Response of Plant Productivity to Improved Agricultural Markets in India: an Advanced Application of Econometric Cross-Section Time Series Analysis

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Background

Agriculture contributes to the 1/3 of the GDP and retains its immense importance for securing food demand in India for many years to come. This requires new approaches and additional knowledge about the potentials for agricultural growth. Few studies on agricultural productivity conducted so far dealt mostly with one-shot surveys attempting to explain the role of agricultural markets in achieving better productivity. Our study, using longitudinal data, gives new dimensions to analyses uncovering both locational and time effects markets have on aggregate crop productivity in India.

Objective

Our main objective in this study is to explore, by means of econometric modelling, the effects of market access (expressed through proxy parameters) on aggregate crop productivity (in monetary terms).

Table: Panel Model Coefficients, Model Specifications for the South Region, 1966-1994, India

Variable	Variable Description	Units		Mean	Std. Dev.	Min	Max
TP	Total prod-ty of major crops	Rs/ha	overall	249.04	132.94	28.48	921.25
			between		112.31	66.78	549.59
			within		72.78	18.16	620.70
FERT	Quantity of fertiliser	kg/ha	overall	58.67	50.14	0.46	342.02
			between		30.43	7.84	141.79
			within		40.07	-44.68	298.37
HYV	Area under high yielding var-ty	% of land	overall	22.36	17.40	0	74.20
			between		12.46	0.42	59.30
			within		12.27	-30.12	61.04
CR	Amount of credit	Rs/ha	overall	441.29	682.31	0.08	7606.36
			between		390.66	33.69	1837.23
			within		561.99	-1041.24	6210.42
IR	Area under irrigation	% of land	overall	28.58	18.95	0	80
			between		18.58	0.79	74.94
			within		4.52	6.95	47.65
RF	Amount of rainfall	mm	overall	1062.12	642.01	345	5399
			between		601.20	551.83	3997.59
			within		239.95	-40.46	2645.61
LT	Level of literacy	No/100000	overall	30.68	11.79	8.62	72.77
			between		10.42	14.63	62.33
			within		5.71	15.38	47.08
FS	Farm size	ha	overall	2.14	1.57	0.67	16.59
			between		1.44	0.95	9.43
			within		0.65	-2.23	9.30
RD	Road density	km/100km2	overall	6.00	3.84	0.18	25.66
			between		2.79	2.83	16.26
			within		2.66	-9.06	18.79
RDLAG3	RD with 3-year lag	km/100km2	overall	5.73	3.69	0.18	25.66
			between		2.66	2.67	15.49
			within		2.58	-8.56	18.83
MD	Regulated market density	No/10000km2	overall	4.94	5.16	0	55
			between		2.80	1.03	13.24
			within		4.35	-4.37	48.63
MDLAG3	MD with 3-year lag	No/10000km2	overall	5.07	5.37	0	55
			between		2.94	1	14.31
			within		4.51	-5.32	47.68



Method

The economic theory or just general logic tells we should get AAP increased should we improve the access to markets. To measure or to describe the market access, we use proxy variables such as road and market densities in respective regions. The basic premise underlying the methodology applied in this study will be panel data modelling.

Analysis

We utilise the dataset compiled by joint efforts of ICAR and ICRISAT on 235 districts in 10 states of semi-arid tropics in India over 29 years from 1966 to 1994.

With the application of a cross-sectional time series FGLS econometric model, this paper examines the rationality behind the evolvement of crop productivity in the time period under question for major part of India (65% of population and 60% of territory covered by the data).

Generalized least squares (GLS) technique performs the best when the errors are heteroskedastic and/or correlated across observations (Stock and Watson, 2003). We run Modified Wald test for groupwise heteroskedasticity in cross-sectional time-series FGLS regression model (Model 3).

H0: sigma(i)^2 = sigma^2 for all i
chi2 (51) = 5245.97
Prob>chi2 = 0.0000

We observe a highly significant test statistic: we reject therefore the H_0 hypothesis that the panels in our model have common disturbance variance and that those disturbances are not correlated with the regressors. Our assumption of heteroskedasticity has been thus confirmed by the above test, so the final model specification will reflect the presence of heteroskedasticity.

Furthermore, we assume the presence of autocorrelation. As iterated GLS with autocorrelation does not produce the maximum likelihood estimates, we cannot use the likelihood-ration test procedure, as with heteroskedasticity. Wooldridge (2002) and Drukker (2003) suggest a test and a routine respectively to test for serial correlation in panel-data models. Applying this test yields,

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
F(1, 50) = 42.523
Prob > F = 0.0000

The significant test statistic indicates the presence of serial correlation.


