Evaluation of Agricultural Extension: Impact on Farm Technical Efficiency

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Agricultural Extension Programs

- Agricultural Extension Programs -> Agricultural Development -> Economic Development

- Objectives:
  - Optimal allocation of resources, innovation.
  - Benefits to producers: Increase in farm productivity, competitiveness, and profitability
  - Benefits to consumers: Increased food security, overall welfare enhancement

How to effectively evaluate agricultural extension programs?

- Traditional outcomes of interest: yield, income, and farm profitability (Davis et al., 2012; Fortson et al., 2012; Wordofa and Sassi, 2014).

- Technical efficiency could be used as a complementary outcome of interest

- E.g.: When farmers are capital constrained extension programs can theoretically have:
    - A large *efficiency* effect on technical efficiency
    - Despite a small or no change in farm profits.

Research Objective

- To develop a theoretical model for using technical efficiency as an outcome variable for evaluating extension program
- To test the validity of the model using randomized control trial (RCT) of a farmer training program in Armenia

Methodology

- **Theoretical model:**

- $\pi(T) = PY(T) - WX(T)$…….…….…..…. (1)

- where π - profit, T-treatment, P and W are output (Y) and input (X) prices respectively.

- $\frac{\partial \pi}{\partial T} = \frac{\partial Y}{\partial T} P - \frac{\partial X}{\partial T} W$ ……..... (2)

- $E(T) = \frac{Y(T)}{X(T)}$ (Battese and Coelli, 1988)

Methodology (cont...)

$$\frac{\partial E}{\partial T} = \frac{\frac{\partial Y}{\partial T}X - \frac{\partial X}{\partial T}Y}{X^2} \quad \ldots\ldots (3)$$

- Rearrange terms:

$$\frac{\partial Y}{\partial T} = \frac{\partial E}{\partial T}X + \frac{\partial X}{\partial T}E \quad \ldots\ldots (4)$$

- Substituting equation (4) in to equation (2), gives:

- $$\frac{\partial \pi}{\partial T} = \frac{\partial E}{\partial T}PX + \frac{\partial X}{\partial T}(PE - W) \quad \ldots\ldots (5)$$

Methodology (cont...)

- Assuming the market is competitive, wage is equal to MVP (P*MPP)
- Recall that efficiency is equal to average productivity (APP).
- This implies that, equation can be written as:
- $\frac{\partial \pi}{\partial T} = \frac{\partial E}{\partial T} PX + \frac{\partial X}{\partial T} * P(APP - MPP)$ ..... (6)
- If App = MPP, both outcome variables have similar results, otherwise, results are different

Methodology (cont...)

- **Data:**
  - Randomized Armenia panel survey data:
    - collected in 2007/2008 and 2010/2011 by
      - Millennium Challenge Corporation's Compact (USIAD project).
  - Sample: 189 number of communities
    - 112 - treatment group and 77 - control group
  - Sample size - 1515 (control: 40% and treatment: 60 %)

Methodology (cont...)

- **Table1: Summary Statistics: Mean value of variables**

Variable	Definition	Mean	Std.
Age	Age of head of household in years	57.10	12.58
Family size	Number of household size	5.42	1.76
Gender	1 if head of household female, 0 otherwise	0.14	0.34
HVA	1 if grow high value crops, 0 otherwise	0.90	0.30
Nonfarm income	Amount of nonfarm income in dollars	1354.66	1761.96
Secondary	1 if completed high school and 0 otherwise	0.40	0.49
Value of crops	Total value of crops per year in dollars	1903.39	1737.21

Methodology (cont...)

- **Table1: Summary Statistics: Mean value of variables**

Variable	Definition	Mean	Std.
Labor and equipment cost	Amount of labor and equipment cost per year in dollars	334.17	299.07
Irrigation cost	Amount irrigation cost per year in dollars	132.31	123.45
Other costs	Other costs per year in dollars	385.92	367.73
Land	Land owned in acres	1.83	1.78
Farm experience	Farm experience in years	20.50	8.86
Livestock	1 if farmer own it, 0 otherwise	0.63	0.48
observations	1515		

Methodology (cont...)

