4.1 Introduction

The basic pattern of industrialization in the growth process of developed as well as developing countries reveal some common features (Kuznets, 1966, Pack, 1988). Growth rates of industrial output in developing countries in the post-war period have tended to exceed that experienced by most developed countries at their corresponding stage of economic development during the 19th and/or early 20th century. In this respect, Indian experience has not been much different (Mookherjee, 1995, p 11).

Rapid rate of industrial growth has resulted in rise in the relative share of secondary sector in most of the economies. From the discussions of Section 2.2 of Chapter 2 it could be observed that the share of the industry in domestic output as well as in labour force has a generally rising tendency in most developing countries, including India. But it still leaves open the question as to how the process of interactions between industry and agriculture works. We try to address these issues in this chapter. We examine the inter-relationships among the agricultural and industrial variables in the Indian context from the macro perspective.

This chapter is organized as follows: Section 4.2 takes a look at the issues relating to industrial sector output, prices, and wages. A brief discussion of the theoretical issues regarding the process of interaction between industry and agriculture is undertaken in Section 4.3. Section 4.4 examines the empirical relationship between the two sectors,
beginning with their levels of income and then to disaggregation into output and price levels of the two sectors respectively. Summary of conclusions and implications of the results is presented in Section 4.5.

4.2 Industrial output growth, price and wages

i) *Industrial output growth:*

Table 4.1 provides the figures of the growth rates of the Indian industrial and agricultural output and price level for different time periods.

**TABLE 4.1: Annual growth rates of Indian agricultural and industrial sector¹**

<table>
<thead>
<tr>
<th>Year</th>
<th>Industry Output</th>
<th>Industry Price</th>
<th>Agriculture Output</th>
<th>Agriculture Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1951-56</td>
<td>5.72</td>
<td>-0.77</td>
<td>3.12</td>
<td>-5.35</td>
</tr>
<tr>
<td>1956-61</td>
<td>6.12</td>
<td>4.19</td>
<td>3.17</td>
<td>20.16</td>
</tr>
<tr>
<td>1961-66</td>
<td>7.02</td>
<td>4.24</td>
<td>0.18</td>
<td>11.93</td>
</tr>
<tr>
<td>Phase II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1966-69</td>
<td>3.85</td>
<td>5.20</td>
<td>8.02</td>
<td>5.07</td>
</tr>
<tr>
<td>1969-74</td>
<td>2.65</td>
<td>8.22</td>
<td>0.50</td>
<td>2.65</td>
</tr>
<tr>
<td>1974-79</td>
<td>7.52</td>
<td>4.44</td>
<td>4.82</td>
<td>10.63</td>
</tr>
<tr>
<td>Phase III</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980-85</td>
<td>6.82</td>
<td>8.61</td>
<td>4.21</td>
<td>7.19</td>
</tr>
<tr>
<td>1985-90</td>
<td>8.17</td>
<td>7.43</td>
<td>5.01</td>
<td>8.85</td>
</tr>
<tr>
<td>1990-91</td>
<td>7.00</td>
<td>8.70</td>
<td>4.05</td>
<td>11.71</td>
</tr>
<tr>
<td>Phase IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991-92</td>
<td>-1.32</td>
<td>10.70</td>
<td>-2.65</td>
<td>19.08</td>
</tr>
<tr>
<td>1992-93</td>
<td>4.11</td>
<td>10.75</td>
<td>6.41</td>
<td>4.64</td>
</tr>
<tr>
<td>1993-94</td>
<td>6.56</td>
<td>6.99</td>
<td>3.70</td>
<td>11.07</td>
</tr>
<tr>
<td>1994-95</td>
<td>9.01</td>
<td>9.42</td>
<td>4.45</td>
<td>9.67</td>
</tr>
<tr>
<td>1995-96</td>
<td>10.95</td>
<td>7.79</td>
<td>-0.28</td>
<td>6.42</td>
</tr>
</tbody>
</table>

