FOOD CROP MARKETING AND AGRICULTURAL PRODUCTIVITY IN A HIGH PRICE ENVIRONMENT IN CENTRAL AND NORTHERN MOZAMBIQUE

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OUTLINE

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- Descriptive Trends/relationship in Outcomes and Intensification
- Econometric Methods
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INTRODUCTION

- Historically weak market participation by rural households
  - ✓ Agricultural production is major economic activity, BUT subsistence oriented
  - ✓ Poorest 40% have virtually no participation in markets
- Since 2008, food prices have been on the rise
  - ✓ Increases in international prices for food and fuels
  - ✓ Increases in urban demand and cereal based livestock feed
- Analyses mostly focused on effects on consumers, generally net buyers
- There is potential for benefits to producers
  - ✓ Profitable market opportunities
  - ✓ Incentives to intensify => Increase productivity => increase food security => income

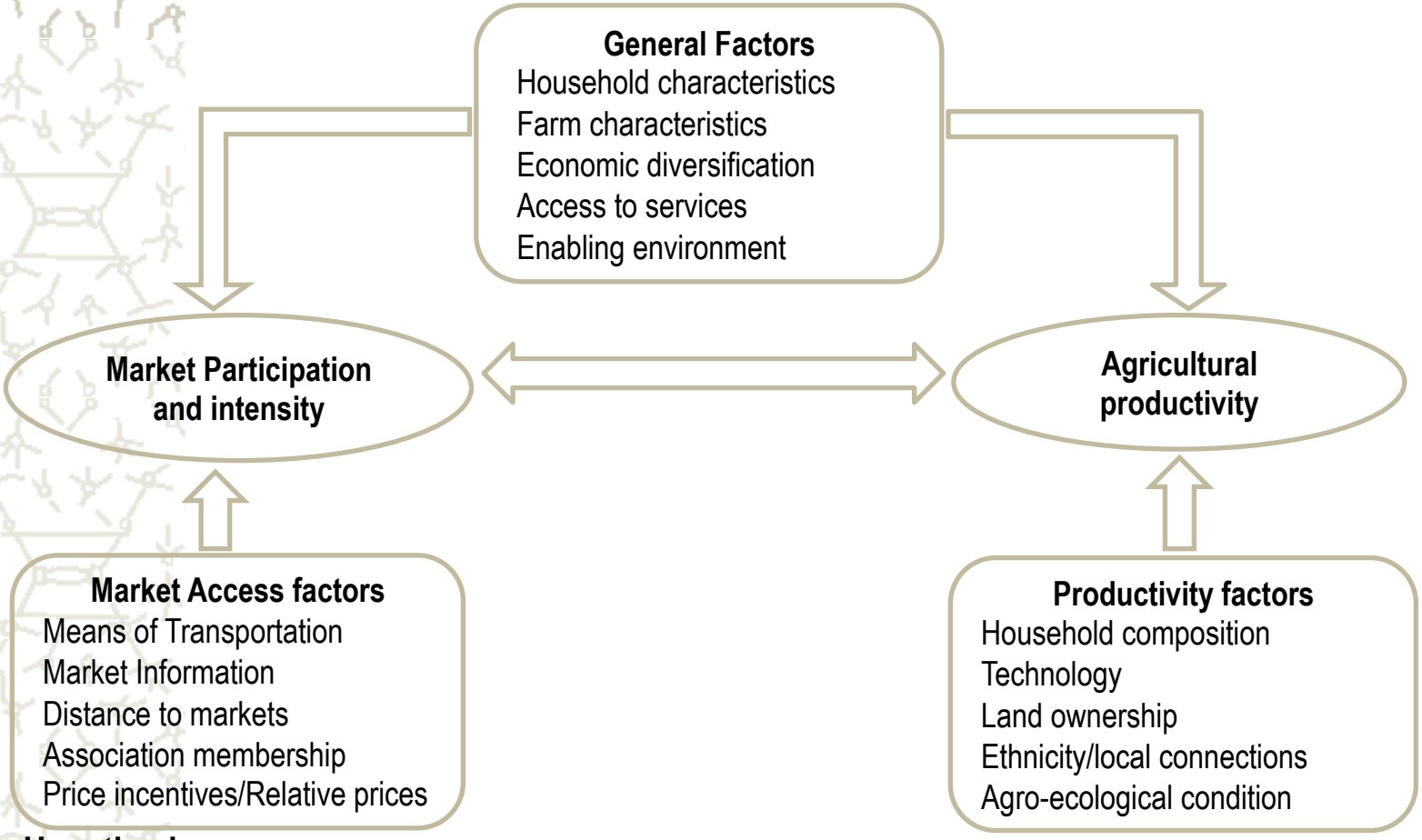
RESEARCH QUESTIONS

Research Questions:

