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ROLE OF INTERSECTORAL LINKAGES IN A HIGH GROWTH AGRICULTURAL ECONOMY - A SIMULATED SECENARIO

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ABSTRACT

The study examines the role of intersectoral linkages in the Punjab economy which is an agriculturally dominant state. Rapid growth in the agricultural sector had widespread impact on the entire economy. To increase agricultural production the industrial sector had to cope up with this sector. Growth in the agricultural sector generated a strong demand for industrial consumption goods thus promoting the growth of the non-farm sector along with its own growth. Further improvements in the growth rates in the agricultural sector would require the industrial sector to improve at an even faster rate.

Introduction

Agricultural development in India, in general, and in high growth regions in particular, is central to all strategies of planned socio-economic development. The example of agriculture-led development are only a few and have succeeded only where inter-sectoral growth stimuli have functioned. The Punjab State, which has shown a high growth in agriculture sector followed also by a high growth in the industrial sector, and which has lately developed certain lags in the growth rate due to constraints that have developed in the support service sector, offers a unique example for a detailed study. During 1960-61 to 1987-88, the net state domestic product of Punjab grew at a rate of 5.26 per cent per annum compared with the growth in GDP of 3.7 per cent for the country as a whole. The growth rate of agriculture sector in Punjab and India during this period was 5.56 and 2.57 per cent, respectively. Likewise the growth rate of industrial sector was 9.90 and 4.89 per cent, respectively (Kaur, 1990). The rapid growth of agricultural sector had widespread impact on the entire economy of the state as well as that of the country as increase in farm incomes stimulates demand for

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consumer goods and services (Mellor, 1976). The rapid growth of agro-industries that supply both current and capital inputs on the one hand and those which make value additions to the raw agricultural produce has strong determinant and determinate linkages with agricultural growth. This also demands significant increase in trade and transport consequent to emergence of large marketed surplus in agriculture. The increase in per capita income of rural population further widens the market for consumption goods and services. Thus, the rapid agricultural growth; raising income of overwhelmingly large proportion of labour force, not only made a deep dent in the rural poverty but also led to development of other sectors through forward and backward linkages.

Although production and consumption linkages have attracted most of the initial interest in agricultural growth linkages at macro level in India (Mellor and Lele, 1973; Jhonston and Kilby, 1975; Malik *et al.* 1979; Rangarajan, 1982; Harriss, 1987; Nachaue, *et al.* 1990; Peter *et al.* 1991), the state-wise analysis done by few researchers for few states (Joshi, 1979; Rai *et al.* 1984; Bhalla, 1981; Bhalla *et al.* 1989) is still too scanty and generally relates to the period prior to 1880's whereas the rapid structural changes have taken place afterwards. The study of linkages between agricultural and industrial growth in Punjab, which is a high growth economy in general and agricultural led growth in particular, would show various alternatives which need to be stimulated to accelerate the total growth of the economy.

Methodology

This paper is mainly based on the secondary data, collected from various sources such as Statistical Abstracts Punjab, Economic Survey of Punjab, Economic Review of Punjab, Bulletin of Food Statistics and Agricultural Situation in India. Complete series of data in respect of some variables were not available. Those were, therefore, indirectly worked out or approximated. The variables included are state domestic product, agricultural production and industrial production. Agricultural production further included foodgrains, non-foodgrains and total production. Industrial products used in agriculture like tractors, diesel engines, electric motors and fertilizer consumption are also included in the study. The study was conducted for the period 1960-61 to 1987-88.

The growth rates for the important economic indicators were worked

out by using the formula:-

$$Y_t = \alpha \beta^t$$

$$\log Y_t = \log \alpha + \log \beta$$

$$\text{Growth rate} = (\beta - 1) \times 100$$

Growth rates were worked out for different decades and for the whole period.