*Source: Computed from Economic Survey 1996-97.*

¹The variables are defined in the Appendix A.
The Indian industrial growth experience suggests four distinct phases: the first phase lasting from early fifties till 1966 when growth proceeded at a rapid pace with the growth rate hovering around 8 percent per annum. The second phase was from 1966 to the late seventies. In this period the growth rate dropped appreciably to just about 4 percent per year. This period is usually referred to as period of industrial recession or deceleration in the literature. The third phase began in the early eighties with the revival of growth to over 7 percent (Mookherjee, 1995, p 16-7). Early nineties were marked with major changes in the global economy in the wake of the third oil shock. This could be referred to as the beginning of the fourth phase of industrial growth in India. As a result of the world oil crisis, the industrial growth became negative and the economy came to a virtual standstill in 1991-92. A general balance of payments exigency forced the policy-makers to make major adjustments in the form of import-compression, devaluation of the rupee, slashing of public investment etc. around the same time. The subsequent process of liberalization and structural adjustment programme, to some extent in conformity with the conditionalities of International Monetary Fund (I.M.F.) loan, was also initiated in this period. This liberalization phase has been characterized by significant policy shifts in the industrial and external sectors of the economy. Industrial deregulation in the form of de-licensing, liberalized trade, significantly pruned list of reserved industries for public sector and small-scale industry sector, opening up of trade of agricultural commodities have been major policy changes introduced in this phase.
On the whole, however, there is general agreement that Indian industry has achieved notable growth and diversification since independence although this growth has been characterized by significant fluctuations. The share of 'Capital Goods' in industrial value added has risen steadily from 4.7 percent in the mid-fifties to 23.7 percent in 1990. 'Basic goods' improved their share relatively modestly from 22.3 percent to 38.4 percent. The 'consumer goods' declined in importance considerably in this period - their share fell 48.4 percent in 1956 to 20.5 percent in 1990 (Krishna, 1996, p 643).

ii) Industrial Price level:

The industrial prices in India have risen almost uninterruptedly over the years, except for a few years in the early fifties. The industrial price index (base 1980-81=100) rose from 19.8 in 1950/1 to 347 in 1995/6, a rise of about 17 times (Graph 4.1).

The main reason for the rise in industrial price level has generally been attributed to cost factors, both on account of labour as well as raw-materials. The changing structure of industry in favour of capital goods and basic industries is also likely to

---

2 This includes tools, boilers and steam generating plants, internal combustion engines, specialized equipment used in specific industries like tractors, etc., and non-electrical machinery, equipment for generation, transmission and distribution of electricity, shipbuilding including repair services, railroad equipment, heavy vehicles and transport equipment.

3 It includes salt, fertilizers, cement, iron and steel, and non-ferrous basic metal goods, electricity and gas, and mining.

4 This consists of consumer durables like furnitures & fixtures, lanterns, comm. office and household equipment (except refrigerators and airconditioners), fans and telecommunications, cars, bicycles, motor cycles, watches and clocks, jewellery and related articles, professional and scientific instruments, and non-durables like food manufactures, beverages industries, tobacco, cotton weaving, woolen/worsted fabrics, art silk, textiles and related goods, footwear and other wearing apparel, paper and paper products except newsprint, printing, publishing and allied industries, rubber footwear, drugs and pharmaceutical, soaps, cosmetics, matches, glass and related products, electrical lamps, photographic and optical goods manufacturing industries, blades, enamelling, polishing metal products, etc.

5 It is computed as the GDP deflator for the industrial sector.
GRAPH 4.1: Industrial Price Deflator and its Annual Rate of Change
have contributed to this rising trend of costs. This is because these sectors are the high labour productivity sectors which tend to push up wage costs.

The close movement of consumer price index (food) for industrial workers and industrial wages, as we will discuss later, indicates that the two might influence each other in so far as wages (or wage bill) are an important component of costs. Wages are also expected to depend on the cost of living of the industrial workers. Labour productivity is likely to be another important contributory factor to the level of industrial wages and changes in it, especially in the newer and more capital intensive industries.

iii) Industrial Wages

Although the average real wage did not increase significantly till the late sixties the evidence on the whole indicates an upward trend. This is quite consistent in view of the continuous productivity growth over the years (Balakrishnan, 1991, p 118). However, there has been wide dispersion across states and industries. The higher wages in newer industries using new and better production technology, in the opinion of Chatterjee (1989), were mainly on account of higher labour productivity and these industries over the years have acquired larger share in the Indian industry. Correspondingly, there has been an increase in the ratio of number of skilled (and relatively better paid) to number of unskilled (and relatively lower paid) workers.
Changes in money wages have been observed to be positively related to changes in the cost of living index for industrial workers and they tend to rise *automatically* with sharp rise in cost of living index. Also, the evidence shows that in the periods of high inflation real wages tend to fall indicating a built in fall or deceleration in the system of wage-adjustment in periods of fast rising prices (Chatterjee, 1989, p 43-44). Moreover, it is also argued that money-wage determination in the organized sector is not influenced by the state of economic activity in industry (Balakrishnan, 1995, p 91). Above discussion suggests that industrial output is unlikely to be influenced by prices and/or wages in the industrial sector.

