# Farm Training and Farm productivity in Armenia: A Cluster Analysis

Weldensie Embaye*, Jason Bergtold*, Ben Schwab*, and Aleksan Shanoyan*

* Department of Agricultural Economics, Kansas State University, Manhattan, KS, USA

Contact Author: wembaye@ksu.edu

Poster prepared for presentation at the Agricultural & Applied Economics Association's

2016 AAEA Annual Meeting, Boston, MA, July 31-August 2, 2016.

# Farm Training and Farm Productivity in Armenia: A Cluster Analysis

**Weldensie Teklay[1], Jason Bergtold[2], Ben Schwab[3] and Aleksan Shanoyan.[4]**

1) Graduate PhD Student Agricultural Economics, Kansas State University; 2) Associate Professor Agricultural Economics, Kansas State University;
3) Assistant Professor Agricultural Economics, Kansas State University, 4) Assistant Professor Agricultural Economics, Kansas State University.

1) "This material is based upon work supported by the USDA Foreign Agricultural Service. Any opinions, findings, conclusions, or recommendations expressed herein are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture."

## Background

- Evaluation of agricultural extension programs (training) that promote agricultural production are increasing in importance.
- Extension programs are commonly assessed through changes in farm and household income (Wordofa and Sassi, 2014). However, treatment effects using these measures may understate the true impact if training primarily resulted in more efficient allocation of factors of production.
- Alternatively, changes in technical efficiency could be used to evaluate treatment effects from training. Technical efficiency is not subject to changes in prices.
- In this study, we assess the impact of an extension program on farm productivity of Armenian farmers.
- To improve farm performance, water to market training was offered using a cluster randomized control trial (RCT) by the Millennium Challenge Corporation. Fortson et al., (2012), evaluated the impact of water to market training on income changes and found no significant effect.
- Farmers heterogeneity is addressed through data clustering. Offering the same or similar farm training for different types of farmers (e.g. commercial vs. subsistence) could affect them differently.

## Purpose and Objectives

*Purpose:* To evaluate the water to market training program on changes in farm productivity for different farmer types.

*Objectives:* (1) Identify farm clusters; (2)Measure farm productivity for farms within each cluster; and (3)Assess the quantitative impact of the water to market training program on farm productivity for each group of farms.

## Data and methods

- Armenia panel survey data collected in 2007/2008 and 2010/2011 by Millennium Challenge Corporation's Compact (USIAD project).
- The data includes training information, household demographics, assets, production, income, household expenditure and other agricultural information.

### Data Clustering

- Measuring efficiency by first clustering similar frms together prior to DEA analysi has been applied by Dai and Kuosmanen (2014).

- Data was clustered using K-means clustering using a Variance Ratio Criteria (VRC) to determine optimal clusters.

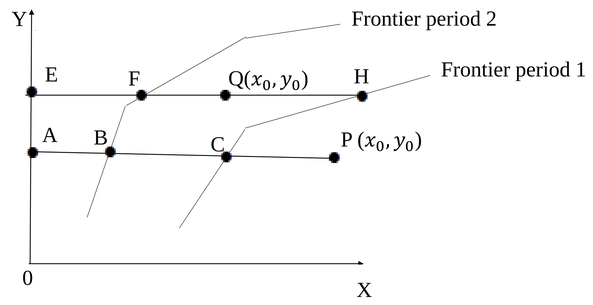
$$VRC_k = \frac{SS_B * (N-K)}{SS_W * (K-1)}$$

where $SS_B$ - between-cluster variance, $SS_W$ - within-cluster variance, $K$ - the number of clusters, and $N$ - number of observations. The larger VRC, the better is the data partition.

### Farm productivity

- Farm productivity is measured using a Malmquist productivity index (MI) which is the product of catch-up (change in technical efficiency) and Frontier-shift (change in technical efficiency frontiers).
- Farm productivity and technical efficiency between the two time periods 2007/8 and 2010/11 was measured using input oriented Data Envelopment Analysis.
- $\boldsymbol{Catch-up\ effect(CP)} = \frac{\delta^2((x_0,y_0))^2}{\delta^1((x_0,y_0))^1}$
- $\boldsymbol{Frontier\ shift\ effect\ (F)} = \left[\frac{\delta^1((x_0,y_0))^1}{\delta^2((x_0,y_0))^1} * \frac{\delta^1((x_0,y_0))^2}{\delta^2((x_0,y_0))^2}\right]^{1/2}$
- Where $\delta^n - techical\ efficiecny\ at\ periond\ n\ (1,2,\dots)\ using\ (x_0,y_0)^n$, −input − output combination at period n (1,2, … ).

