

## ABSTRACT

This paper examines the relationship between three expense ratios: total expense ratio; adjusted total expense ratio; and economic total expense ratio; and discusses economies of size for a sample of Kansas farms. The total expense ratio and the adjusted total expense ratios, though commonly used to examine financial efficiency, are not as good of indicators of economies of size as the economic total expense ratio which includes opportunity costs on unpaid operator and family labor, and farm equity. Using the economic total expense ratio, cost per dollar of value of farm production for farms with an average value of farm production greater than \$1,000,000 was 52 percent and 29 percent lower than it was for farms with an average value of farm production less than \$100,000, and for farms with an average value of farm production between \$100,000 to \$250,000, respectively. Results confirm previous literature that indicated long-run cost curves for production agriculture are L-shaped.

## Measuring Economies of Size with Expense Ratios

By Michael Langemeier

### Introduction

Previous literature pertaining to production agriculture suggests that long-run cost curves are L-shaped (e.g., Hallam, 1991; Yeager & Langemeier, 2009). This shape indicates that economies of size are present, and more importantly that costs drop significantly for the first incremental increases in output and then drop at a slower rate thereafter. The range of output in which costs drop rapidly is of course an empirical question.



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Long-run costs described in economic textbooks (e.g., Pindyck & Rubinfeld, 2013; Baye, 2010), as well as previous literature related to economies of size, include both accrual costs and opportunity costs. Relevant opportunity costs for farms and ranches would include unpaid operator and family labor, and an opportunity charge on farm equity. Interestingly, financial efficiency ratios suggested by the Farm Financial Standards Council (2008) and those commonly used to measure financial performance, such as the total expense ratio, exclude opportunity costs on unpaid operator and family labor, and farm equity. A natural question to ask is how important these exclusions are to the measurement of economies of size.

The objectives of this paper are to examine the relationship between three expense ratios: total expense ratio; adjusted total expense ratio; and economic total expense ratio; and to illustrate economies of size for a sample of farms. The total expense ratio is one of the efficiency measures suggested by the Farm Financial Standards Council. This measure includes accrual expenses, but excludes opportunity costs. The adjusted total expense ratio includes all of the expenses involved in the computation of the total expense ratio as well as the opportunity costs associated with unpaid operator and family labor. This measure is closely related to the operating profit margin ratio, one of the most important measures of farm profitability. The economic total expense ratio includes all opportunity costs and is thus closely aligned with economic theory. By discussing all three expense ratios, this paper bridges the gap between efficiency ratios commonly used and economic theory

pertaining to the measurement of economies of size.

### Definitions of Expense Ratios

Before describing the data and illustrating how the expense ratio values change as output or farm size increases, it is important to define the three expense ratios used in this paper: total expense ratio, adjusted total expense ratio, and economic total expense ratio. These three expense ratios are used by the Kansas Farm Management Association (KFMA) in comparisons and summaries (see Herbel & Langemeier for an example using 2010 KFMA data). The differences between the three expense ratios are related to the inclusion or exclusion of opportunity costs. The total expense ratio is computed by dividing accrual expenses (cash costs, accrual cost adjustments, and depreciation) by value of farm production. As indicated above, this efficiency ratio is included in the ratios presented by the Farm Financial Standards Council.

The other two expense ratios discussed in this paper are not included in the ratios suggested by the Farm Financial Standards Council. In addition to accrual expenses, the adjusted total expense ratio accounts for unpaid operator and family labor. This ratio is computed by adding unpaid operator and family labor to the expenses included in the total expense ratio and dividing by value of farm production. A ratio below one would indicate that a farm or group of farms is covering accrual expenses and unpaid operator and family labor. The economic total expense ratio is computed by adding an opportunity charge on farm equity to the expenses included in the adjusted total expense ratio and

dividing by value of farm production. A ratio below one would indicate that a farm is covering accrual expenses, unpaid operator and family labor, and the opportunity charge on farm equity. In this instance, the farm or group of farms can be thought of as earning an economic profit, explaining the origination of the name of this expense ratio.