4.3 Agriculture-Industry Interactions:

Now, we attempt to see how industrial sector interacts with agricultural sector. One important feature of various models of the agriculture-industry interaction has been the assumption of the relative exogenity of the agricultural output and its momentum (Lewis, 1954; Jorgenson, 1961; Fei and Ranis, 1964; Kaldor, 1967). Agricultural sector growth is considered to be the driving force of the process of economic growth. Corresponding to the autonomous behaviour of farm output, the prices of this sector are argued to be *flexible* in nature responding more or less instantaneously to the fluctuations in levels of output. Therefore, the agricultural producers are asserted to be 'price-takers'. To quote Taylor(1983),"The food, or agricultural sector ... has fixed (or price-inelastic) supply in the short run, while its price varies to clear the market".

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*See Section 1.1 and also Skarstein(1997), and Storm ((1994) for a survey these issues.*
In India, the prices in the agricultural sector fall regularly on a seasonal basis. However, on the annual base decline in agricultural prices has been a rare phenomenon (see Graph 2.3 earlier). Over the years the strength of farm lobbies has led to procurement prices being increased even in good years, thereby making the farm prices downwardly inflexible (Little and Joshi, 1994, p 43; Pandit, 1993, p 41; Balakrishnan, 1991, p 45-6; Chakravarty, 1986, p 26).

It is generally held that shortfall in food availability may lead to price rise, in turn, eroding investible resources. A slower growth in agricultural outputs used as inputs in manufacturing can limit the growth of certain sub-sectors of the industry. Most importantly, the slow growth of productivity can lead to deficiency of domestic demand for the industrial output.

The literature on India has also moved along similar lines (Rudra, 1967; Bagchi, 1970; Chakravarty, 1974; Raj, 1976; Vaidyanathan, 1977 and Rangarajan, 1982). Many of these authors have identified agricultural output as setting the binding constraint on the industrial growth process. Though the interdependence of the two sectors is recognized, agricultural surplus has been considered to play a crucial role for the growth of the industrial sector. Mahalanobis (1960, p 220) was of the opinion that,

"...in India, the production of an agricultural surplus is the key to industrialization.

---

7 For a more detailed literature survey see Section 1.1 Chapter 1.
It is not only essential to grow enough food and fibres for our own requirements but it is also necessary to produce a surplus in the form of industrial or food crops. In India, the agriculture and manufacturing industries are completely interlocked. Economic progress depends on the advance of both. Advance of one step in agriculture would supply food and raw materials for advance of one step in manufacturing industries. Which, again, in its turn, would speed up irrigation, and increase the supply of fertilizers and pesticides and help in the promotion of scientific research which would lead to further advance in agriculture.

In contrast, in the theoretical literature on industrial pricing, it is usually argued that changes in the prices of industrial goods are 'cost-determined'. They are supposed to be influenced mainly by changes in the prices of inputs. In the context of U.S. economy, Okun (1981) argued on the basis of overwhelming evidence that ‘most industries adjust prices more promptly and more reliably in response to changes in costs than in response to changes in demand.”

In the context of the Indian economy, it is a well-established empirical finding that cost-push factors have a greater influence than the demand-pull factors in affecting the industrial price level. Industrial prices are found to be “almost entirely cost-determined” in so far as “prices are based on a mark-up over costs and that demand factors have no significant role to play” (Chatterjee, 1989, p 157). The fallout of this

---

8 Agricultural prices being the most important due to their cascading effect (Kalecki, 1954, p 43).
9p 148-153.
10 See Bhattacharya and Lodh (1990).
finding, the structuralist theory of inflation, emphasizes cost-side variables which usually characterize the data-generating process of industrial price behaviour in India.\footnote{Sen and Vaidya, 1995, p 29.}

To sum up, theoretical arguments have been advanced to suggest that the agricultural sector output could influence industrial sector output from the supply as well as from the demand side. The industrial sector, in its turn, may influence agricultural output positively through expanding the demand for agricultural surplus (Kaldor, 1967). In the light of the theoretical literature and empirical evidence on agricultural and industrial sector pricing, we would expect the price of agricultural sector to be influenced by a combination of demand and supply variables. There could also be some role for the procurement price policy of the government in this process of interaction as has been argued by some studies (see for instance, Chakravarty, 1987; Balakrishnan, 1991). The price of the industrial sector, on the other hand, could be influenced by various factors. Cost-factors are likely to be more dominant in this context. Let us now examine empirically this process of inter-linkages between industry and agriculture in some detail in the context of the Indian economy.

