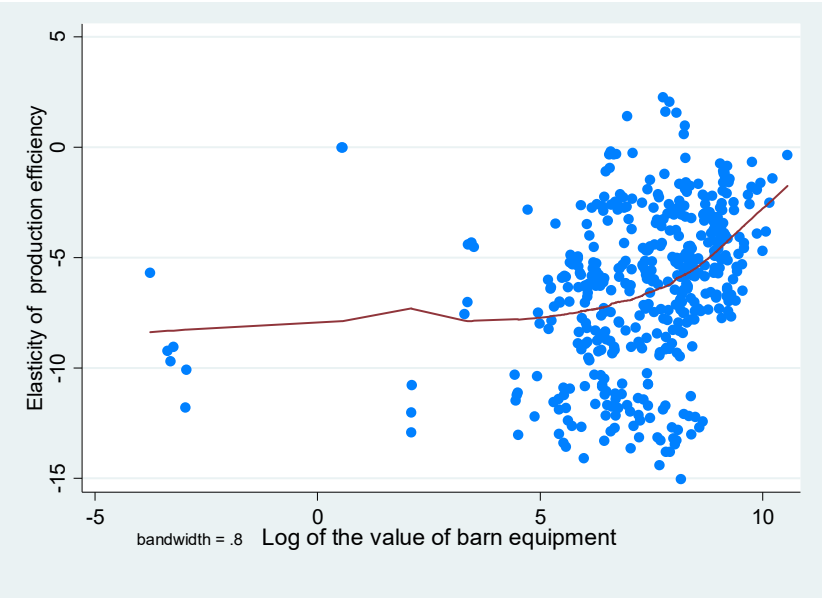

Figure 4 Relationship between milk yield and debt to asset ratio

3. HOW WAS THE STUDY CONDUCTED?

We use the Ontario Dairy Farms Accounting Project (ODFAP) data. The ODFAP is a co-operative project of Dairy Farmers of Ontario, and the Canadian Dairy Commission (CDC), which started in 1976. The Project develops and maintains a representative and consistent farm to obtain production and management data that meets the farm database requirements of the Ontario dairy industry in the three areas of policy, research and extension. "This is being achieved (1) by maintaining a sample of farms which represents typical Ontario dairy farm situations and which reflects different levels of technology, regional differences and other significant factors and, (2) through the development and maintenance of a data collection and information reporting system which will provide the participating agencies with the information which they require." (CDC-DFO, 2019; p.5).

We estimate farm-level productivity as a ratio of total milk to the number of cows - *i.e.,* milk yield per cow per year. Second, we estimate production efficiency using an econometric method – stochastic distance function. Based on the ODFAP data, the stochastic distance function allows us to create an index on managerial performance or efficiency, and benchmark farms with their peers (see for example our dairy Benchmarking website at https://www.getuhailu.com/projects/benchmarking/). We then use kernel-based regularized least squares to assess the relationship between capital structure – measured by debt to asset ratio – capital vintage -measured by the value of barn equipment, investment and barn conditions– milk yield and production efficiency. The values of production efficiency provide insight into potential cost savings from improvement in farm management practices.

References

Ferwerda, J., Hainmueller, J., & Hazlett, C. 2015. Krls: A Stata package for kernel-based regularized least squares. *Journal of Statistical Software*, *55*(2).

Hailu, G. and Poon, K., 2017. Do Farm Support Programs Reward Production Inefficiency? *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 65(4), pp.567-589.

Moschini, G. 1988. The Cost Structure of Ontario Dairy Farms: A Mirco-Econometric Analysis. *Canadian Journal of Agricultural Economics* 36(2):187-206.

Syverson, C., 2011. What determines productivity? *Journal of Economic Literature*, *49*(2), pp.326-65.

Tauer, L.W. and A.K. Mishra. 2006. Can the Small Dairy Farm Remain Competitive in U.S. Agriculture? *Food Policy* 31(5):458-468.