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INVERSE FARM SIZE-PRODUCTIVITY RELATIONSHIP : A TEST USING REGIONAL DATA ACROSS TWO TIME-POINTS

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ABSTRACT

The debate on farm-size productivity relationship continues to attract the scholars even today. This study wishes to carry on the arguments advanced in this debate to the pre-liberalisation period on a set of farmers in an underdeveloped region. The region is known to have successful tradition of land reforms and opening up avenues of rural governance and decentralisation. Yet liberalisation policies that are concomitant on the broader aspect of globalisation have led to substantial changes in the pattern of resources utilisation by the different types of farmers. Big farmers gained substantially in the reform process while the poor lost their ground. Without some support in the public policy they may not be able to subsist in an increasingly liberalised economy.

Introducion

The farm-size productivity debate was originally initiated by Sen (1962, 1964) using aggregate data from Indian Farm Management Study. He found inverse relationship between farm-size and productivity and sparked a debate because it reemphasised the importance of the Land Reform Policy at a time when it became clear that the national government would not be able to implement it but this inverse relationship started to disappear following the adoption of High Yielding Variety Programme (HYVP), popularly known as green revolution, in 1964-65. Rudra documented these changes in three papers, 1968a, 1968b and 1973 and in 1980 Rudra and Sen wrote a rejoined commenting on the same phenomenon. Similar phenomenon was also said to have been confirmed in different parts of the world (Dyer, 1991, 1996, 1998).

There seems to be reawakening of this debate for underdeveloped agrarian economies in the recent years ever since the publications of newer results that are based on more recent data on farm level economic characteristics and application of some new methodologies. The late debate has been based on the alleged confirmation of inverse relation in agriculturally advanced zones (Berry and Cline, 1979; Khan 1979; Carter 1984; Chattopadhyay and Sengupta, 1997, 1999).

The basic argument is the ability of small farmers in reaping the benefit of new technology (Sharma and Sharma, 2000). In the traditional logic, new technology is heavily

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biased towards rich farmers because of the large setup cost involved in adopting such technologies (Dyer, 1998). However, recently several authors feel that there are certain aspects of new technology (such as efficient use of water resources, proper selection of crop mix etc.) that might benefit even the small farmers particularly in a situation when the government assistance favoured the poor (Chattopadhyay and Sengupta, 1997, 1999). The government started to spend inputs more sparingly and offered subsidised loans to the farmers.

The arguments advanced in this debate have been confined to the pre-liberalisation period. Though the soft liberalisation process started since the eighties, it really speeded up since the nineties. In the recent years, the Indian government has taken several steps towards liberalising the economy in an effort to integrate it with the international economy. Many such steps were directed towards agricultural sector. Under the new economic policy government withdrew from much of the direct and indirect support that was traditionally provided to the agriculture. The subsidies given to the farmers (in providing cheap electricity, loan assistance scheme, support prices to the farm product, fertiliser subsidy etc.) were slashed down. The role of the state as the buyer of surplus output (that is stripping demand) is also considerably lowered. The policies have direct bearing of the farmer's choices, their output decisions and their viability vis-a-vis the big farmers.

There must be a connection between these financial reform policies of the national governments and the broader process of globalisation. Many of the reform agenda were a direct consequence of the World Bank and IMF conditionality. This does not mean globalisation is alone responsible for all the possible outcomes of the productivity indicators. Rather it is a result of various factors that may be directly or indirectly affected by this broader process. In fact, some of these factors may be independent of this global process also and essentially *local* in character. Many others are a consequence of the public policies in trying to cope up with the world situation. We are just interested in studying the farm productivity relations in the era of global integration and liberal reforms.

Proper analysis of such micro aspects requires panel data for a set of farmers over almost a decade of liberalisation. However, the problem of gathering such a data set is really surmounting especially in a turbulent situation that we are witnessing in the post-reform era. Farmers often shift to other occupations or cultivation of other types of crops. Their family composition, asset structure and economic position are likely to alter significantly over such a long period. The village itself may become increasingly urbanised leading to a change in opportunities and costs.