To analytically examine the relationship between agriculture and industrial sectors, one could construct a model of a large number of simultaneous equations. For the Indian economy, we have reported elsewhere a model of 10 simultaneous equations (Kaur, 1992). But due to non-availability of data for some of the variables at the state level, only the following five simultaneous equations could be used in the model for the Punjab state:

$$1. \text{GSDP}_t = b_{10} + b_{11} \text{AQI}_t + b_{12} \text{IQI}_t + W_{1t}$$

$$2. \text{ICI}_t = b_{20} + b_{21} \text{IQI}_{t-1} + b_{22} \text{AQI}_{t-1} + b_{23} \text{FGTT}_{t-1} + W_{2t}$$

$$3. \text{FGTT}_t = b_{30} + b_{31} \text{IQI}_{t-1} + b_{32} \text{NAFG}_t + b_{33} \text{ICI}_t + W_{3t}$$

$$4. \text{NGFTT}_T = b_{40} + b_{41} \text{ICI}_{t-1} + b_{42} \text{NFI}_{t-1} + b_{43} \text{ICMI}_t + W_{4t}$$

$$5. \text{TT}_T = b_{50} + b_{51} \text{FGTT} + b_{52} \text{NFGTT} + W_{5t}$$

Equations used in the Model

1. Gross state domestic product (GSDP) as a function of agricultural (AQI) and industrial production (IQI). This equation is not an identity equation because the output of the tertiary sector which services the other two sectors and is closely related with their individual as well as total performance, and has for this reason, not been included in this equation.

2. Index of industrial consumption goods (ICI) is determined by agricultural output, industrial output and foodgrains terms of trade (FGTT), all of the previous year.

3. Foodgrain terms of trade (FGTT) is the ratio of price of foodgrains to the price of manufactured consumption goods index with base

1980-81 = 100. The FGTT is explained by index of industrial output of the previous year, net availability of foodgrains (NAFG) and index of industrial consumption goods (ICI).

4. Non-foodgrains terms of trade (NFGTT) is the ratio of price of non-foodgrains to the price of manufactured consumption goods and is dependent on index of industrial consumption goods, nonfoodgrain production index of the previous year (NFI) and index of inedible crude material imports (ICMI).

5. Overall Terms of Trade (OTT) is ratio of the price of agricultural commodities to the price of manufactured goods and is determined by foodgrain terms of trade and non-foodgrain terms of trade.

To estimate the equations using regression analysis, the model was tested for identification. There are two conditions order and rank which must be fulfilled for an equation to be identified. The order condition for identification was satisfied because in each equation of the model the total number of variables excluded from it but included in other equations were atleast equal to (or more than) the number of equations of the system less one, thereby indicating, if rank conditions were satisfied, then all the equations would be overidentified. This model also satisfied the rank condition of identification because with the constructed set of variables in the 5 equations, it is possible to construct the non-zero determinant of order 4×4 .

For an overidentified model the method of ordinary least squares cannot be applied because it does not give unique estimates of the structural parameters. The three stage least square method was used to estimate the equations.

Results and Discussion

Technological Change in Punjab Agriculture

The rapid growth and structural transformation of the Punjab economy has taken place primarily as a result of technological breakthrough in agriculture. The Punjab experience underlines that in an agriculture dominant, labour surplus economy, rapid growth in agriculture depends upon the increased use of industrially produced inputs thereby requiring a rapid advance in industrialisation and service sectors to foster required linkages.

The growth rate of fertilizer consumption was found to be higher than all other inputs (Table 1). The long term growth rate of fertilizer consumption was 17.87 per cent during 1960-61 to 1987-88. However, it has shown a decreasing trend. In the earlier half of the period of the study, the growth rate of fertilizer consumption was 31.26 per cent which decreased to 13.36 per cent in the latter half. Decade-wise, it has even come down to 6 per cent during the eighties. The growth rate in electricity consumption has also shown the same trend i.e., a higher growth rate during the early period. Thus the highest growth of electricity consumption was during the sixties i.e. 26.38 per cent; it decreased to 16.08 per cent in seventies and further to 11.90 per cent in the eighties. The overall growth rate of electricity consumption was 16.31 per cent during 1960-61 to 1987-88. Supply of electricity for tubewell irrigation at a subsidized rate provided a great impetus to exploitation of ground water resources. As a result, the number of electric motors rose very rapidly; the growth rate during the sixties was 23.44 per cent which declined to 12.73 per cent in seventies and 8.81 per cent in the eighties. The number of diesel engines increased rapidly during the sixties (31.64%) but as the electricity supply increased, the electric motors being more economical (to farmers) than diesel engines, the number of diesel engines even showed a decline during the eighties, i.e., there was a substitution of electric motors for diesel engines during the eighties.