In addition to the three expense ratios (i.e., total expense ratio, adjusted total expense ratio, and economic total expense ratio), this paper illustrates differences in the operating profit margin ratio, the asset turnover ratio, the debt to asset ratio, and financial stress among farms. The operating profit margin ratio is computed by adding interest and subtracting unpaid operator and family labor from net farm income, and dividing the result by value of farm production. Based on the items included in their computation, there is close relationship between the operating profit margin ratio and the adjusted total expense ratio. The asset turnover ratio is computed by dividing value of farm production by average total assets. The rate of return on assets can be computed by multiplying the operating profit margin ratio by the asset turnover ratio. Farms that are financially stressed are not covering accrual expenses and unpaid operator and family labor (i.e., have an adjusted total expense ratio above 1.00), and have a debt to asset ratio above 70 percent.

Value of farm production is used as a measure of farm size in this paper. The financial performance measures and ratios described above are illustrated for the following farm size or value of farm production categories: less than \$100,000; \$100,000 to \$250,000; \$250,000 to \$500,000; \$500,000

to \$1,000,000; and greater than \$1,000,000. In addition, expense ratios for individual farms are illustrated graphically.

To further illustrate differences in per unit costs, the farms are divided into operating profit margin quartiles. The primary use of this categorization is to contrast the percentage of farms in the top profit margin quartile among the farm size categories.

### Data

Farms in the Kansas Farm Management Association with continuous data from 2006 to 2010 are included in the analysis. Table 1 reports the median values and the averages for the sample of farms. Five-year average data is used instead of data from a single year to mitigate the impact of weather. The median farm size is smaller than the average farm size. The average value of farm production and net farm income are \$430,427 and \$108,994 while the median values are \$318,039 and \$72,860, respectively. Median and average total acres for the sample of farms are 1,632 and 2,037, respectively. Though not shown in Table 1, the average percentage of acres owned is 33.37.

Interest expense, total expense, unpaid operator and family labor, opportunity charge on farm equity, total debt, and total assets are presented in Table 1 to enable the reader to compute the financial ratios presented. Unpaid operator and family labor is computed using data on labor months and a flat charge per operator. The opportunity charge for a full-time operator averaged \$47,210 during the study period and ranged from \$40,300 in 2006 to \$52,500 in 2010. The opportunity charge for part-

time operators is based on months worked on the farm. Wages paid to the operator, or his or her family, are not included in the computations. The charge for farm equity is computed using a long-run average opportunity interest rate of eight percent and average farm equity.

Before discussing the average expense ratios, it is important to note the magnitudes of the opportunity cost items. Average unpaid operator and family labor is \$50,945 and the average opportunity cost on farm equity is \$77,409. These amounts are considerably higher than hired labor expense (\$15,081) and interest expense (\$20,908).

The average total expense ratio, adjusted total expense ratio, and economic total expense ratio are 0.747, 0.865, and 1.045, respectively. Note that the average adjusted total expense ratio is less than one. This indicates that, on average, the farms are covering accrual expenses and unpaid operator and family labor. Approximately 65 percent of the farms are able to cover these expenses. In contrast, only 33 percent of the farms are able to cover all costs, including the opportunity charge on farm equity.

The average profit margin ratio is 0.1834 and the average asset turnover ratio is 0.3259. Multiplying these two items together yields an average return on assets of 0.0598. Note that this measure of return on assets excludes capital gains on land. The percentage of farms exhibiting financial stress is 4.43 percent.

### Illustration of Differences in Expense Ratios

Table 2 reports the financial measures for five farm size categories. The farms are sorted into

size categories using average value of farm production for each farm. The total expense ratio is substantially higher for farms in the smallest farm size category, but similar for farms with a value of farm production greater than \$100,000. The total expense ratio for the farms in the smallest value of farm production category is 22 percent higher than the total expense ratio for the farms in the largest value of farm production category. The differences between the farms in the smallest and largest value of farm production categories are even wider for the adjusted total expense and economic total expense ratios. Using the adjusted total expense ratio, the difference is 73 percent. For the economic total expense ratio, the ratio for the smallest average value of farm production farms is more than double the ratio for the farms with the largest average value of farm production.