In such a situation it might be possible to gather some insights into this problem by concentrating on two *comparable*[1] cross-sectional data sets for two different time points that are widely separated from one another. By *comparability* we mean data sets that are generated by same authority following same sampling techniques for a specific geographical location[2]. The units selected are likely to differ but the selection criterion of the sampling units will remain the same. The data collected for various districts of the State of West Bengal in India under the Cost of

[1] We refrained from using the more popular term *pseudo-panel* data because we have used not a continuous series but data sets over a gap of almost fifteen years.

[2] The idea closely resembles village studies where the same village or same location is visited after a gap of few years.

Cultivation Scheme provides such *comparable* sets. We have used farm level disaggregate data for the Midnapore district of the State collected under the scheme for our purpose. Information on the use of different inputs like land, human labour (family & hired), bullock labour (family & hired), fertiliser, manure, plant protection chemical, machine (tractor & power tiller), irrigation etc. and output of all the crops cultivated at the farm level is collected under this scheme every year since the late seventies. In our study we have used data for two different years: one proceeding the current globalisation era (1985-86) and the other in relatively recent period (2003-04). Since the data sets are separated by a long span of almost twenty years, they are likely to capture much of the impact of globalisation on farm economy.

In a dynamic economy as the macro parameters change, individual's reaction also undergoes considerable alterations. Traditional inputs may give place to modern inputs. Old crops may be replaced by newer varieties that are remunerative. New forms of institutions including market forms may be emanating. Even the socio-cultural types may undergo radical changes[3]. Since it is not possible to deal with the entire gamut of such changes, we may however be contended with a narrow set of quantifiable economic characteristics[4].

Salient Features of the Agrarian Economy of West Bengal

Eastern India (where West Bengal belongs) has emerged as a new centre of growth in the agricultural sector since the 1980s. Over the period, the foodgrains production increased at a compound annual rate of 3.01 per cent per annum.

Of India's incremental output of 45.6 million tonnes in foodgrains over this period, around 20 per cent was contributed by the Eastern region. This impressive performance is a relatively recent phenomenon. Until the early 1980s, the growth of agricultural production in this region was low (around 1.6 per cent per annum) and lagged behind the national average. This turns around, from a situation of low and less than the all-India average rate of growth to high agricultural growth rates, occurred in the last two decades.

A notable feature of the accelerated growth performance in the eighties and the early nineties is the striking performance of foodgrains, especially rice. For example, the growth rate of rice production increased to more than 6 per cent per annum in West Bengal in the eighties. Studies by Saha and Swaminathan (1994), Rawal and Swaminathan (1998) reveal that the rapid growth in rice production in West Bengal was brought about primarily by an expansion in the boro (summer) crop. Over the period, the share of boro rice production increased in total rice production, primarily due to an expansion in the area under cultivation, and the yield growth was modest. Yield increases were significant for the aman (kharif) crop as well; however, the aus (rabi) crop saw a decline in the area under cultivation. The significant upsurge in agricultural productivity in general is attributed to two major factors. One is the role of institutional changes and other factor is the wider adoption of new technology, better utilisation of fertilisers credit and so on.

[3] For example, a higher level of education status, more gender equality, removal of traditional ties and bondages etc. can be ascertained.

[4] Even such features are innumerable (such as size-productivity relations, shifting in the technology frontier and input use , changes in cropping intensity, price movements both of inputs and output etc.). We concentrate only on a few of them.

Particulars of the land utilisation position in West Bengal as well as Midnapore district are given in Table 1. This Table provides some data on land utilisation pattern during 1980-1981 and 2000-2001. From this Table it can be seen that during this period, net cropped area in West Bengal has fallen whereas in Midnapore district it has risen marginally. The cropping intensity has increased in West Bengal as well as Midnapore district. The per capita agricultural land in the district is only about 0.14 hectare as against 0.11 in the State as a whole.

