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Explaining Technical Inefficiency and Income Variation from Apple Adoption in Highland Ethiopia: The Role of Unequal Endowments and Knowledge Asymmetries.

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Introduction

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- Apple (Malus Domestica), a temperate climate zone fruit tree, is not an indigenous crop to Ethiopia and can thus be considered relatively 'new' for Ethiopian farmers (Ashebir et al. 2010).

- According to Hayesso (2008) and (Girmay et al. 2014) it was introduced to the country some fifty years ago by missionaries.

- However, it is only after active promotion by NGOs, which led to the establishment of a marketing cooperative in 1998, that the product became widely known to a large number of producers and taken up as a means of income by those living in the highland agro-climatic zones of Chencha.

Intro…

- Chencha is one of the leading districts in the country to adapt this fruit to the Ethiopian context and distribute the seedlings to other parts of the country (Dagnew et al. 2009).

- Nowadays, a number of other highland regions are becoming competent producers of different varieties of apple fruit and seedling (Hruy et al. 2012), assisted by government policies that promote apple as a strategic crop.

Intro…

- Researchers that have studied the impacts of apple fruit adoption in the highlands around Chencha (Dagnew et al. 2009; Girmay et al. 2014; Hayesso 2008; Freeman 2013).

- While using different methods, ranging from large-scale surveys to ethnographic fieldwork, the studies agree on the fact that the income generated from apple varies dramatically among those households who have adopted the crop.
- For instance, the top five per cent of producers account for no less than 75 per cent of total income generated from apple, while the bottom 60 per cent fail to generate even five per cent that of the total surplus Girmay et al. (2014) (p.171).

- They also stress the unequal distribution in production factors.

Intro…

- At the same time, however, the research alludes to the existence of knowledge gaps.

- For instance, the finding that roughly three out of four producers interviewed fail to prune and graft their seedlings properly, is explained by 'the lack of technical know-how', in addition to the non-availability of equipment (Girmay et al, 2014, 170).

- Unfortunately, the study only presents selective descriptive statistics on both factor constraints and knowledge asymmetries and does not perform a statistical test that relates these directly to income differentials, so that the relative importance of endowments and knowledge remains unclear.

Objective

- To estimate technical efficiency using the Cobb-Douglas stochastic frontier production function and identify whether knowledge of the producer contributes to output and quality in fruit and seedling production.

Materials and methods

- 380 households were interviewed with a structured questionnaire from 4 randomly selected kebeles of the chencha district.
  - 4 Focus group discussions and
  - 10 key informant interviews were also conducted.

Materials and Methods

$$Y = Af(K^{\alpha}, L^{\beta}, N^{\gamma})e^{\varepsilon_i}$$

- Where Y = apple fruit output or the number of seedling produced, K, L and N are capital, labor and land that have been used in the production of apple fruit and seedling, $\varepsilon_i = v_i - u_i$ is the composite error term containing the random error (v) and the technical efficiency component (u), A is production technology, and α, β and γ are the elasticity coefficients of output with respect to capital, labor and land, respectively.

Materials and Method

- Logarithmic transformation:

$$\ln Y = \beta_0 + \alpha \ln K_i + \beta \ln L_i + \gamma \ln N_i + v_i - u_i$$