4.4 Hypothesis on agriculture-industry interactions: the empirical results and their implications

A) The background and the earlier results:

We saw in Section 2.5 that the flexible price character of the agricultural sector\footnote{Where agricultural price is argued to move inversely with the level of agricultural output.} is
not found to hold empirically in the Indian context. Instead we observe the price and quantity in agricultural sector to move in the same direction in the long run. Moreover, the direction of causality between the two was not found to be clear either\textsuperscript{13}. In view of these results, we could argue that the agricultural price and quantity could be exercising independent influence on the output level of the industrial sector.

The demand for industrial products is likely to be significantly and positively influenced by changes in agricultural output as it raises the incomes of rural population (of rich as well as the poor), thus, enlarging the size for the market of industrial products\textsuperscript{14}. On the supply-side, a larger agricultural output would imply an expansion in the level of foodgrains supply as well as agricultural raw-materials (the cash crops) availability used by the industrial sector.

The impact of changes in the agricultural price is likely to depend on a host of factors as a rise in farm prices would mean a higher level of incomes of the surplus producing cultivators which is likely to have expansionary impact on the demand for industry. The impact of rising agricultural prices, however, would also mean reduction

\textsuperscript{13} Using the bivariate Granger-causality tests.

\textsuperscript{14} See Section 3.3 for detailed discussion of the distributional impact of agricultural output and agricultural price level on industrial sector.
in the real incomes of the net buyer agriculturists\textsuperscript{15}. This effect might become stronger in so far as industrial workers and self-employed or informally employed persons in the services sector are also net buyers of foodgrains. They would have to spend a larger share of their real incomes on food; further the proportion of income spent on food will also rise broadly in accordance with the Engel's law. Krishnaji (1992, p 105) also is of the opinion that "other things remaining the same, rising cereal prices depress the demand for the manufactures". This argument is based on the perceived notion of narrowness of the market base for the industrial products in the context of wide-spread poverty in India (Mukherjee, et al, 1998, 165-70)\textsuperscript{16}. Graph 3.1 in the last chapter and Graph 4.2 below show very clearly the close association between annual rate of growth of agricultural price and annual rate of growth in cost of living index for industrial workers as well as agricultural labourers\textsuperscript{17}. This indicates strong positive impact of changes in agricultural price level on the two cost of living indexes. This is the demand-side impact of the agricultural price level.

On the supply (or price) side, the higher level of agricultural prices is likely to raise the costs of production of industry through its impact on food and raw-material prices. This is going to increase the cost of labour as well as that of raw material of the industrial sector which would put pressure on the industrial prices to go up

\textsuperscript{15}Comprising agricultural labourers and small and marginal farmers.

\textsuperscript{16}Bose (1993, p 6) is also of the same opinion. He argued that the impact would be negative as the income is moving from section of population with high propensity to consume to section with low propensity to consume.

\textsuperscript{17}Using the CPI(IW) for food and CPI(AL) for food respectively.
GRAPH 4.2: Annual Rates of Growth of Agricultural Price and Consumer Price Index (food) for Industrial Workers
accordingly, to maintain the 'cost-plus' norm at the earlier level. So, the net effect of changes in agricultural prices on the industrial sector would depend on the interplay of these forces.

_B) Empirical testing of agriculture-industry interactions_

In this section, we test empirically the process of interactions between industry and agriculture for the Indian economy. We use the _cointegration technique_ for checking whether there exists any long run relationships among the two sectors. The analysis shows that there exists a long-run relationship between agricultural sector income ($Y_{agr}$) and industrial sector income ($Y_{ind}$) levels\(^{18}\). However, the direction of causality (using bivariate Granger causality test), somewhat surprisingly, is found to be from industrial income to agricultural income. But, it is a somewhat weak result found to be significant only at 10 percent level.

The cointegrating equation works as follows:

$$
\text{Log}(Y_{agr}) = 2.744 + 0.765 \text{Log}(Y_{ind})
$$

\((t\text{-ratios}) \quad (30.9) \quad (83.7)\)

\[R^2 = 0.994, \text{ adj-}R^2 = 0.993, \text{ DW} = 0.634, \text{ ADF} = -3.48 (-3.474^{19})\]

*indicates significance at 1 percent level.