Why do the differences between the expense ratios for the farms in the smallest and largest value of farm production categories get wider as the opportunity costs are added? The answer of course relates to differences in opportunity costs among the farms. There are two primary reasons for the widening of differences in expense ratios between small and large farms. First, smaller farms tend to hire fewer workers. Because hired labor expense is included in total expense, and unpaid operator and family labor is excluded, using the total expense ratio underestimates total labor costs for the smaller farms. Second, the smaller farms tend to own more acres. Including cash rent and at the same time excluding the opportunity cost on owned land underestimates land costs for the smaller farms. Combining these two reasons, results in an increasing difference in expense ratios as we move

from an examination of the total expense ratio to an examination of the economic total expense ratio.

Expense ratios below one indicate that expenses, and opportunity costs when examining the adjusted total expense ratio and the economic total expense ratio, are being covered. All of the average total expense ratios for the five farm size categories are less than one. The average adjusted total expense ratio is below one for farms with a value of farm production greater than \$250,000 while the average economic total expense ratio is below one for farms with a value of farm production greater than \$500,000. Because they include opportunity costs, comparisons among farms using the adjusted total expense ratio and the economic total expense ratio are more appropriate than comparisons among farms using the total expense ratio. It is particularly problematic to compare the total expense ratio between a group of farms with no hired labor and a group of farms with hired labor. As noted above, hired labor is included in the total expenses that make up the total expense ratio, but unpaid operator and family labor is not. The percent of farms with an adjusted total expense ratio and an economic total expense ratio less than one increases with farm size. Approximately 62 and 77 percent, respectively, of the farms with an average value of farm production between \$500,000 and \$1,000,000, and greater than \$1,000,000 were covering all accrual expenses and opportunity costs (i.e., economic total expense ratios are less than one).

The operating profit margin ratio for farms with a value of farm production greater than \$500,000 is above the average profit margin ratio. Similarly,

the asset turnover ratio for farms with a value of farm production greater than \$500,000 is above the average for all farms. The negative profit margin for farms with a value of farm production below \$100,000 reflects the problem these farms have in covering unpaid operator and family labor. Only four percent of the small farms are in the top profit margin quartile (i.e., in the fourth category). In contrast, over 51 percent of the farms with a value of farm production greater than \$1,000,000 are in the top profit margin quartile. Thus, it is possible for small farms to have above average profitability, but it certainly is more difficult for these farms to achieve that target.

Financial stress is below average for the farms with a value of farm production greater than \$500,000. These farms tend to be able to cover opportunity costs on operator and family labor, making these farms relatively less financially stressed.

Figures 1-3 are used to further illustrate the wide difference in per-unit costs among farms. Each triangle in these figures represents the average total expense ratio, adjusted total expense ratio, and economic total expense ratio for an individual farm. Even after adjusting for the scale of the vertical axis, the graphs are clearly not identical. The graph for the economic total expense ratio shows more variability among the smaller farms and less variability among the larger farms than the other two graphs. The difference in per-unit cost graphs is particularly evident when comparing Figures 1 and 3. Computation of the total expense ratio does not include the opportunity costs for unpaid labor or farm equity. Because the amount

of hired labor and asset ownership varies widely among farms, comparing the total expense ratio among farms is often like comparing apples and oranges, particularly when these comparisons are made across farm size categories. When measuring economies of size, all accrual and opportunity costs should be included. Thus, the economic total expense ratio would be a more appropriate measure of economies of size than the total expense ratio or the adjusted total expense ratio. The economic total expense ratio graph, Figure 3, clearly indicates that there are economies of size for the sample of farms, and that the long-run average cost for farms is L-shaped.