This paper investigates the relationship between food market behavior and agricultural productivity in Mozambique in face of higher food prices

1. How did food market participation and intensity change in face of higher price expectations?
2. What is the relationship between food marketing behavior and agricultural productivity after controlling endogeneity and specific factors?
   - ✧ Does increased marketing of crops induced by the high price environment consistently increase productivity?
   - ✧ Do the increases in agricultural productivity increase market sales, even where market access is poor?
3. What are are the implications for policy and investment priorities?

CONCEPTUAL FRAMEWORK AND HYPOTHESES



Hypothesis:

H1: Stronger market participation leads to higher agricultural productivity

H2: Higher agricultural productivity leads to stronger market participation

DEFINITION OF OUTCOMES

MARKETING BEHAVIOR

- ✓ Participation in crop markets
  - ✓ Cereals, beans/groundnuts, roots/tubers
  - ✓ At least one sales episode during the agricultural season
- ✓ Sales Intensity SI_i, by crop group i (j crops)
  - ✓ Share of sales in total value of production

$$SI_i = \frac{\sum_{j=1}^{j} CS_{ij}}{\sum_{j=1}^{j} CP_{ij}} \quad , \quad for\ j = 1, \dots, j$$

CS – Crop sales of group i (j crops)

CP – Crop production of group i (j crops)

DEFINITION OF OUTCOMES

AGRICULTURAL PRODUCTIVITY/EFFICIENCY

- ✓ Value of Production per Hectare

$$AP_i = \frac{\sum_{j=1}^{j} P_j CY_{i,j}}{\sum_{j=1}^{j} CA_{i,j}} \quad , \quad for\ j = 1, \dots, j$$

- ✓ Value of production per adult
- ✓ Technical Efficiency Index
  - Value of Production of household *h* relative to Maximum in District

DATA

- Partial Panel of households visited in 2008 (TIA08) and 2011
  - ✓ Survey with 1,186 rural households
  - ✓ Nampula, Zambézia, Manica, Sofala, and Tete
- Survey Instruments
  - ✓ Demographics, education and employment
  - ✓ Agricultural production and marketing
  - ✓ Use of inputs, technologies, access to resources (land, finance)
  - ✓ Income from economic activities, on and off-farm
  - ✓ Village level information on infra-structure, resources, etc

TRENDS/RELATIONSHIP IN OUTCOMES AND INTENSIFICATION

- Changes in Marketing Outcomes
- Changes in Productivity Outcomes
- Marketing-Productivity Relationship
- Agricultural Intensification trends

Changes in Marketing Outcomes
2008-2011

Marketing Indicators	Survey Years		Difference	
	2008	2011	Diff	p-value
Market Participation (% of Households)				
Cereals	37.4	44.6	+7.2	0.000
Beans and Groundnuts	57.1	56.7	-0.4	0.868
Roots and Tubers	63.0	54.0	-9.0	0.000
Share of Sales (% of Production)				
Cereals	13.5	15.4	+1.9	0.057
Beans and Groundnuts	19.8	22.5	+2.7	0.056
Roots and Tubers	5.1	6.4	+1.3	0.127
Value of Sales Share of Food Groups (%)				
Cereals	51.8	46.8	-5.0	0.032
Beans and Groundnuts	36.6	40.3	+3.7	0.111
Roots and Tubers	11.6	12.9	+1.3	0.367
All Annual Food Crops	100.0	100.0	100.0	

Source: Partial Panel Survey (2008 and 2011)

- Increase in participation for cereals and drop in root crops
- High but stagnant participation for beans/groundnuts;
- Higher market intensity (sales index) for cereals and beans/groundnuts
- Dominance of cereals in terms of value marketed each year