This regression shows that the long run elasticity of $Y_{agr}$ with respect to $Y_{ind}$ is 0.765,

\(^{18}\) Both were found to be integrated of order one, for detailed discussion of these issues see Appendix A.

\(^{19}\) At 5 percent level of significance. Source: MacKinnon(1991).
i.e. for each unit change in industrial income the farm income rises by about 0.77 percent in the long run. Their movements over the period under consideration are shown in Graph 4.3.

To improve our understanding of the process of interactions between the two sectors, we decomposed the incomes of the two sectors into their respective prices and quantities. Then, we carried out further empirical investigation of the process of interaction among these variables using bivariate cointegration techniques (detailed results are reported in Endnote 4.1). The results could be summarized as follows:

(a) Agricultural output ($Q_{agr}$) and industrial output ($Q_{ind}$) levels were found to be cointegrated. Here, we find that the industrial output Granger-causes agricultural output but the result, as earlier, is found to be significant only at 10 percent level;

(b) No systematic long run relationship was observed between industrial output and industrial price level. This seems to indicate that the two do not influence one another this may mean that there are other variables also which influence the price and output level of the industrial sector;

(c) while we did not find any evidence of long-run relationship between agricultural price and industrial price level (in the bivariate case), we did observe a close association between the annual rates of growth of the two price levels (Graph 4.4);

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20 We also carried out analysis of likely influence rainfall might have on the agricultural and industrial sector output and we found that the rainfall positively influences the level of output in both the sectors. Though, its influence is on the expected lines but the explanatory power of the rainfall variable is not sufficiently high, i.e. the $R^2$ is found to be only about 0.2. However, it does confirm the close link between the outputs of the two sectors.
GRAPH 4.3: Gross Domestic Product at factor cost - Agriculture and Industry
GRAPH 4.4: Annual Rates of Growth of Agricultural and Industrial Price Deflators
we saw earlier that for agricultural sector price and quantity are cointegrated though there was no clear evidence of direction of causality between the two (see Section 2.5 of Chapter 2 earlier);

Using the evidence from the (a) and (d) above, we carried out multivariate Engle Granger (EG) Cointegration test of agricultural output level with industrial output level and agricultural price level. This tool is likely to improve our understanding of the nature of inter-relationships between the two sectors. The empirical results, interestingly, show that there does exist a long run relationship among them.

The cointegration regression shows:

\[
\log(Q_{agr}) = 7.00 + 0.287 \log(Q_{ind}) + 0.15 \log(P_{agr}(-1))
\]

\[
(t\text{-ratios}): \quad (17.6) \quad (5.04) \quad (3.4)
\]

\[
R^2 = 0.973, \quad \text{adj}-R^2 = 0.971, \quad DW = 1.33, \quad ADF = -4.799 (-3.935^{21})
\]

Note: All variables were found to be significant at 1 percent level.

This result shows that the agricultural output is cointegrated with lagged agricultural price level as well as industrial output level. It is also clear that in the long run, agricultural sector responds positively to the expanding demand for its products as well as to the price level of its output. The long run elasticity of agricultural output with respect to industrial output is found to be (+) 0.29 whereas the agricultural price elasticity of farm output is found to be (+) 0.15. So, we find that in the long run

\[21\text{At 5 percent level of significance. Source: MacKinnon(1991).}\]
demand for agricultural commodities (proxied by the level of industrial production) as well as the lagged agricultural price play an important role in influencing the level of output of the agricultural sector.22

We have noted above [in (a), p 74] the relative exogenity of the industrial output. In Section 2.5 we argued that state intervention along with the stockholding behaviour of surplus-producing farmers and public agencies is likely to influence the level of agricultural price quite independently of the level of current agricultural output.

The result seems to suggest that in the long run agricultural sector output responds to the requirements of industry endogenously and also to the level of farm prices. This finding seems contrary to the (existing positions in the) theoretical literature which typically assumes the direction of causation to be from agricultural output to industrial output23 (see Section 1.1 of Chapter 1).

The above cointegration analysis is useful so far as the long run relationship among the variables is concerned, but to understand the short run dynamics we need to set up an error correction model. Such an attempt would help us to examine the short run behaviour of these variables. This can be used to study the short-run dynamics of the above relationship. This involves regressing the first difference of the dependent

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22 Agricultural price is also partly influenced by the procurement policy of the government which have been used as a policy tool to encourage the farm production, especially since the mid-sixties.

variable in the cointegrating equation onto the first difference of all the variables plus the lagged value of the error correction term (denoted as $e_{t-1}^{24}$). It is used to capture the correction for departures from the long run 'equilibrium' relationship, captured in the above cointegrating regression, among the variables. The coefficient of the error correction term indicates the speed of adjustment in the event of disturbance of the agricultural output from the level determined by the long run relationship (see Appendix A and B for details).