The results in Table 2 and Figures 1-3 suggest that the three expense ratios are correlated, though certainly not perfectly correlated. Table 3 illustrates the correlation of the total expense ratio and the adjusted total expense ratio with the economic total expense ratio. The correlations with value of farm production, the operating profit margin ratio, the asset turnover ratio, and the debt to asset ratio are also presented in Table 3. All of the correlation coefficients in Table 3 are statistically significant at the one percent level.

The economic total expense ratio is more highly correlated with the adjusted total expense ratio and the operating profit margin ratio than the total expense ratio. This suggests that in the absence of the economic total expense ratio, it would be more appropriate to use the adjusted total expense ratio or the operating profit margin ratio to measure economies of size than the total expense ratio. It is also important to note that value of farm production

is negatively correlated with the economic total expense ratio. This negative correlation confirms the existence of economies of size for the sample of farms. As the average value of farm production increases, the economic total expense ratio decreases.

### Summary and Conclusions

This paper examines the incidence of economies of size using three expense ratios: total expense ratio; adjusted total expense ratio; and economic total expense ratio. The total expense ratio does not include opportunity costs on operator and family labor, or farm equity. The adjusted total expense ratio accounts for the opportunity charge on operator and family labor, while the economic total expense ratio accounts for all opportunity costs. An economic total expense ratio below one would be indicative of a farm that is earning economic profit.

Using the total expense ratio or adjusted total expense ratio to measure economies of size is found to be problematic. The total expense ratio appears to bottom out at a value of farm production of approximately \$250,000 and then increase past this point. Because this expense ratio excludes opportunity costs, it does not account for the facts that farms below \$250,000 in value of farm production tend to hire fewer additional workers and tend to own more of their acres. The adjusted total expense ratio, even though it includes the opportunity costs on unpaid operator and family labor, shows similar tendencies to that of the total expense ratio. Expense seems to drop sharply until farms reach approximately \$250,000 in value of farm production and then increase with farm size.

The importance of including all opportunity costs when measuring economies of size was certainly evident in this study. The economic total expense ratio, which includes all opportunity costs, for the sample of farms indicates that there are substantial economies of size in Kansas agriculture. The economic total expense ratio declined from 1.93 for the farms with an average value of farm production less than \$100,000 to 0.93 for the farms with an average of value of farm production greater than \$1,000,000. Approximately 77 percent of the farms with an average value of farm production greater than \$1,000,000 had an economic total expense ratio below one and are thus earning an economic profit.

As noted in this paper, opportunity costs are often not included in the computation of expense ratios. Among the possible reasons for excluding opportunity costs from the computation of expense ratios is the difficulty associated with measuring

opportunity costs. The interpretation problems associated with excluding opportunity costs are too great to let this reason prevent us from including these items in the measurement of economies of size. Suggestions regarding the measurement of the opportunity costs on unpaid labor and farm equity are as follows. For unpaid operator and family labor, use labor months and average family living. When doing this, it is important to make sure that a part-time operator is assigned less than 12 labor months. Also, any wages paid to the operator or family should be excluded. These wages are often related to tax management strategies rather than the actual costs incurred. For the opportunity cost on farm equity, use a long-term interest rate (e.g., average interest rate on real estate loans for the last ten to twenty years) and average farm equity. As a final note, with both of these opportunity costs, it is important to use the same methodology across farms.

## References

Baye, M.R. *Managerial Economics and Business Strategy*, Seventh Edition. New York: McGraw-Hill, 2010.

Farm Financial Standards Council. *Financial Guidelines for Agricultural Producers*, 2008.

Hallam, A. "Economies of Size and Scale in Agriculture: An Interpretative Review of Empirical Measurement." *Review of Agricultural Economics*. 13(January 1991):155-172.

Herbel, K. and M. Langemeier. Kansas Farm Management Association, Annual Profitlink Summary, 2010.

Pindyck, R.S. and D.L. Rubinfeld. *Microeconomics*, Eighth Edition. Upper Saddle River, New Jersey, Prentice Hall, 2013.