The pace of tractorization in Punjab agriculture has shown a somewhat more consistent trend. The long-term growth rate in the number of tractors was found to be 16.6 per cent. It was 16.0 per cent during the sixties, 13.9 per cent during the seventies and 8.5 per cent during the eighties. In absolute terms, the incremental number of tractors per year is still much higher than during the sixties as the replacement demand is increasingly becoming relatively more significant (Rajinder Singh, 1992).

As a result of these developments, not only has mechanization increased rapidly, but the capital structure in Punjab agriculture has also undergone a significant change. The state has a disproportionately high share in the distribution of capital and other modern production assets at the national level. A number of factors have been responsible for the rapid mechanization of agriculture in Punjab. In the sixties the spurt in tractors was caused by the need for both timely completion of field crop operations and relief from the pressure on labour demand. Tractors were also increasingly used for transport purposes and soon became a status symbol. This drove quite a few

Table 1: Compound growth rates of industrial products used in Punjab agriculture, 1960-61 to 1987-88

Period	No. of tractors	No. of diesel engines	No. of Elec. motors	Electricity consumption	Fertilizer consumption
1. Whole period					
1960-61/1987-88	16.59	14.25	14.54	16.31	17.87
2. Decades					
Sixties 1960-61/1969-70	15.98	31.64	23.44	26.38	36.97
Seventies 1970-71/1979-80	13.91	13.11	12.73	16.08	9.83
Eighties 1980-81/1987-88	8.46	-7.92	8.81	11.90	6.01
3. Two sub periods					
Earlier 1960-61/1973-74	19.43	31.26	20.82	25.08	31.26
Later 1974-75/1987-88	13.49	-5.08	10.29	13.21	13.36

Source : Based on data from various issues of Statistical Abstracts of Punjab, The Economic Advisor to Govt. of Punjab, Chandigarh.

medium and even small farmers to purchase tractors regardless of the size of their holdings.

The increasing modernization of production technology in Punjab agriculture can also be seen in the composition of material inputs. The relative share of modern inputs (for example, chemical fertilizers, diesel oil, electricity) increased dramatically; and that of traditional inputs (such as organic manures, bullock operations, etc.) declined steeply over time, especially after the sixties. The relative share of purchased inputs increased sharply from about 38 per cent in 1960-61 to about 87 per cent in 1980-81 (Bhalla, 1990). Clearly, agriculture in Punjab is increasingly linked with non-agricultural sectors for the supply of its inputs.

How much and how long these imbalances can be sustained remains a serious issue which can be more appropriately studied through a simultaneous equation model. The next section is an attempt to analyse this scenario.

The significant increase in the growth of productivity increasing current inputs and capital investments have resulted into a high growth of agricultural output in Punjab. The growth rate of total agricultural production during the period 1960-61 to 1987-88 was 5.65 per cent; the growth rate of foodgrains was even higher this time being 6.93 per cent (Table 2). In the earlier period (1960-61 to 1973-74), which is also known as the green revolution period so far as Punjab is concerned, the growth rate of foodgrains (8.03%) as well as of total agricultural production (6.89%) were higher than the other sub-periods between 1960-61 to 1987-88. The industrial sector also showed a growth rate of 9.43 per cent in the latter half (1974-75 to 1987-88). Thus, the new farm technology has proved to be a boon.

The Punjab economy has shown some glaring differences from the Indian economy. Punjab economy had much higher growth rates than the Indian economy. Also the bread sector (measured as proportion of value of cereals in the total value of agricultural production) of Punjab within agriculture accounts for a much higher proportion than in India: it was 54 per cent in Punjab and 25 per cent in India in 1970-71. This bread sector has grown in proportion over the years to as high as 73 per cent in 1980-81 in Punjab compared to 42 per cent in India. The trend continued to be the same, though much near to be negligible to come to 74 per cent in Punjab and 43 per cent in India in 1985-86 (Singh and Dhillon, 1990). Thus, it would be

Table 2 : Performance of agriculture and industry in Punjab during 1960-61 to 1987-88