The result from the error correction model is as follows:

$$
\Delta \log(Q_{agr}) = 0.581^* \Delta \log(Q_{ind}) + 0.0234 \Delta \log(P_{agr(-1)}) - 0.785^* e_{t-1} \\
(t\text{-ratios}): \quad \begin{array}{ccc}
(4.3) & \quad \begin{array}{c}
(0.3) \\
(-5.31)
\end{array}
\end{array}
$$

NOTE: $R^2$ is not reported due to the absence of the intercept term in the regression.

*indicates significance at 1 percent.

The result of ECM shows that in the short run the influence of change in agricultural price on output becomes insignificant. This means that agricultural price takes comparatively longer time to invoke the expected supply response from agricultural sector$^{25}$. As against this the change in industrial output is observed to be statistically significant with short run elasticity coefficient of (+) 0.58 which is well above the long run elasticity coefficient. This suggests that in the short run the industrial output evokes a considerably stronger response from the farm sector output, though, this

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$^{24}$i.e., the least square error term (lagged) from the cointegrating regression.

$^{25}$Dantwala (1967) was also of the opinion that some crops will respond quickly but aggregate response will be sluggish.
response becomes weaker as time elapses. The expansion of the industrial sector leads to a faster growth of demand for agricultural commodities. This means a growing dependence of agricultural output level on industrial output level\textsuperscript{26}. Also, we find the \textit{error correction term} to be statistically significant with a coefficient at (−) 0.79 which indicates a relatively faster adjustment in case of the departures of agricultural output from industrial output and agricultural price level from their long run relationship.

This shows that the demand-side impact (proxied by industrial output) is much stronger than the price-side impact on agricultural output in the short run as well as in the long run. The disturbance from the long run relationship also significantly influences the output adjustment of the farming sector. The price effect has its impact only in the long run; in the short run it does not seem to have any significant impact on the farm output.

To return to some classic debate on the subject. These results seem to confirm relevance of the argument of Bukharin (1926). In the context of Soviet industrialization debate he had argued that the process of industrialization may be ‘financed’ by \textit{voluntary} exchange of industrial products with the farm sector. His idea was to induce the peasantry to exchange voluntarily the required amount of agricultural surplus against industrial goods on reasonably favourable terms of trade (Bhaduri, 1993, p 156). The result also points to the importance of industrial output

\textsuperscript{26}Especially products like fertilizers, tractors, pesticides, insecticides, etc., and consumer goods.
growth for promoting agricultural growth (Domar, 1957; Mahalanobis, 1960; Kaldor, 1967; Skarstein, 1997). This implies taking account of the requirements of agricultural sector and expanding production of consumer goods as well as that of industrial products used as raw materials in the agricultural sector for which the farmers would be willing to exchange part of their produce as marketed surplus. This would also ensure that the farmers have sufficient reason (incentive) to keep on expanding their output levels.

Next, we attempt to understand the price level of the two sectors in the context of interactions of industry and agriculture in the multivariate Engle Granger framework. First, we look at the agricultural price level. Here, we find it to be cointegrated with the lagged agricultural output and lagged industrial income. The cointegrating regression is as follows:

\[
\log(P_{agr}) = 6.61 - 0.923 \log(Q_{agr}(-1)) + 0.764 \log(Y_{ind}(-1))
\]

(t-values): (2.9) (-3.5) (13.7)

\[R^2 = 0.990, \text{ Adj-R}^2 = 0.989, \text{ DW} = 1.01, \text{ ADF} = -4.256 (-3.935)\]  

*indicates significance at 1 percent.

We find that there is long run relationship among these variables. The long run elasticity coefficients of agricultural price with respect to lagged agricultural output level is observed to be (-) 0.92 which shows that the lagged farm output has dampening effect on the current farm price level. This indicates strong lagged supply

---

side influence of output on the level of agricultural prices in the long run. The lagged industrial nominal income level, on the other hand, also has significant positive impact on the level of farm prices in the long run. This manifests strong demand side impact. The long-run elasticity between the two stands at (+)0.76, indicating that supply side impact is stronger than demand-side impact in the long run.