Table 1 : Land Utilisation Statistics (1980-1981) & (2000-2001)

Particulars	Area	Percentages	Area	Percentages
	West Bengal (1980-1981)		(2000-2001)	
Total Area	8604.85	100	8687.71	100
Gross Cropped Area	7661.60	89.04	9116.60	104.94
Net Cropped Area	5508.15	64.01	5417.38	62.36
Cropping Intensity	-	139	-	168
	Midnapore (1980-1981)		(2000-2001)	
Total Area	1360.63	100	1323.88	100
Gross Cropped Area	1074.90	79	1438.55	108.66
Net Cropped Area	861.96	63.35	874.24	66.04
Cropping Intensity	-	125	-	164

Source : Directorate of Agriculture, Evaluation wing, Govt. of West Bengal.

In West Bengal paddy is the main crop (Dyer, 1998). The crop is generally cultivated more than once a year (normally referred to as aman, boro and aus). In recent years, some other crops (such as vegetables, pulses, oilseed, potato, etc.) have substituted aus. Aman is the traditional variety while boro is the modern variety with high return, huge investment and large risk involved. Wheat is another main crop in this region. Detailed information regarding area, production and yield rate of principal crops are provided in Table 2. From this Table it can be seen that during the period both the foodgrains production and the cash crops production have gone up.

We are also interested to understand the changing composition of the farmer's category over this period. There is a lot of debate regarding the classification of farmers. The traditional categorisation based only on the possession of cultivable land was seriously challenged by a number of economists (Patnaik, 1994)[5]. The argument is that land is not a very reliable basis for categorisation. It depends upon other things such as the degree of commercialisation, use of improved technology, family structure etc. Thus we have used the categorisation developed by the West Bengal government. Using a host of social and economic features they have identified four broad categories (Marginal, Small, Medium and Big). Particulars of the number of rural households according to area of land owned are given in Table 3.

Table 2 : Area and Production of Principal Crops (1980-1981) & (2000-2001)

Crop	(1980-1981)		(2000-2001)	
	Area ('000 hectors)	Production ('000 tonnes)	Area ('000 hectors)	Production ('000 tonnes)
West Bengal				
Rice	5176.20	7465.6	5435.3	12428
Wheat	283	473.2	426	1058.6
Total Cereals	5575	8043.2	5918.4	13595.7
Total Pulses	524.30	238.2	274.5	219.5
Total Foodgrains	6099.30	8281.4	6192.9	13815.2
Total Oilseeds	317.40	150.4	598.6	570.7
Total Fibres	656.90	4711.5	626.6	7521.6
Potato	115.6	1971.8	299.7	7673.1
Sugarcane	14.3	867.4	21.6	1465.6
Midnapore				
Rice	903.3	1255.5	1108.5	2584.4
Wheat	8.8	16.4	13.6	31.2
Total Cereals	913.7	1273.3	1123.8	2618.6
Total Pulses	55.6	15.9	20.8	20.1
Total Foodgrains	969.3	1289.2	1144.6	2638.7
Total Oilseeds	21.5	9.4	72.5	82.9
Total Fibres	23.6	265.5	8.7	148
Potato	15.6	6.5	60.4	348.7
Sugarcane	1.2	252.3	4.6	1596.6

Source : Agricultural Census, Directorate of Agriculture, Govt. of West Bengal.

[5] We however could not use Patnaik's E-criterion due to lack of some crucial data.

A glance at the changing distribution of these categories over the two time periods reveals a tendency of *marginalisation* of the farmers. There is an increase of the percentage of marginal farmers with a simultaneous reduction of the farmers belonging to the higher category. Increased population pressure together with the disadvantages created by globalisation may be a direct cause of this phenomenon.