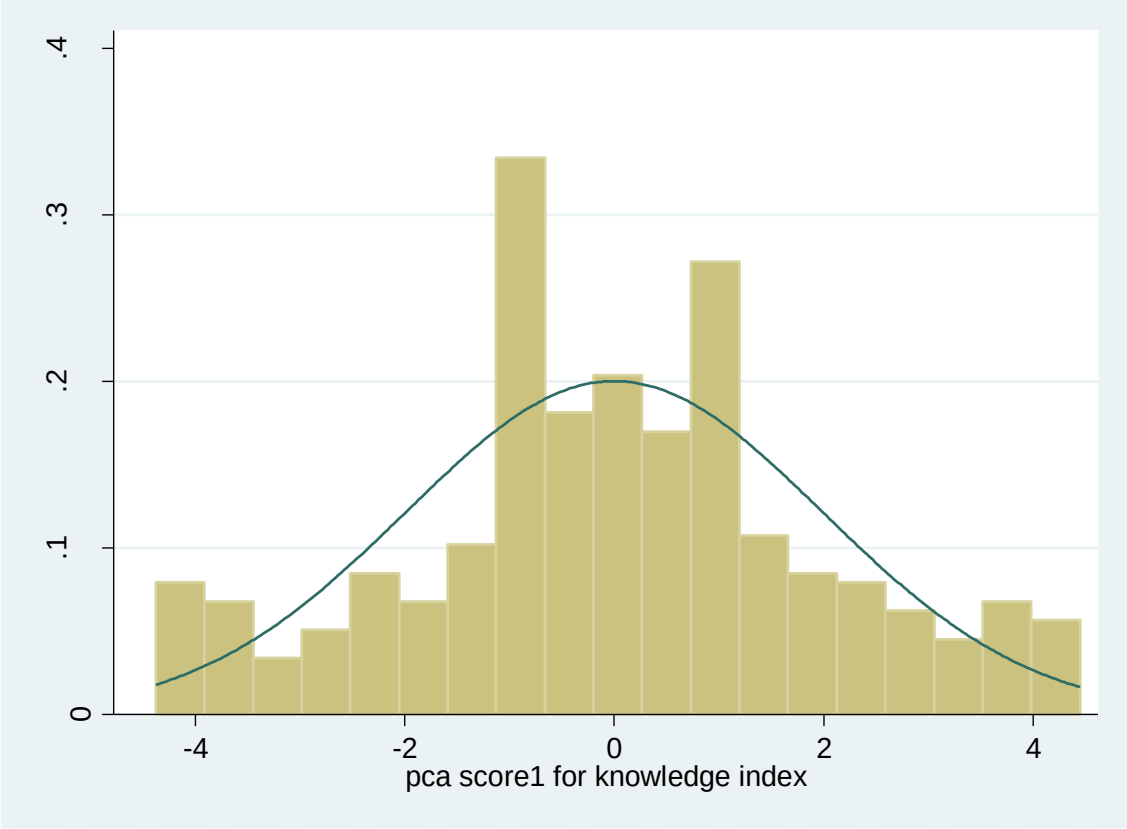
- maximum likelihood estimation and the half-normal distribution assumption for the error term.

$$TE = \frac{Y}{Y^*} .$$

- The level of inefficiency (1-TE) is subsequently used in the regression.

- The ratio of first grade to total production, denoted by ($\frac{Q_1}{Q_T}$), is used as a dependent variable for quality.

Knowledge Index



Results

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Descriptive Statistics

Variable	Observation	Mean	Stand Dev.	Minimum	Maximum
Family size	380	6.20	2.51	1	14
Sex of head	380	1.12	0.32	1	2
Age	380	44.20	13.97	16	95
Education in years	380	7.79	4.64	0	16
Cultivation experience	380	10.52	5.47	1	34
Knowledge index	380	0	1.99	-4.38	4.45
Number of trees	380	47.93	69.55	2	718
Fruit price ratio ($1^{st}/2^{nd}$) grade	240	1.38	0.32	0.74	3
Seedling price ratio ($1^{st}/2^{nd}$) grade	200	1.68	0.71	0.81	4.78
Cooperative membership	380	.81	.40	0	1
Non-farm work participation dummy	380	.72	.45	0	1

Frontier results(variables are in log)

Variables	Fruit output (in kg)		# of seedlings produced	
	Average function	Stochastic frontier	Average function	Stochastic frontier
Quantity of manure applied (in kg)	0.22	0.18	0.39	0.36
	(0.07)**	(0.06)**	(0.05)**	(0.05)**
Value of apple plantation asset (Birr)	0.30	0.28	0.21	0.20
	(0.06)**	(0.06)**	(0.05)**	(0.04)**
Land allocated (in hectares)	0.52	0.54	0.28	0.28
	(0.06)**	(0.05)**	(0.05)**	(0.04)**
Labor used (in man-days)	-0.05	-0.06	0.13	0.16
	(0.08)	(0.07)	(0.05)**	(0.05)**
Constant	2.88	4.80	3.00	3.73
	(0.73)**	(0.73)**	(0.57)**	(0.57)**
F- Statistic	56.46	-	94.94	-
Adjusted R- squared	0.39	-	0.55	-
λ	-	2.27	-	1.63
		(0.21)		(0.20)
σ^2	-	3.48	-	1.48
		(0.42)		(0.22)
Log Likelihood	-	-561	-	-397.5
χ^2 for u=0	-	22.5**	-	7.87**
Average inefficiency, %		60		48
Number of Observations	343	343	307	307

Productivity

Variables	Log of Fruit output/hectare	Log of Seedling produced/hectare
Log of manure applied in kilo grams/hectare	0.22 (0.06)**	0.43 (0.05)**
Log of apple plantation asset/hectare	0.303 (0.054)**	0.07 (0.04)*
Log of Labor used in man-days/hectare.	-0.12 (0.056)*	0.192 (0.03)**
Constant	3.37 (0.62)**	4.065 (0.53)**
F- Statistic	23.46	91.10
Adjusted R- squared	0.16	0.47
Number of Observations	354	311