Period	Agriculture			Industrial production (1975-76 prices)
	Food grains	Non-food grains	Total production	
1. Whole period				
1960-61/1987-88	6.93	2.02	5.65	9.90 (1970-71/ 87-88)
2. Decades				
Sixties : 1960-61/1969-70	7.23	4.04	6.39	N.A
Seventies: 1970-71/1979-80	4.88	3.80	5.27	13.93
Eighties : 1980-81/1987-88	3.15	4.02	4.03	5.62
3. Two sub periods				
Earlier : 1960-61/1973-74	8.03	0.29	6.89	7.00 (1970-71/1973-74)
Later : 1974-75/1987-88	6.15	2.02	4.50	9.43

N.A. Data not available

Source: Based on data from various issues of Statistical Abstract of Punjab. The Economic Adviser to Govt. of Punjab.

Note : All the growth rates were significant at 10 per cent level.

pertinent to study the agriculture industry linkages in Punjab which is a high growth and more specialized agricultural economy.

Linkages between agricultural and industrial sectors in Punjab

The coefficient of the five simultaneous equations estimated using three stage least squares method for Punjab explains the interdependence between agriculture and industry (Table 3). The index of gross domestic product in the current period is positively influenced by the index of agricultural production and the index of industrial production. Both the variables are highly significant. The coefficient of agricultural output is higher (0.800) than coefficient of industrial output (.709), which is opposite to the case for India. This shows that Punjab economy is dominated by the agricultural sector and accordingly the accelerated growth in other sectors of the Punjab economy would originate through their linkages with the agricultural sector.

The demand for industrial consumption goods is explained by the index of industrial output, index of agricultural production and foodgrains terms of trade, all of the previous year. The coefficient of the index of industrial output and the index of agricultural output were positive and significant, but that of the foodgrains terms of trade was negative.

Allocation of resources between sectors, the profitability of sectors and the rate of growth of the sectors in an economy are affected by the changes in prices of products in one sector in relation to those in other sectors. For the sectoral analysis, generally commodity terms of trade are worked out, which is the ratio of the index of agricultural prices to the index of industrial prices with reference to a common base year. The change in foodgrains terms of trade as studied in equation 3, were found to be explained by the changes in industrial output index (positively), net availability of foodgrains (positively) and index of industrial consumption goods (positively). These were just the indications as none of the coefficients was significant and the explanatory power of the equation ($R^2 = 0.217$) was also very low. The non-foodgrain terms of trade were significantly affected by the index of crude material imports. The production of nonfoodgrains is lower in the Punjab state and it is still dependent on the importation. Index of non-foodgrain production and index of industrial production has the coefficient less than one which was not statistically significant.

Table 3 . Production and demand linkages for the agriculture and industrial sector of Punjab 1960-61 to 1987-88

Independent Variables	Dependent variables				
	Gross State Domestic products	Index of industrial consumption goods	Food grain terms of trade	Non food grain terms of trade	Terms of trade
Equation No.	1	2	3	4	5
Index of agricultural Production (AQI)	0.800** (1.754)	.385(-1)** (5.522)			
Index of Industrial production (IQI)	0.709 *** (2.514)	1.116 (-1) (.408)	.139.1 (.408)	.015 (.225)	
Foodgrain terms of trade (FGTT)		-.821(-1)** (-1.847)			-.958*** (-3.156)
Net availability of foodgrains (NAFG)			.066 (.277)		
Index of industrial consumption goods (ICI)			0.024 (.093)		
Index of non foodgrain production (NFI)				.070(-1) (.550)	
Index of crude material imports (ICM I)				.180*** (3.089)	.045 (-.226)
Non foodgrain terms of trade (NFGTT)					.045 (-.226)
R ²	0.904	0.942	0.217	0.611	1.00

Note: -1 leads to lagged by variable. Figures in parentheses represent 't' values of the respective coefficients. *** Significant at 1 per cent level