To improve our understanding of the short run agricultural price dynamics, we constructed the error correction model, the results of which are as follows:

\[
\Delta \log(P_{agr}) = -0.447 \Delta \log(Q_{agr(-1)}) + 0.567 \Delta \log(Y_{ind(-1)}) - 0.468 u_{t-1}
\]

(t-values): (-2.7) (5.99) (-3.75)

*indicates significance at 1 percent level.

NOTE: The R^2 is not reported as the intercept term is not used in this regression equation.

We observe that both the variables have significant influence, as earlier, on the agricultural price dynamics in the short run. The short run elasticity coefficients of agricultural price with respect to agricultural output and industrial income (both lagged) are observed to be (-)0.45 and (+)0.57 respectively. This shows that faster growth in the agricultural output level (lagged) dampens the growth in the farm price level whereas a faster growth in the industrial income level leads to faster growth in the farm price level. The result shows that in the short run the impact of the demand

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28 Possibly through stockholding behaviour of private traders and public agencies (see section 2.5 of Chapter 2 for a detailed discussion).

29 We did not find any significant influence of current output on current level of farm price.
side variable (proxied by the lagged industrial income) is stronger than the impact from the supply side variable (proxied by lagged farm output) on the farm prices in the Indian context. However, in the long run, the case is just the reverse.

C) Multivariate causality test
We use the Wald's coefficient restriction test to check whether these two (agricultural price and industrial output) significantly influence the farm output. The test clearly shows that industrial output and agricultural price do significantly influence the output of the agricultural sector (detailed result in Endnote 4.1).

The Wald test for the farm price also shows that the agricultural price is significantly influenced by the farm sector output and industrial income (along with their lagged values). Detailed results are reported in Endnote 4.1.

4.5 Summary of empirical results
Contrary to the usual presupposition, the above analysis finds that the agricultural output responds to industrial output, possibly through its demand impact as also the agricultural price level (lagged), perhaps in response to the expanding demand which pushes up the agricultural price level (see Section 2.5 of the Chapter 2). This is likely to incorporate some supply stimulating impact as well on the part of government's agricultural price policy. However, the farm output's response to agricultural price is found to be sluggish in the long run and not even significant in the short run. These
results, however, raise serious doubts about generally assumed 'exogenity of agricultural output'. In fact, in the analysis carried out so far, we find it to be endogenous. Industrial output seems to be the relatively exogenous variable in the process of interactions of the industry and agriculture sector in India.

The agricultural price, in the empirical analysis is found to depend on lagged farm output level and lagged industrial income. This means that the positive demand side impact on the farm price level is mainly through the one period lagged income level of the industrial sector in the long run as well as in the short run. The lagged impact of the agricultural output on agricultural price seem to confirm our earlier finding that current output does not significantly influence the current price level. However, the lagged output level does seem to play a more vital role.

However, we do not find any long run relationship between the two price levels in the bivariate analysis. We do find that agricultural price level is significantly influenced by lagged industrial income (which is nothing but industrial price multiplied by industrial output). A more general exercise is attempted in the later analysis to better understand the long run relationship of industrial price with other variables (in addition to agricultural price level). This is done in the light of the industrial pricing literature.

However, we could not explain the industrial sector output satisfactorily with these
agricultural variables. The results from the cointegration tests for industrial output level with agricultural output and price level also did not give any clear evidence of a systematic long run relationship between them. This suggests a weakening impact of agricultural sector on its own, on the one hand; and, on the other, of additional factors being also important in their influence on level of industrial output as also industrial price over the years in the Indian economy.

Some possible contributory factors to the weakening of the impact of agriculture on industrial sector could be:

i) A continuous decline in the share of agriculture in the production base over the 1950 to 1995 period and correspondingly in the national income during the same period (Section 2.2 earlier). This seems to indicate that in the long run the wage-goods constraint\(^{30}\) has been largely taken care of through the policies of the government. The other segments of the economy, e.g., services, public investment and consumption, which have gained in importance over the years, could also have had some influence on the industrial output level;

ii) The effect of a rise in the amount of purchased inputs used by farm sector has spilled over to the balance of payments creating a proportionately larger increase in import demand, especially for fertilizers and petroleum products, rather than for the domestic industrial sector (Chakravarty, 1987, p 63);

For a better understanding of determinants of industrial performance we need to turn to some of the other variables.