Table: Panel Model Coefficients, Model specifications for the South Region, 1966-1994, India

Models / Model variables	(1) Fixed-effects	(2) Random-effects GLS	(3) FGLS homosk., no auto-correlation	(4) GLS heterosk., no auto-correlation	(5) GLS heterosk., cross-sectional correlation	(6) GLS AR1 within-unit correlation	(7) GLS AR1 panel specific correlation	(8) GLS PSAR1 heterosk.
IR	2.05***	2.43***	3.44***	3.02***	3.43***	3.11***	2.59***	2.89***
	(.341)	(.284)	(.183)	(.136)	(.076)	(.243)	(.207)	(.174)
HYV	.26	.262	-1.21***	-.778***	-1.07***	-.010	.261	.146
	(.183)	(.181)	(.221)	(.157)	(.089)	(.231)	(.198)	(.144)
FERT	.261***	.282***	.352***	.315***	.330***	.222***	.289***	.169***
	(.054)	(.053)	(.061)	(.048)	(.020)	(.065)	(.054)	(.048)
RF	.023**	.022**	.030***	.037***	.027***	.021***	.019***	.014***
	(.010)	(.010)	(.011)	(.007)	(.004)	(.008)	(.007)	(.005)
RFSQ	-5.26e-07	-1.14e-06	-1.42e-06	-3.60e-06**	-7.17e-07	-1.09e-06	-8.76e-07	-6.83e-07
	(2.56e-06)	(2.53e-06)	(2.64e-06)	(1.69e-06)	(7.81e-07)	(1.97e-06)	(1.73e-06)	(1.41e-06)
CR	.026***	.027***	.026***	.028***	.024***	.010***	.011***	.015***
	(.003)	(.003)	(.004)	(.003)	(.001)	(.004)	(.003)	(.003)
FS	1.96	-1.74	-13.13***	-11.62***	-12.18***	-7.78***	-4.58**	-3.35*
	(2.63)	(2.41)	(1.56)	(1.31)	(.700)	(2.52)	(1.91)	(2.08)
LT	4.76***	3.83***	1.95***	2.46***	1.98***	3.10***	3.11***	3.57***
	(.549)	(.473)	(.284)	(.205)	(.136)	(.438)	(.390)	(.343)
RD_{t-3}	-.20	1.65	21.04***	17.09***	20.38***	9.42***	8.56***	10.04***
	(1.97)	(1.93)	(2.18)	(2.08)	(.885)	(2.89)	(2.41)	(2.677)
$RDSQ_{t-3}$	.187**	.150*	-.524***	-.445***	-.495***	.005	-.127	-.190
	(.088)	(.087)	(.101)	(.106)	(.035)	(.134)	(.110)	(.133)
MD_{t-3}	2.82***	3.06***	4.59***	5.31***	4.75***	3.65***	5.44***	4.60***
	(1.01)	(1.00)	(1.06)	(.795)	(.415)	(1.43)	(1.17)	(1.006)
$MDSQ_{t-3}$	-.06***	-.063***	-.033	-.049**	-.036***	-.032	-.069***	-.041*
	(.019)	(.019)	(.021)	(.023)	(.007)	(.027)	(.023)	(.024)
Constant	-33.5*	-17.06	-28.66**	-38.78***	-28.20***	-21.52	-23.55	-39.99***
	(19.84)	(19.55)	(13.55)	(11.14)	(5.68)	(19.35)	(15.64)	(15.12)
Wald-Chi2		1644.21	2815.61	4776.30	13483.99	944.95	1119.21	1460.68
F(12,1263)	130.07							
Prob > F	0.0000							

Note: in parentheses standard errors; *significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Results

The findings show that the market access determinants have significant effect on total crop productivity in the South of India.

- A unit increase of road density ($km/100km^2$) will contribute to 10.04 Rs/ha increase in aggregate crop productivity.
- A unit increase of density of regulated markets ($Nr/10000km^2$) will contribute to 4.60 Rs/ha increase in aggregate crop productivity.
- In the particular case, lags are 3 years.

Conclusions

The results of the study are consistent with the hypothesis that the aggregate crop productivity may be largely improved merely through prompting the states (districts, farmers) to allocate their resources in a more efficient way, without even using more inputs.

It is obvious, however, that increased use of inputs would be adding to that positive effect considerably.

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