Yeager, E. and M. Langemeier. "Measuring Sustained Competitive Advantage for a Sample of Kansas Farms." *Journal of the American Society of Farm Managers and Rural Appraisers*. 72(2009):112-123.

Table 1. Summary Statistics for 1,016 KFMA Farms with Continuous Data from 2006-2010

Item	Median	Average
Value of Farm Production (VFP)	\$318,039	\$430,427
Net Farm Income	\$72,860	\$108,994
Interest	\$12,628	\$20,908
Total Expense	\$245,179	\$321,433
Unpaid Operator and Family Labor	\$46,932	\$50,945
Opportunity Charge on Farm Equity	\$59,158	\$77,409
Total Debt	\$215,684	\$352,880
Total Assets	\$998,324	\$1,320,806
Total Expense Ratio (TER)	0.771	0.747
Adjusted Total Expense Ratio (ATER)	0.918	0.865
Economic Total Expense Ratio (ETER)	1.104	1.045
Operating Profit Margin Ratio	0.1212	0.1834
Asset Turnover Ratio	0.3186	0.3259
Debt to Asset Ratio	0.2160	0.2672
Percent of Farms Financially Stressed		4.43%
Percent of Farms with TER less than 1.000		92.13%
Percent of Farms with ATER less than 1.000		65.06%
Percent of Farms with ETER less than 1.000		32.78%
Percent of Farms with VFP less than \$100,000		10.33%
Percent of Farms with VFP between \$100,000 and \$250,000		27.76%
Percent of Farms with VFP between \$250,000 and \$500,000		33.76%
Percent of Farms with VFP between \$500,000 and \$1,000,000		20.18%
Percent of Farms with VFP greater than \$1,000,000		7.97%

Source: Kansas Farm Management Association 2010 Databank.

Table 2. Summary Statistics by Farm Size Category<sup>a</sup>

Item	Value of Farm Production (thousands of dollars)				
	< \$100	\$100 to \$250	\$250 to \$500	\$500 to \$1000	> \$1000
Number of Farms	105	282	343	205	81
Value of Farm Production (VFP)	\$63,324	\$176,631	\$357,289	\$678,570	\$1,482,013
Net Farm Income	\$5,662	\$37,067	\$88,805	\$187,798	\$379,399
Interest	\$5,283	\$10,633	\$18,523	\$28,533	\$67,731
Total Expense	\$57,662	\$139,564	\$268,485	\$490,773	\$1,102,614
Unpaid Operator and Family Labor	\$30,143	\$41,860	\$51,079	\$61,139	\$83,177
Opportunity Charge on Farm Equity	\$34,541	\$51,525	\$67,527	\$104,483	\$196,422
Total Debt	\$80,976	\$166,690	\$302,250	\$497,203	\$1,202,695
Total Assets	\$512,763	\$810,776	\$1,146,596	\$1,803,251	\$3,660,629
Total Expense Ratio (TER)	0.911	0.790	0.751	0.723	0.744
Adjusted Total Expense Ratio (ATER)	1.387	1.027	0.894	0.813	0.800
Economic Total Expense Ratio (ETER)	1.932	1.319	1.083	0.967	0.933
Operating Profit Margin Ratio	-0.3031	0.0331	0.1574	0.2287	0.2456
Asset Turnover Ratio	0.1235	0.2179	0.3116	0.3763	0.4049
Debt to Asset Ratio	0.1579	0.2056	0.2636	0.2757	0.3285
Percent of Farms Financially Stressed	7.62%	7.09%	4.66%	0.49%	0.00%
Percent of Farms with TER less than 1.000	63.81%	89.36%	97.38%	99.51%	97.53%
Percent of Farms with ATER less than 1.000	9.52%	40.43%	77.26%	95.12%	95.06%
Percent of Farms with ETER less than 1.000	2.86%	10.28%	32.65%	61.95%	76.54%
Percent of Farms in First Profit Margin Quartile	84.76%	43.97%	10.50%	2.44%	0.00%
Percent of Farms in the Second Profit Margin Quartile	10.48%	29.79%	32.65%	15.61%	18.52%
Percent of Farms in the Third Profit Margin Quartile	0.95%	14.54%	33.24%	36.10%	29.63%
Percent of Farms in the Fourth Profit Margin Quartile	3.81%	11.70%	23.62%	45.85%	51.85%

<sup>a</sup> Farms in the first profit margin quartile have the lowest operating profit margin ratio. Farms in the fourth profit margin quartile have the highest operating profit margin ratio.