Changes in Productivity Outcomes
2008-2011

Productivity Indicators	Survey Years		Difference	
	2008	2011	Diff	p-value
Production Efficiency (Index)				
Cereals	0.15	0.18	0.03	0.001
Beans and Groundnuts	0.13	0.15	0.02	0.032
Roots and Tubers	0.10	0.12	0.02	0.005
Value of Output/hectare (000 MZN)				
Cereals	6.7	8.3	+1.6	0.148
Beans and Groundnuts	6.5	8.1	+1.6	0.038
Roots and Tubers	4.5	4.5	0.0	0.994
Value of Output/adult (000 MZN)				
Cereals	2.5	2.8	0.3	0.254
Beans and Groundnuts	0.8	1.0	0.2	0.006
Roots and Tubers	1.7	1.9	0.2	0.249
Value of Production Share of Food Groups (%)				
Cereals	57.6	53.6	-4.0	0.001
Beans and Groundnuts	16.6	21.0	+4.4	0.000
Roots and Tubers	25.8	25.3	-0.5	0.678
All Annual Food Crops	100.0	100.0		

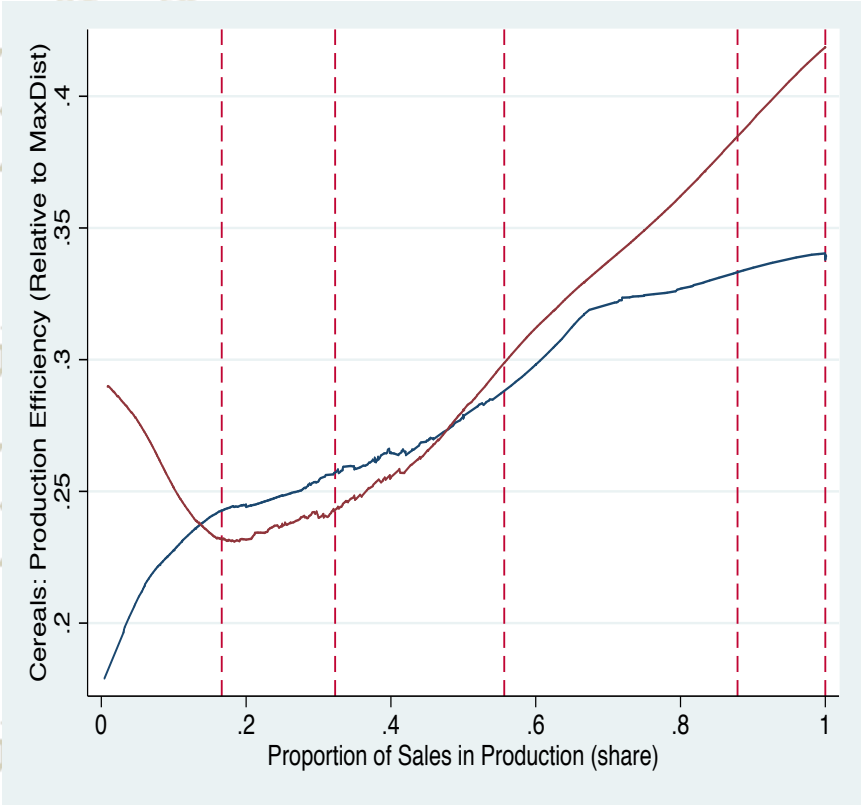
Source: Partial Panel Survey (2008 and 2011)

- Production efficiency gains observed for all crop groups
- Increase in land and labor productivity for all crop groups but only statistically significant for beans/groundnuts