Table 3 : Estimated Number and Area of Operational Holdings According to Size Class (1980-1981) & (2000-2001)

Farmers Types	No. of Holdings (Number)	Area of Holdings (Hectare)	No. of Holdings (Number)	Area of Holdings (Hectare)
	West Bengal			
	(1980-1981)		(2000-2001)	
Marginal	4096001 (69.67%)	1619657 (29.16%)	5462089 (80.44%)	2758843 (49.74%)
Small	1148936 (19.55%)	1733512 (31.21%)	1009328 (14.86%)	1606686 (28.97%)
Medium	519445 (8.84%)	1403246 (25.26%)	282992 (4.17%)	783773 (14.13%)
Big	113263 (1.93%)	798367 (14.37%)	35582 (0.52%)	397274 (7.16%)
All Size	5877649 (100%)	5554782 (100%)	6789991 (100%)	5546576 (100%)
	Midnapore			
	(1980-1981)		(2000-2001)	
Marginal	788298 (75.76%)	293892 (35.92%)	1127637 (89.37%)	569488 (69.13%)
Small	168302 (16.18%)	254931 (31.16%)	108853 (8.63%)	180648 (21.93%)
Medium	69250 (6.66%)	188180 (23%)	23411 (1.86%)	64246 (7.79%)
Big	14653 (1.41%)	81096 (9.91%)	1816 (0.14%)	9379 (1.14%)
All Size	1040503 (100%)	818099 (100%)	1261717 (100%)	823761 (100%)

Source : Agricultural Census, Directorate of Agriculture, Govt. of West Bengal.

It is in this background that we have undertaken the present study. However, as is well known, one of the major problems in such studies is the difficulty in getting farm-level data. We did, however, have access to a large-scale sample survey on agriculture, which is known as "Cost of Cultivation Survey", and used the relevant data obtained from this survey for the purpose of our study. The results of this study are described in the next section.

Farm-size and Productivity

First, we considered the traditional farm-size productivity debate. It was a brilliant article written in the mid sixties (Mazumdar, 1965) that really fueled the farm size productivity debate soon after its inception by Sen (Sen, 1962, 1964). There seems to be reawakening of this debate for underdeveloped agrarian economies in the recent years ever since the publications of newer results that are based on more recent data on farm level economic characteristics and application of some new methodologies. The latest debate has been based on the alleged confirmation of inverse relation in agriculturally advanced zones (Khan, 1979; Carter, 1984; Dyer, 1991, 1998; Chattopadhyay and Sengupta, 1997, 1999).

The basic argument is the ability of small farmers in reaping the benefit of new technology (Sharma and Sharma, 2000). In the traditional logic, new technology is heavily biased towards rich farmers because of the large setup cost involved in adopting such technologies (Dyer, 1998). However, recently several authors feel that there are certain aspects of new technology (such as efficient use of water resources, proper selection of crop mix etc.) that might benefit even the small farmers (Chattopadhyay and Sengupta, 1997, 1999; Sengupta and Kundu, 2006). The debate remains as yet inconclusive.

However, most of these studies are cross-sectional. They mostly cover a number of farmers for a given time-period[6]. Using *comparable* cross-sectional data sets that are separated by a gap of almost twenty years, our analysis can reveal the long run tendencies of globalisation process at the farm level. Many of these tendencies are averaged out when broad macro perspectives are concerned. The present study was undertaken to examine the relationship between farm-size and productivity as well as input use of a traditional crop namely aman and a modern crop namely boro (a variety of paddy)[7]. For this we have fitted both linear and log-linear relationships showing output per acre against net cultivated area and input use per acre against net cultivated area. The effect of farm size on gross value productivity and input use was quantified by estimating the following regression equations.