Table 3. Correlation of Selected Financial Measures and Ratios with the Economic Total Expense Ratio

Financial Measure or Ratio	Correlation Coefficient
Value of Farm Production	-0.390
Total Expense Ratio	0.651
Adjusted Total Expense Ratio	0.824
Operating Profit Margin Ratio	-0.839
Asset Turnover Ratio	-0.466
Debt to Asset Ratio	-0.193

Figure 1. Total Expense Ratio for Sample of Kansas Farms, 2006 to 2010 Data

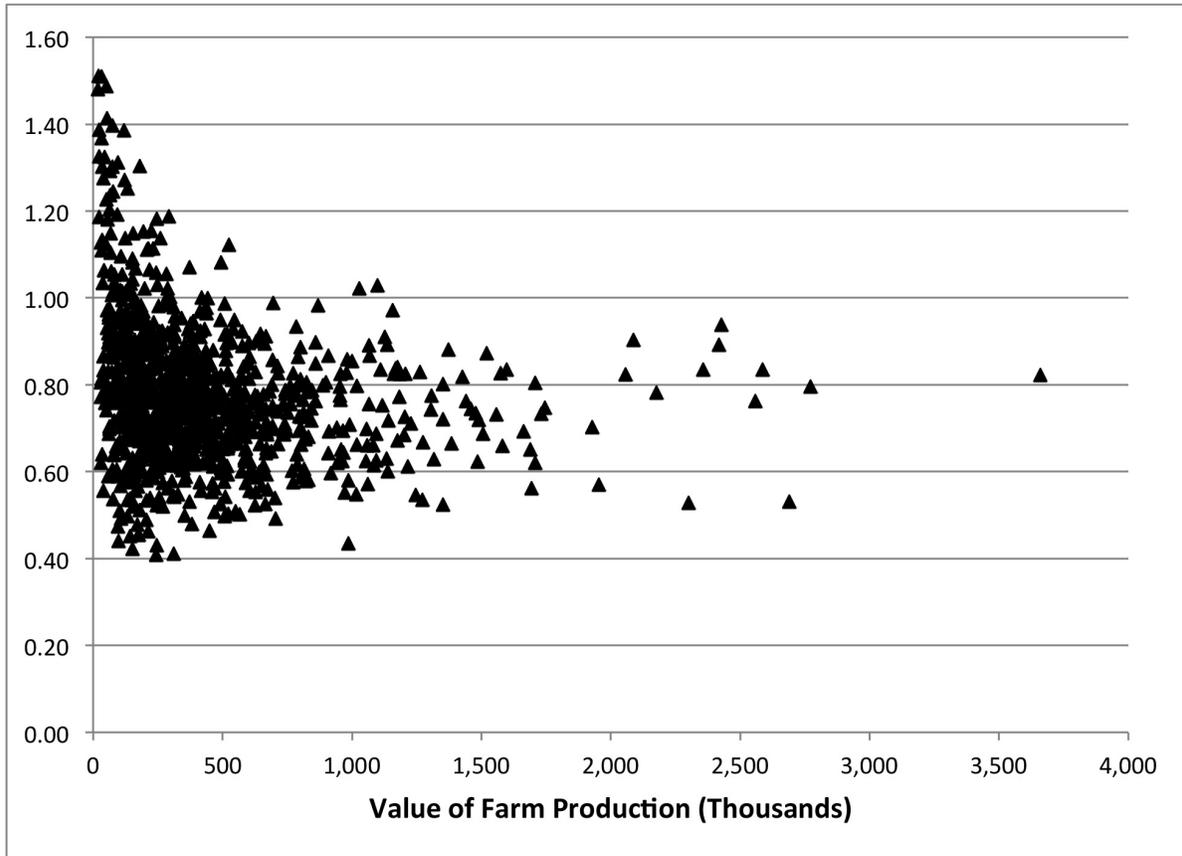


Figure 2. Adjusted Total Expense Ratio for Sample of Kansas Farms, 2006 to 2010 Data