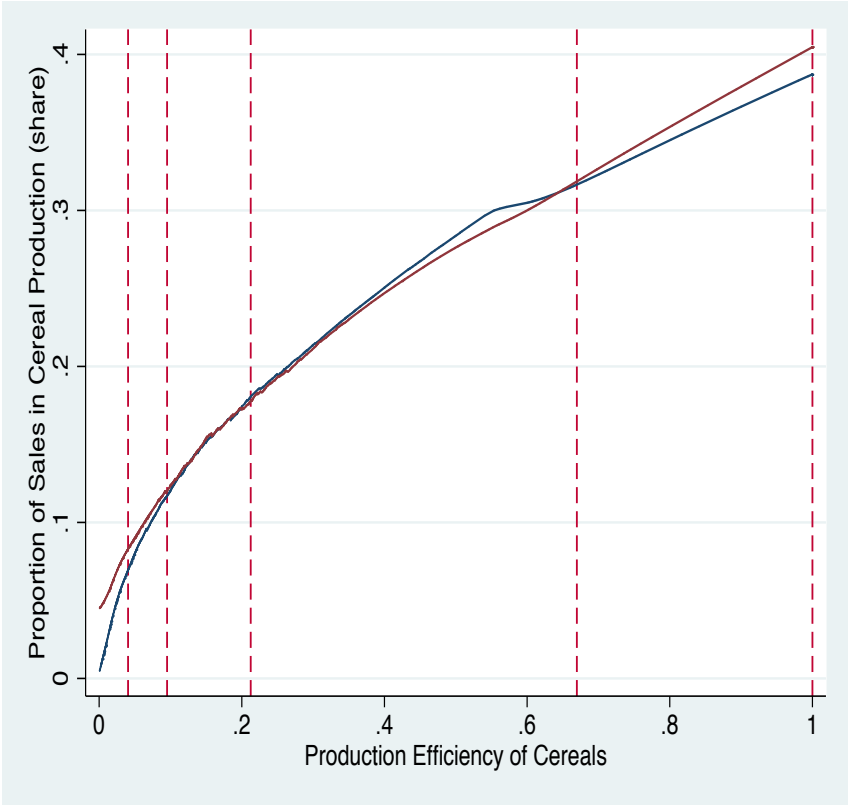
Marketing-Productivity Relationship

2008 and 2011

Productivity by share of sales (Cereals)

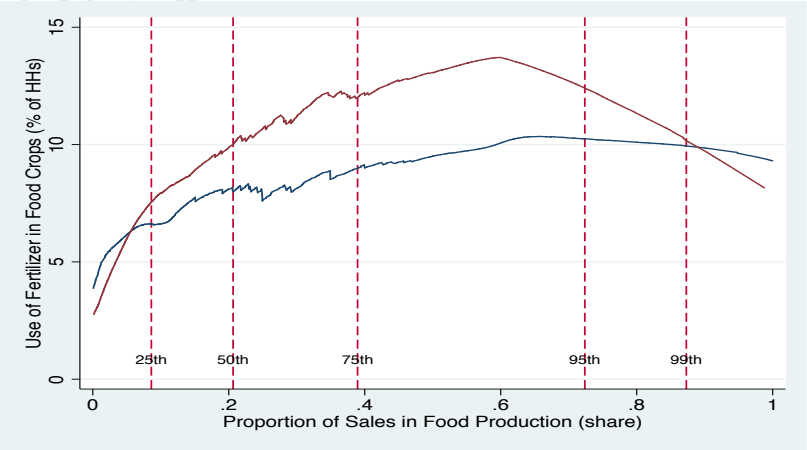


Share of sales by Productivity (Cereals)