Linear Regression Equations :

(i) $Y = A + BX$ (ii) $L_{h} = A + bX$

(iii) $L_{f} = A + bX$ (iv) $L_{b} = A + bX$

(v) $F_{ch} = A + bX$ (vi) $F_{or} = A + bX$

(vii) $M_{h} = A + bX$ (viii) $I_{r} = A + bX$

(ix) $P_{c} = A + bX$

[6] A notable exception is the study by Bhattacharya and Saini (1972). In their study they covered the sample districts for a number of time periods. Using farm level disaggregated data collected under the Farm Management Scheme, the study revealed a dynamic view of farm-size and productivity relation in Indian Punjab. They found that the relationship changed its sign from negative to positive due to the impact of Green Revolution.

[7] For the reasons concerning this multi-crop analysis, see the arguments provided in Sengupta and Kundu (2006).

Log-Linear Regression Equations :

(i) $\text{Log}Y = A + b\ \text{Log}X$

(ii) $\text{Log}\ L_{h} = A + b\ \text{Log}X$

(iii) $\text{Log}\ L_{f} = A + b\ \text{Log}X$

(iv) $\text{Log}L_{b} = A + b\ \text{Log}X$

(v) $\text{Log}\ F_{ch} = A + b\ \text{Log}X$

(vi) $\text{Log}\ F_{or} = A + b\ \text{Log}X$

(vii) $\text{Log}\ M_{h} = A + b\ \text{Log}X$

(viii) $\text{Log}\ I_{r} = A + b\ \text{Log}X$

(ix) $\text{Log}\ P_{c} = A + b\ \text{Log}X$

Where Y is gross value productivity of different variety crops per acre, X is farm size, L_h and L_f are per acre hired and family labour use, respectively, L_b is per acre bullock labour use, F_c & F_r are the value of chemical fertiliser and organic fertiliser per acre. M_h, I_r & P_c are per acre machine charge, irrigation charge and plant protection chemical cost, respectively and b is regression coefficient of both traditional variety crop and modern variety crop. Here the yield rate, labour (hired &family) use, fertiliser (chemical & organic) use, plant protection chemical cost, machine and irrigation charges were computed on the basis of per acre of net shown area.

We first examine the effect of farm size on productivity of traditional variety crop and modern variety crop in the pre and post-globalisation era using both linear and log-linear regression. The results of regression analysis[8] (Table 4) indicate that except for the traditional variety for the post-globalisation era, all the other significant coefficients are positive. Thus, the result of the study does not support the view that the inverse farm-size productivity relationship has disappeared in the new era for the traditional variety. Rather it has reappeared. For the modern variety, in contrast the positive trend is strengthened. Considering the entire gamut of crop production the relationship is consistently positive. A plausible reason is provided in Table 5. In the pre-globalisation era though boro was more costly to cultivate, it was not so disadvantageous for the marginal farmers as compared to others. In fact, it was the medium farmers for whom the position was most awkward. The position changed drastically after liberalisation. The marginal farmers were to bear the brunt of rising relative cost ratio. For all other categories the relative cost-ratios actually fell[9]. Thus, the marginal farmers who were cultivating the modern variety efficiently before might have moved out of it. Naturally for survival they fell back on the traditional variety. Thus, there appears to be a reverse movement to more traditional crops due to the liberalisation process initiated at the macro-level.

Next we present the input use pattern of the farmers in Table 6. We divided the inputs into two categories : traditional and modern for the ease of our analysis. Among the traditional inputs family labour bears a negative relation to farm size, a tendency appeared to have been strengthened in the post-reform period. Loss of job opportunities elsewhere might be a plausible reason for this tendency. Bullock labour that was positively related in the pre-globalisation era appeared to have lost much of its significance. Organic manure indicates a negative relation to farm size for all crops in the pre-reform period. However, all other significant relations for this input appear to be positive. This might be a

[8] We present only the slope coefficients that are relevant due to brevity of presentation.