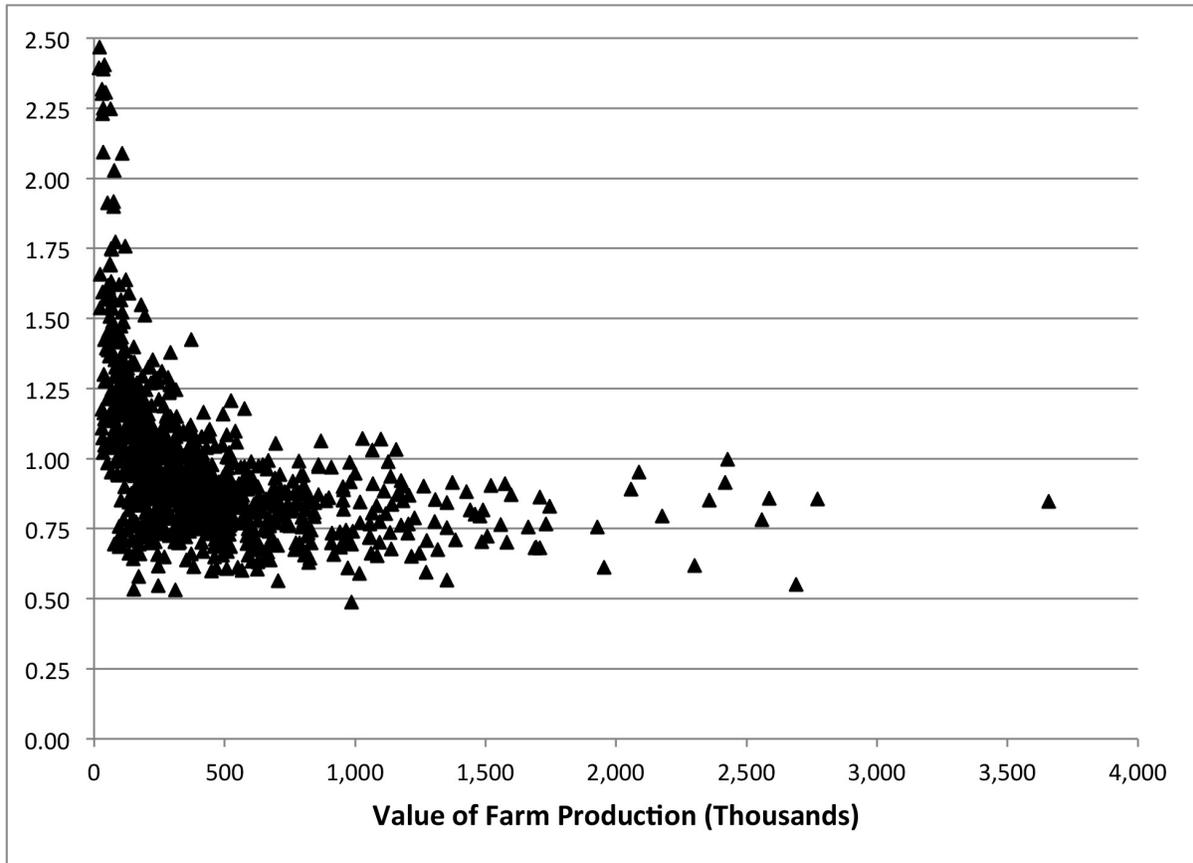


Figure 3. Economic Total Expense Ratio for Sample of Kansas Farms, 2006 to 2010 Data