## Graphical Representation




- Where Y-output, X-input, Q- farm at period 1 and P - farm at period 2
- Catch-up=$\frac{EF}{EQ} / \frac{AC}{AP}$
- $Frontier\ shift = \sqrt{\frac{AC}{AB} * \frac{EH}{EF}}$
- MI= catch-up*Frontier shift

### Treatment Effect – Tobit Analysis

- Impact of the training program on productivity was assessed using a Tobit regression model

$$Y_k = \alpha X_k + \delta D_k + \varepsilon_k$$

where $D_k = 1$ if a farmer participated in training and 0 otherwise; $Y_k$ is technical efficiency for farmer $k$, $X_k$ are control factors, $(\alpha, \delta)$ are parameters to be estimated, and $\varepsilon_k$ is a mean zero IID error term

## Results

### Data Clustering

- Total sample size: 2796
- Optimal data clusters: 3
  - Commercial: 319 farmers
  - Semi-commercial: 2117 farmers
  - Subsistent: 360 farmers

### Farm productivity (FP)

**Table 1: Average Farm productivity for Farms By Cluster**

| Type of farms | FP | Median without cluster | Median within cluster |
|---|---|---|---|
| Commercial | CP | 0.49 | 0.36 |
| | F | 0.90 | 0.86 |
| | MI | 0.42 | 0.18 |
| Semi-commercial | CP | 0.57 | 0.68 |
| | F | 1.20 | 1.04 |
| | MI | 0.75 | 0.80 |
| Subsistent | CP | 0.53 | 1.00 |
| | F | 1.59 | 1.06 |
| | MI | 0.91 | 1.32 |

- Productivity value greater than 1 shows progress, equal to 1 shows no change and less than shows regress.

## Results (continued)

- Median farm productivity with and without cluster is less than one for commercial farmers
- Unlike catch –up and Malmquist index, frontier shift indicated progress with and without cluster for semi-commercial farms.
- Only Catch-up and Malmquist index with cluster and frontier-shift without cluster have values higher than one for subsistence farms.

### Tobit model

- Results below show the impact of treatment on farm productivity comparing farms by cluster. The coefficient estimates from the resulting Tobit model for each cluster is shown with its associated asymptotic standard error.

| Variable | Commercial | Semi-commercial | Subsistent |
|---|---|---|---|
| Treatment for CP | -0.7200 (0.508) | 0.0758 (0.246) | 0.0053 (0.065) |
| Treatment for F | 0.7086 (0.392) | -0.0463 (0.186) | 0.0262 (0.161) |
| Treatment for MI | 0.3524 (0.487) | 0.0242 (0.242) | 0.0610 (0.248) |

- The treatment effect was insignificant for catch-up, frontier and Malmquist index.
- Controlling for other variables (e.g. size, education, etc.), the training program was statistically insignificant across all types of farmers.
- Our results is similar to the results found by Fortson et al. (2012), which they examined the treatment effect on income change.

## Conclusion

- Data clustering showed optimal grouping divided farmers into three clusters: Commercial, Semi-commercial, and Subsistence
- After clustering the data:
  - Farm productivity indicated no effect on average from the water to market training program
  - Evaluating extension program using change in farm productivity (technical efficiency) and income showed similar results.
- Hence farm productivity (technical efficiency) change is feasible alternative to evaluate extension program.

## References

- Dai, X., & Kuosmanen, T. (2014). Best-practice benchmarking using clustering methods: Application to energy regulation. *Omega*, *42*(1), 179-188.
- Fortson, K., Rangarajan, A., Blair, R., Lee, J., & Gilbert, V. (2012).*Evaluation of water-to-market training in Armenia* (No. 8336f2393a7f4513b95947ee7face8b0). Mathematica Policy Research.
- Wordofa, M. G., & Sassi, M. (2014). Improving Smallholder Farmers' Income through Farmer Training Centers: an Impact Evaluation in Haramaya District, Ethiopia.
- *Contact: Weldensie Teklay; wembaye@ksu.edu.*