[9] Globalisation of the Indian economy since the early nineties may have led to increased competition in the input and output market and withdrawal of many of the direct and indirect public support system. They have opened up previously protected arena to the dictum of competition.

direct fall-out of the rising cost of the substitutable input fertiliser in the reform period. So far as modern inputs they all show a positive relation except for chemical fertiliser and plant protection chemicals (PPC) in the case of modern variety (Boro) for the post-globalisation period. A possible explanation might be sought in the rising relative price of these items after withdrawal of subsidies to a certain extent.

Table 4 : Farm Size and Productivity Relationship : Result of Regression Analysis (1985-86 & 2003-2004)

Crop	Slope	Correlation Coefficient (R^2)	t df (N-2)
	1985-1986	(N=110)	
Aman	0.12	0.14	2.71**
Boro	0.01	0.02	0.87
All Crops	0.07	0.02	1.61**
	2003-2004	(N=166)	
Aman	-0.18	0.03	-1.67**
Boro	0.08	0.04	1.98**
All Crops	0.09	0.04	2.74*

* and** significant at 1 and 5 per cent level, respectively.

Table 5 : Cost Ratios of Boro/Aman per Hectare at Constant Prices

Farmer Types	1985-1986	2003-2004
Marginal	1.5445701	9.317372
Small	1.3979268	0.857264
Medium	5.7508333	0.528552
Big	1.4484927	-
All	1.4802962	2.384264

Conclusion

Analysis of the data at two time periods reveals such an interesting dynamics. There appears to be a bias against the marginal farmers in favour of larger groups. The vulnerability of the poor farmers is clearly exposed. Without some support in the public policy they may not be able to subsist in an increasingly liberalised economy. However, there is a general decline in efficiency that is quite surprising. This may reflect some gross infrastructural failure and appropriate capital formation in the agrarian sector.

Table 6 : Farm Size and Input Use Relationship: Result of Regression Analysis (1985-1986) & (2003-2004)

	INPUT	AMAN		BORO		ALL CROPS	
		Slope	R^2	Slope	R^2	Slope	R^2
		1985-1986					
Modern	Hired Labour	1.025* (3.14)	0.177	0.958* (3.14)	0.219	0.288* (2.73)	0.069
	Chemical Fertiliser	0.769* (5.46)	0.163	0.006 (0.21)	0.001	-0.144 (-1.35)	0.019
	Irrigation	-0.215 (-1.20)	0.001	1.128* (3.38)	0.295	0.348** (1.69)	0.026
	P.P.C.	-0.172 (-0.61)	0.008	0.257 (1.41)	0.053	1.129* (3.45)	0.215
Traditional	Family Labour	-0.724* (-3.07)	0.171 (-0.52)	-0.206	0.007	-0.162 (1.56)	0.023
	Bullock Labour	0.893* (3.35)	0.196	0.002 (0.13)	0.001	0.280* (3.18)	0.088
	Organic Manure	0.906* (4.43)	0.299	-0.16 (-0.51)	0.007	-0.155** (-1.94)	0.036
		2003-2004					
Modern	Hired Labour	0.910* (4.56)	0.144	0.579* (2.98)	0.084	0.724* (6.39)	0.203
	Chemical Fertiliser	0.077 (0.53)	0.008	-0.139** (-2.28)	0.053	0.355* (3.71)	0.078
	Machine	0.022 (0.07)	0.001	0.022 (0.07)	0.001	0.670* (2.93)	0.048
	Irrigation	-	-	0.018 (0.14)	0.004	1.307* (5.54)	0.152
	P.P.C.	-0.148 (-0.59)	0.003	-0.503** (-2.27)	0.053	0.888* (5.11)	0.068
Traditional	Family Labour	-0.260** (-1.84)	0.026	-0.731* (-2.76)	0.073	-0.240* (-2.33)	0.032
	Bullock Labour	0.153 (0.48)	0.002	0.432 (-0.52)	0.003	-0.074 (-0.31)	0.001
	Organic Manure	0.547* (2.35)	0.044	-0.210 (-0.82)	0.008	0.888* (5.11)	0.137

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