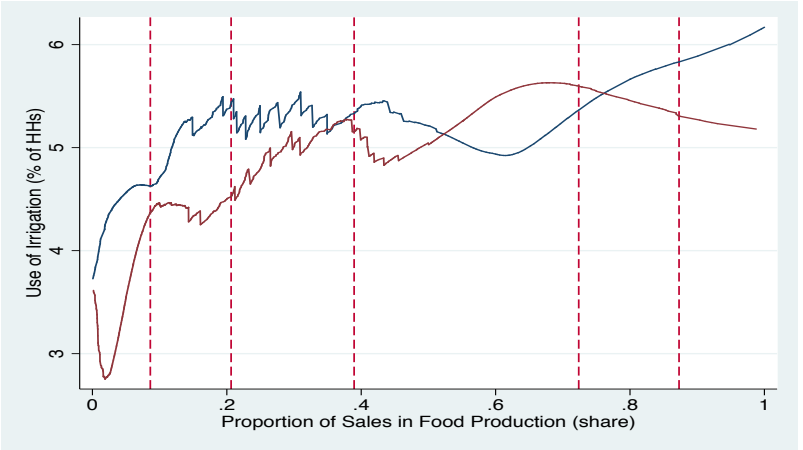


Agricultural Intensification and Share of Sales

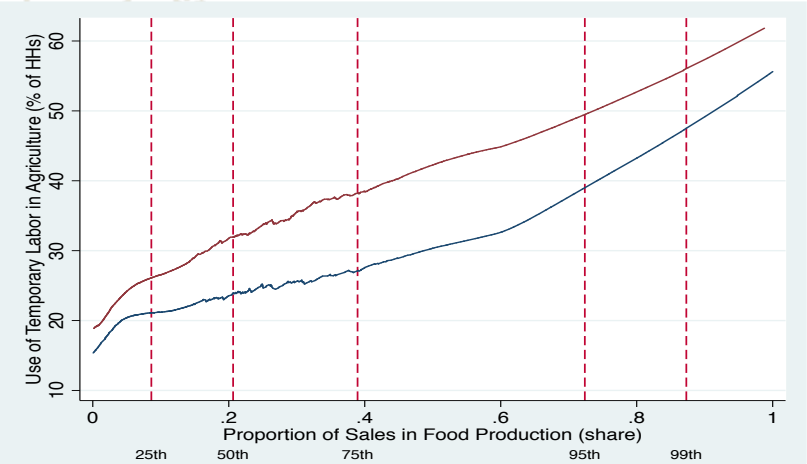
Fertilizer Use by Share of Sales



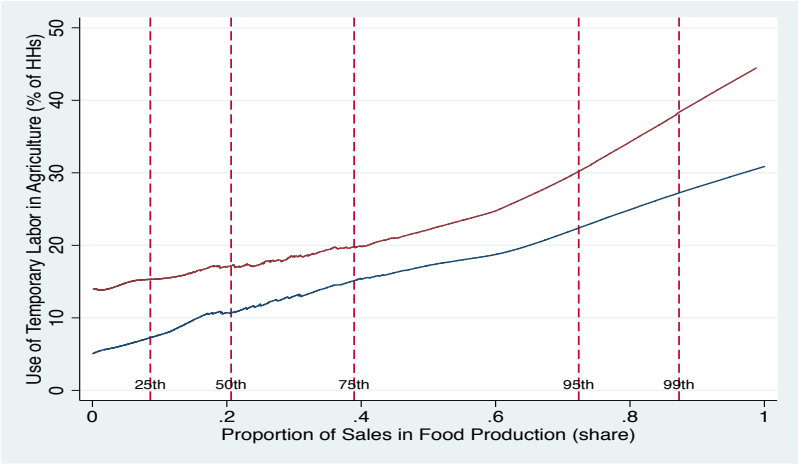
Irrigation Use by Share of Sales



Hiring Labor by Share of Sales

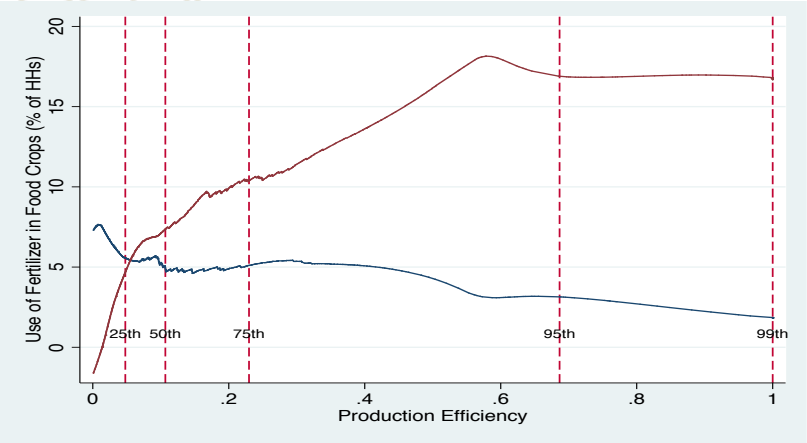


Animal Traction Use by Share of Sales

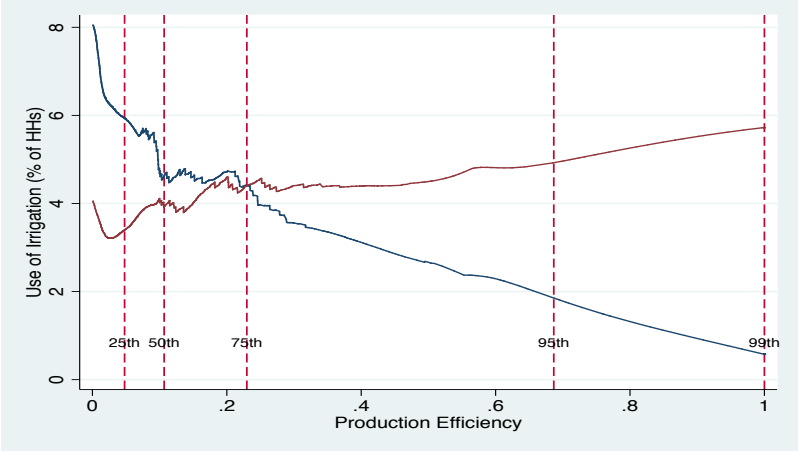


Agricultural Intensification and Production Efficiency

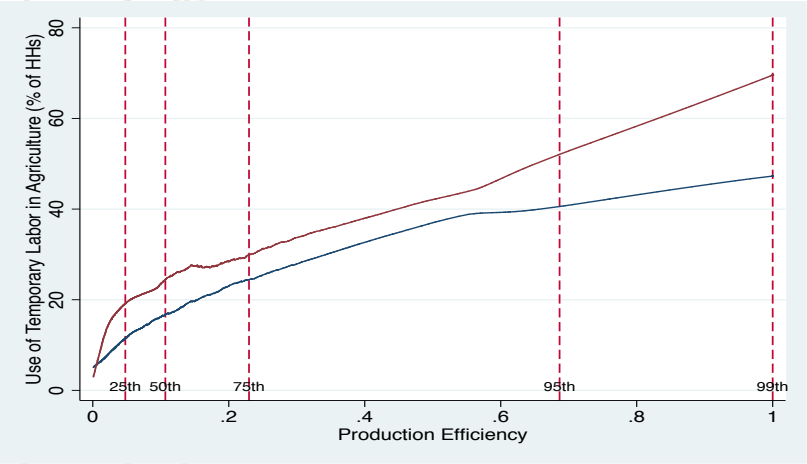
Fertilizer Use by Production Efficiency



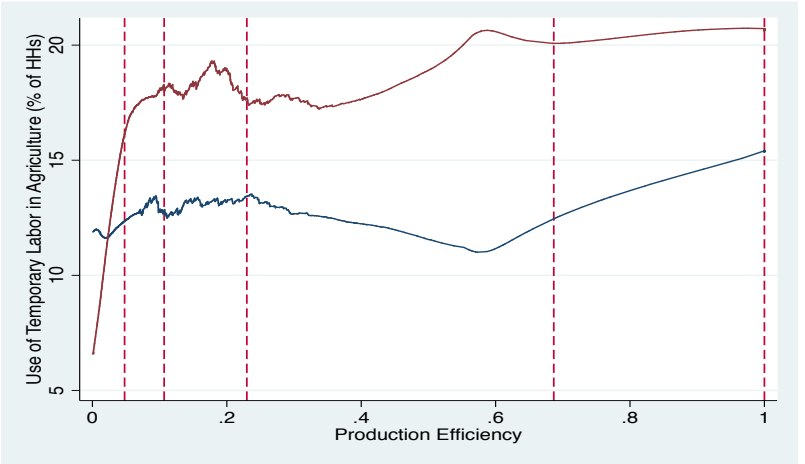
Irrigation Use by Production Efficiency



Hiring Labor by Production Efficiency



Animal Traction Use by Production Efficiency



ECONOMETRIC METHODS

- There is potentially endogeneity (or reversed causality) of market participation and agricultural productivity => OLS Not Efficient
- IV Two-Stage Least Squares (2SLS)
  - ✓ 2 Models to test Hypotheses 1 and 2
  - ✓ Pooled data for 2008 and 2011 with year dummy
  - ✓ Selection of instruments
    - Relevance and validity
    - Correlated with the endogenous variable and uncorrelated with the error term
    - Related to the outcome only through the endogenous variable
  - ✓ Post Estimation Tests
    - Tests of endogeneity
    - Tests of over-identifying restrictions (validity of second instrument)