Seedling production

Manure for seedling

Weeding

Apples from Chencha

Low quality, roadside Arbaminch

Better quality

Apple Quality

Good quality apples (Chencha)

Low quality (Hawassa road side sales)

Factors contributing to Technical Inefficiency

Variables	TIE for Fruit	TIE Seedling
Gender of household head	0.057 (0.051)	0.140 (0.060)*
Education in years	0.003 (.004)	0.009 (.004)+
Age in years	-0.000 (0.001)	0.005 (0.001)**
Cooperative membership	-0.064 (.049)	-0.184 (0.072)*
Knowledge index	0.004 (.011)	-0.024 (0.012)+
Cultivation Experience	-0.012 (.004)**	-
Doko Shaye village	-0.372 (.052)**	-
Doko Losha village	0.158 (.054)**	-
Chencha Town	-0.126 (.048)*	-
Constant	0.779 (.121)**	0.198 (0.137)

Tobit model for quality

Variables	Fruit quality	Seedling quality
Market availability (rated 1-5)	0.05	0.00
	(0.01)**	(0.01)
Density (number of tree/area)	-0.00	0.00
	(.00)	(0.00)
Per-capita manure applied	-0.00	-0.10
	(0.00)	(0.049)*
Knowledge index on apple technology	0.02	0.02
	(0.01)**	(0.01)*
Sex of the respondent	0.03	0.02
	(0.03)	(0.03)
Age of the respondent	-0.00	-0.00
	(0.00)	(0.00)
Highest grade education in years	-0.00	0.00
	(0.00)	(0.00)
Cooperative membership dummy	-0.06	0.00
	(0.04)+	(0.04)
Frequency of invitation by neighbors	0.03	0.02
	(0.01)**	(0.01)**
Dummy for Doko Shaye Village	0.14	0.04
	(0.03)**	(0.03)
Dummy for Doko Losha Village	-0.13	-0.05
	(0.04)**	(0.04)
Dummy for Chencha Town	0.09	0.04
	(0.03)**	(0.03)
Constant	0.30	0.54
	(0.10)**	(0.07)**
LR Chi2	(110.08)**	(29.09)**
Number of Observations	239	199

Summary of results

Fruit				
Variable	Output Performance	Income Performance	Technical Efficiency	Quality
Knowledge	(-)	(-)	(+)	(+)***
Education	(-)		(-)	(-)
Experience	(+)***	(+)	(+)***	
Age	(-)		(+)	(-)
Gender	(+)	(+)	(-)	(+)
Cooperative membership	(+)*	(+)***	(+)	(-)*

Seedling				
Varaible	Output performance	Income performance	Technical efficiency	Quality
Knowledge	(+)***	(+)***	(+)*	(+)**
Education	(-)		(-)*	(+)
Experience	(-)	(-)	(-)	
Age	(-)**		(-)***	(-)
Sex	(-)***	(-)***	(-)**	(+)
Cooperative membership	(+)**	(+)***	(+)**	(+)

conclusions

- First, the stochastic frontier production function estimation has shown that there was 60% and 48% technical inefficiency in the production of apple fruit and seedling in Chencha district, respectively.

- Knowledge of apple fruit and seedling producers is a positive and significant driver of output from the apple business and production quality.

- But, the level of formal education attained by the producer was not significant for both fruit and seedling outputs. It is striking that what matters in the apple business is the knowledge acquired by the producer specific to the technology rather than the formal education he or she has attained.

Conclusions

- Second, apple crop cultivation experience in years tends to improve output from the fruit but not from the seedling; whereas the age of the producer was negatively related to seedling production performance. These indicate that fruit production needs long time experience where as seedling production seems to work well for knowledgeable young producers.

- Third, concerning fruit quality, in addition to knowledge of the producer, availability of market, first to second grade price ratio, cooperative membership and visiting others' orchards also have positive and significant effect on fruit quality.

Recommendation

- There is ample room to take measures that push inefficient producers towards the frontier.

  - Improve the knowledge of the producers on various aspects of the technology.
  - Strengthening weak cooperatives or linking farmers to strong cooperatives and other potential customers.
  - Planting more orchard trees and promote livestock production (manure).
  - Consider access to land and licensing of knowledgeable seedling producers.

Thank you for attending!

- Any comment or questions?

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