** Significant at 15 per cent level * Significant at 20 per cent level.

The demand linkages generated by agricultural sector in respect of industrial consumption goods can be seen from the coefficients in Equation 2. Both the coefficients of index of industrial production and index of agricultural production were found to be positive. Though the coefficient of index of industrial production is higher than the coefficient of index of agricultural production, the former was not statistically significant, whereas the latter was statistically significant. Favourable movements in foodgrains terms of trade for agricultural sector together with simultaneously growing flow of marketable surplus in a developing agricultural economy may benefit the rich peasantry. Obviously, with increasing farm incomes rural demand for industrial goods, both for consumer durables and non-durables, would grow substantially. Hazel and Ramaswamy (1991) also estimated demand multipliers emanating from agricultural growth over the seventies. They estimated that as a result of production and consumption linkages every Rs. 100 increase in agricultural income induced an additional Rs. 87 income in other sectors of the rural economy. Production linkages accounted for about half of the increase and the consumption linkages for the other half.

It shows the growth in agricultural production generates a very strong demand for industrial consumption goods. The agricultural sector not only provides a major domestic market for industrial consumption goods but additionally also generates the demand for non-traditional agricultural inputs produced in the industrial sector. Thus it simultaneously promotes the growth of non-farm sector along with its own development. The interdependence of the two sectors for their respective growth becomes obvious.

Simulating the Effect of Improvements in Growth Rates in GDP and Agriculture Sector

Effect of improvement in gross domestic product from 5.23 per cent (actual) to 6.00, 6.50 and 7.00 per cent were simulated. The simulation exercise was also repeated for accelerating the growth rate in agriculture sector from 5.65 per cent (actual) to 6.00, 6.50 and 7.00 per cent. It was found that for an improvement in the state GDP, the coefficients of both agricultural production and industrial productions improved in every case. It was significant to note that the ratio of two coefficients in each case remained the same (1.128). However, replication of the simulation exercise with improvement in the growth rate of agricultural sector showed the role of lags in linkages between the two sectors. When the growth rate of agricultural sector was marginally improved from 5.65 per cent to 6.00 per

cent, the coefficient for the agricultural production declined, albeit marginally, from 0.800 to 0.792; whereas that of industrial production remained constant at 0.709. But when the growth rate in agricultural sector was further simulated to increase to 6.5 per cent, the coefficient of agricultural production declined significantly to 0.582 and that of industrial production increased, also significantly to 0.836. This shows that to sustain improvement in growth rate in agricultural sector, the industrial sector (and other) sectors of the state had to improve at relatively much higher growth rates. It is only after these changes have been sustained through building strong linkages between different sectors that further improvement in growth rate in agricultural sector to 7 per cent would withstand a balanced growth rate of the two sectors; that is, when the coefficient of agricultural production again improves to 0.752 and that of industrial production comes back closer to what it is at present (0.711).

An Overview

The study highlights that the Punjab economy had a high growth rate, both in agricultural and industrial sectors. However, since agriculture is the dominant sector in the state, rapid growth of this sector showed widespread impact on the entire economy. The direct impact of this growth was seen through the rapid increase in the demand for modern (industrial) inputs, such as fertilizer, insecticides, diesel fuels, machinery, etc. To sustain the past growth rates, we have to extend the new technology to more difficult districts and to more difficult set of farmers (Bhalla, 1977). This argument is still valid in 1990s as shown by recent studies which have examined the scope to increase the agricultural production in the Punjab state (Kahlon and Singh 1993).

This study further shows that to increase the agricultural production, industrial sector had to cope up with this sector. In the Punjab state, the infrastructure is most important, Punjab is at a consolidation stage in the field of agricultural development (Bawa and Singh, 1990). The hypothesis that development changes the sequence of leading sectors and structural rigidities that lie dormant in the socio-economic matrix of traditional societies but tends to level off when new technology catches up is supported (Pant, 1983). The simultaneous equation analysis further supported this argument that growth in the agricultural sector generates a very strong demand for industrial consumption goods. The agriculture sector not only provides a major domestic market for industrial consumption goods but

additionally also generates the demands for nontraditional agricultural inputs produced in the industrial sector. Thus it simultaneously promotes the growth of non-farm sector along with its own development.

The improvements in the growth rates in agriculture sector, it was simulated, demands the industrial sector to improve even at a faster rate, i.e., a further cementing of agricultural and industrial linkages, in the context of high growth agriculturally dominant economy is needed. It is only after that the development linkages have been sustained for long enough period, that a balanced growth model can be adopted.

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