    - Test of Joint significance of the instruments (strength of the instruments)

MODEL 1: IV 2 SLS FOR HYPOTHESIS 1

H1: Stronger market participation (SI_i) leads to higher agricultural productivity (AP_i)

$$SI_i = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \eta_{1,i}$$

$$AP_i = \alpha_0 + \alpha_1 X_{1,i} + \alpha_2 SI_i^{p} + \varepsilon_{1,i}$$

- Endogenous Variable: Log Share of Sales (SI_i)
- Explanatory Variables (X1's): Household and head characteristics, Farm Characteristics/Technology, economic diversification, access to services
- Instruments (X2's):
  - ✓ Ownership of bicycles
  - ✓ Access to market information
- Outcome (Second Stage) : Log Production Efficiency (AP_i)

MODEL 2: IV 2 SLS FOR HYPOTHESIS 2

H2: Higher agricultural productivity (AP_i) leads to stronger market participation (SI_i)

$$AP_i = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \eta_{1,i}$$

$$SI_i = \alpha_0 + \alpha_1 X_{1,i} + \alpha_2 AP_i^{P} + \varepsilon_{1,i}$$

- Endogenous Variable: Log Production Efficiency (AP_i)
- Explanatory Variables (X1's): Household and head characteristics, Farm Characteristics/Technology, economic diversification, access to services
- Instruments (X2's):
  - ✓ Household Composition (Labor Adult Equivalents)
  - ✓ Use of animal traction
- Outcome (Second Stage): Log Share of Sales (SI_i)