- **Empirical Strategy:**

- The effect of treatment could causes a change in:

  - Technical efficiency, measured using the ‘catch-up’ effect.

  - Innovation that results improvement in technical efficiency, detected as a frontier-shift effect.

  - Overall farm productivity, the product of catch-up and frontier-shift effect, measured using Malmquist index.

Methodology (cont...)

- **Empirical model:**

- $MI = \frac{d^t(Y_t,X_t)}{d^s(Y_s,X_s)}\left[\frac{d^s(Y_t,X_t)}{d^s(Y_s,X_s)} * \frac{d^t(Y_t,X_t)}{d^t(Y_s,X_s)}\right]^{0.5}$ ..... (7)

- $CI = \frac{d^t(Y_t,X_t)}{d^s(Y_s,X_s)}$ ..... (8)

- $FS = \left[\frac{d^s(Y_t,X_t)}{d^s(Y_s,X_s)}\frac{d^t(Y_t,X_t)}{d^t(Y_s,X_s)}\right]^{0.5}$ ..... (9)

- Where MI-Malmquist index, CI-catch up index, FI-Frontier shift measure, d-technology, s-before treatment, and t-after treatment.

Methodology (cont...)

- **Treatment effect:**

- IV: instrument for training completion using intention to treat (ITT)

- ITT- random assignment of treated and control

- $Y_k = \alpha_k X_k + \delta \widehat{D}_K + \varepsilon_k$ ..... (11)

- $\widehat{D}_k$-fitted values from the first stage.

- Where Y_k- farm productivity for farmer k, X_k-Other factors, α_k and δ are parameters, and ε_k-is a mean 0 IID error term.

Result and Discussion

- **Median of farm productivity**

Type of farmers	Farm productivity	without cluster	within cluster
Commercial farmers	Catch-up	1.00	0.92
	Frontier shift	0.87	1.21
	Malmquist Index	0.89	1.15
Semi-commercial	Catch-up	1.06	1.02
	Frontier shift	0.90	1.09
	Malmquist Index	0.95	1.13
Subsistent farmers	Catch-up	1.21	0.93
	Frontier shift	0.75	1.00
	Malmquist Index	0.89	0 .87

Result and Discussion

- **Treatment effect**

Type of farmers	Farm productivity	without cluster	within cluster
Commercial farmers	Catch-up	-0.310 (0.28)	-0.249 (0.543)
	Frontier shift	0.408 (0.31)	0.492 (2.440)
	Malmquist Index	0.100 (0.41)	0.300 (1.00)
Semi-commercial	Catch-up	0.066 (0.14)	1.246 (1.560)
	Frontier shift	0.022 (0.10)	0.262 (0.73)
	Malmquist Index	0.082 (0.10)	0.606 (1.56)
Subsistent farmers	Catch-up	0.05 (0.10)	0.052 (1.470)
	Frontier shift	-0.20 (0.19)	-0.26 (0.28)
	Malmquist Index	-0.26 (0.28)	0.083 (0.54)

Result and Discussion

- Median of farm productivity
    - Are different among with and without clustering
- Generally, treatment effect is
    - Not significantly different from zero in both with and without clustering
- Our result is similar to the result found by Fortson et al. (2012), which they examined the treatment effect on income and cost change.

Conclusion and Recommendation

- Treatment effect is statistically insignificant across all
    - Type of farm productivity and farmers
- Evaluating using change in technical efficiency versus income and cost showed similar results.
- This shows that the methods are robust

References

- Battese, G. E., & Coelli, T. J. (1988). Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of econometrics*, *38*(3), 387-399.

- Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development*, *40*(2), 402-413.

- 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.

Thank You!!!


TIME FOR QUESTIONS


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