Descriptive Statistics of Regressors, 2008-2011

Variables	Survey Year		Difference	
	2008	2011	Diff	p-value
Household head characteristics				
Male headed households (%)	83.0	82.0	-1.0	0.552
Age of Head (years)	41.8	44.4	2.6	0.000
Head Schooling (years complete)	2.9	3.0	0.1	0.696
Farm Characteristics/Technology				
Land Area per AE (he/AE)	0.61	0.66	0.05	0.151
Use Fertilizer in Food Crops (%)	5.3	8.6	3.3	0.002
Use Pesticides (%)	2.9	2.4	-0.5	0.440
Use Irrigation (%)	4.9	4.1	-0.8	0.277
Hiring of temporary Labor (%)	18.5	28.2	9.7	0.000
Economic Diversification				
Head is Self-Employed (%)	34.4	42.2	7.8	0.000
Head has Wage Income (%)	24.5	34.3	9.8	0.000
Grow Cotton (%)	4.9	5.9	1.0	0.319
Grow Tobacco (%)	5.9	6.6	0.7	0.497
Access to Services				
Association membership (%)	6.9	9.5	2.6	0.020
Participated in extension (%)	10.0	18.4	8.4	0.000
Productivity Factors (Instruments)				
Household Composition (AEs)	4.6	5.1	0.5	0.000
Use Animal Traction (%)	12.6	17.2	4.6	0.002
Market Access Factors (Instruments)				
Household Owns Bike (s) (%)	55.5	53.5	-2.0	0.343
Access to Market Information (%)	26.0	42.2	16.2	0.000

Source: Partial Panel Survey (2008 and 2011)

Testing Hypothesis 1
Effects of Marketing Intensity on Agricultural Productivity

Independent Variables	IV 2SLS: Log Productivity, Endogenous Log Share of Sales					
	Cereals		Beans and Groundnuts		Roots and Tubers	
	1st Stage: Log Share of Sales	2nd Stage: Log Productivity	1st Stage: Log Share of Sales	2nd Stage: Log Productivity	1st Stage: Log Share of Sales	2nd Stage: Log Productivity
Log Share of Sales		0.224**		0.235*		-0.179
Household head characteristics						
Sex of Head (1=Male)	1.260**	-0.053	1.062**	0.016	-0.112	0.085
Age of Head	-0.024**	0.004	-0.020	0.003	-0.004	-0.001
Head years of Schooling	-0.054	0.038**	0.101+	-0.005	0.030	0.007
Farm Characteristics/Technology						
Land Area per AE	2.211**	-0.005	1.558**	0.078	1.284+	0.881**
Land Area per AE (Squared)	-0.133**	0.001	-0.121**	-0.005	-0.050	-0.121
1=Use Fertilizer in Food Crops	0.886	0.201	2.559**	-0.095	-0.391	-0.129
1=Use Pesticides (dummy)	0.977	-0.313	0.260	-0.233	1.329	0.404
1=Use Irrigation	0.618	-0.166	-0.774	0.178	-0.550	-0.751**
1=HH Employs Temporary Labor	1.008**	0.224+	1.321**	0.145	0.821*	0.240
Access to Services						
1=HH belongs to Association	0.117	0.057	0.390	-0.081	0.239	-0.023
1=HH received extension	0.316	0.036	0.132	-0.026	0.767+	0.281
Productivity Factors						
Household Composition (LAE)	0.140*	0.071**	-0.028	0.068**	-0.034	0.078**
1=Use Animal Traction	-0.120	0.535**	0.426	0.305*	0.294	0.012
Year (1=2011)	0.757**	-0.062	1.058**	-0.277+	0.394	-0.176
District Fixed-Effects	YES	YES	YES	YES	YES	YES
Market Access Factors (Instruments)						
1= HH Owns Bike	0.300+	-	0.225+	-	-0.358	-
1= HH accesses Market Information	0.654*	-	0.626*	-	0.364	-
Constant	-13.431**	-0.225	-10.548**	-0.626	-11.666**	-4.758+
Observations	2,276	2,276	1,797	1,797	1,339	1,339

Testing Hypothesis 1
Effects of Marketing Intensity on Agricultural Productivity

- Controlling for productivity and other factors, an increase of 10% in the share of sales leads to
  - ✓ Approximately 2.2% increase in productivity of cereals
  - ✓ About 2.3% increase in productivity of groundnuts and beans
  - ✓ No effects in the productivity of roots and tubers
- <u>Post estimation Tests</u>
  - ✓ Reject exogeneity of share of sales for all groups, except roots/tubers
  - ✓ Reject over-identifying restriction for all groups, except roots/ tubers
  - ✓ Instruments jointly significant for all crops

Testing Hypothesis 2
Effects of Agricultural Productivity on Marketing Intensity

Independent Variables	IV 2SLS: Log Share of Sales, Endogenous Log Productivity					
	Cereals		Beans and Groundnuts		Roots and Tubers	
	1st Stage: Log Productivity	2nd Stage: Log Share of Sales	1st Stage: Log Productivity	2nd Stage: Log Share of Sales	1st Stage: Log Productivity	2nd Stage: Log Share of Sales
Log of Productivity		**0.835+**		0.261		-0.475
Household head characteristics						
Sex of Head (1=Male)	0.210**	1.104**	0.239**	0.980*	0.064	-0.073
Age of Head	-0.001	-0.022*	-0.001	-0.020+	0.000	-0.004
Head years of Schooling	0.025**	-0.075+	0.018	0.097+	0.000	0.031
Farm Characteristics/Technology						
Land Area per AE	0.478**	1.726**	0.432**	1.515**	0.609**	1.548*
Land Area per AE (Squared)	-0.027**	-0.105**	-0.033**	-0.117**	-0.103*	-0.093
1=Use Fertilizer in Food Crops	0.390**	0.527	0.492**	2.460**	-0.075	-0.421
1=Use Pesticides (dummy)	-0.104	1.068	-0.171	0.299	0.150	1.387
1=Use Irrigation	-0.030	0.640	-0.007	-0.775	-0.666**	-0.847
1=HH Employs Temporary Labor	0.439**	0.616+	0.434**	1.216*	0.068	0.866*
Access to Services						
1=HH belongs to Association	0.083	0.057	0.012	0.376	-0.075	0.211
1=HH received extension	0.113+	0.211	0.010	0.131	0.121	0.837+
Market Access Factors						
1= HH Owns Bike	0.195**	0.171	0.220**	0.150	0.168*	-0.278
1= HH accesses Market Information	0.081+	0.601*	0.080	0.595+	0.035	0.385
Year (1=2011)	0.121**	0.661**	-0.009	1.053**	-0.249**	0.285
District Fixed-Effects	YES	YES	YES	YES	YES	YES
Productivity Factors (Instruments)						
Household Composition (AE)	0.509**	-	0.403**	-	-0.045	-
1=Use Animal Traction	0.100**	-	0.059**	-	0.079**	-
Constant	-3.237**	-10.504**	-3.110**	-9.919**	-2.667**	-12.929**
Observations	2,276	2,276	1,797	1,797	1,339	1,339

Testing Hypothesis 2
Effects of Agricultural Productivity on Marketing Intensity

- Controlling for marketing and other factors, an increase of 10% in the efficiency index leads to
  - ✓ Not statistically significant effect in marketing intensity of beans/ groundnuts and roots/tubers crops;
  - ✓ A strong 8.8% increase in the share of sales of cereals
- <u>Post estimation Tests</u>
  - ✓ Reject exogeneity of productivity for all crop groups, except roots/tubers
  - ✓ Reject over-identifying restriction: for all groups, except roots/tubers
  - ✓ Instruments jointly significant for all crops

CONCLUSIONS AND POLICY IMPLICATIONS

- Strong increase in agricultural marketing, more in terms of participation rates, but somewhat in intensity of participation
- Some increase in productivity of all crop groups
- High correlation between market participation and productivity
- In spite of greater market access, slow pace of intensification
  - ✓ Increasing but still low levels of use fertilizers and animal traction;
  - ✓ Stagnant use of pesticides and irrigation; and
  - ✓ Significance increase in use of hired labor

CONCLUSIONS AND POLICY IMPLICATIONS

Econometric Results suggest the following implications

- ✓ Creating an enabling environment for greater access to marketing opportunities can have important effects on productivity of cereals and groundnuts/beans, even with limited investments in productivity

- ✓ However, acknowledging low levels of productivity (vis-à-vis slow intensification), productivity investments are unquestionably necessary

CONCLUSIONS AND POLICY IMPLICATIONS

- ✓ For beans/groundnuts (where there are no effects of productivity on market performance), investments in productivity alone without investing in market access can have limited return and may not be sustainable
- ✓ For cereals productivity investments can help boost market participation intensity significantly in a time when market participation rates are on the rise
- ✓ Roots are an essentially subsistence crop. Creating demand for processed root products (value addition) combined with improvements in production may have long run prospects