\(^{30}\)This was considered to be a major obstacle to the growth process in the sixties and early seventies.
The Data and Econometric Results

i) Data series
In the empirical exercise, agricultural output, $Q_{agr}$, is proxied by GDPfc (at constant, 1980-81, prices) from agriculture sector and the GDPfc (at constant prices) from secondary sector is used as the indicator for industrial sector output, denoted as $Q_{ind}$. This consists of three broad sectors: (i) Manufacturing; (ii) Mining and Quarrying, or Mining sub-sector; and (iii) Electricity, Gas and Water Supply, or the Electricity sub-sector. The manufacturing sub-sector with a value-added share of about 80 percent in the industrial sector has two broad sub-divisions: the Factory Sector and the Non-Factory Sector. It also includes household and small-scale non-household enterprises\(^3\).

The GDPfc (at current prices) from secondary sector is used as the indicator for industrial income, denoted as $Y_{ind}$; and the GDPfc (at current prices) from agriculture sector is used as the indicator for agricultural income, denoted as $Y_{agr}$.

Finally, $P_{agr}$, the price for agricultural output refers to the agricultural GDP-deflator and $P_{ind}$ is the industrial GDP-deflator\(^2\).

ii) The econometric results:

a) Cointegration Results

Results from Bivariate Cointegration

<table>
<thead>
<tr>
<th>Variable Pair</th>
<th>Selected lags*</th>
<th>Coefficient</th>
<th>test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_{agr}$ - $Y_{ind}$</td>
<td>3</td>
<td>0.765</td>
<td>-3.48</td>
</tr>
<tr>
<td>$Q_{agr}$ - $Q_{ind}$</td>
<td>0</td>
<td>0.475</td>
<td>-4.10</td>
</tr>
<tr>
<td>$P_{agr}$ - $P_{ind}$</td>
<td>1</td>
<td>1.009</td>
<td>-2.53</td>
</tr>
<tr>
<td>$Q_{agr}$ - $P_{agr}$</td>
<td>0</td>
<td>2.603</td>
<td>-4.25</td>
</tr>
<tr>
<td>$P_{agr}$ - $Q_{ind}$</td>
<td>4</td>
<td>1.263</td>
<td>-1.53</td>
</tr>
</tbody>
</table>

*NOTE: All variables are in the log-transformation.


\(^3\)For detailed discussion about data series and their sources, and econometric techniques see Appendix A and B.
b) Causality test results

b 1) Bivariate Granger causality results

Pairwise Granger Causality Tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>Obs</th>
<th>Lags</th>
<th>F-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y_{ind} does not Granger Cause Y_{agr}</td>
<td>43</td>
<td>2</td>
<td>2.425</td>
<td>0.1021</td>
</tr>
<tr>
<td>Y_{agr} does not Granger Cause Y_{ind}</td>
<td></td>
<td></td>
<td>0.477</td>
<td>0.6243</td>
</tr>
<tr>
<td>Q_{ind} does not Granger Cause Q_{agr}</td>
<td>42</td>
<td>3</td>
<td>2.250</td>
<td>0.0997</td>
</tr>
<tr>
<td>Q_{agr} does not Granger Cause Q_{ind}</td>
<td></td>
<td></td>
<td>0.065</td>
<td>0.9783</td>
</tr>
</tbody>
</table>

NOTE: all the variables are in log-difference form.

b 2) Multivariate causality tests

A dynamic specification of the equation was estimated with three set of lags, thought reasonable, of the variables. The model, as in the estimated equation, was progressively reduced to the most parsimonious representation possible. The estimated regression equation is as follows:

b 2.1) The agricultural output level:

First we check out the direction of Granger-causality for the agricultural output level. The results is as follows:

\[ \Delta \log(Q_{agr}) = -0.04 + 0.896 \Delta \log(Q_{ind}) + 0.316 \Delta \log(P_{agr}(-1)) \]

<table>
<thead>
<tr>
<th>Wald coefficient elimination test</th>
<th>F-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>\gamma_1 = 0</td>
<td>7.766</td>
<td>0.008</td>
</tr>
<tr>
<td>\gamma_2 = 0</td>
<td>6.403</td>
<td>0.015</td>
</tr>
</tbody>
</table>

So, we find using the Wald test that the industrial output as well as lagged agricultural price significantly influence agricultural output.
b 2.2) The agricultural price level

Next, we do the testing for the agricultural price level and arrive at the following result:

\[ \Delta \log(P_{agr}) = -0.02 - 0.711 \Delta \log(Q_{agr}) - 0.71 \Delta \log(Q_{agr}(-1)) - 0.435 \Delta \log(Q_{agr}(-2)) \\
0.88 \Delta \log(Y_{ind}) + 0.163 \Delta \log(Y_{ind}(-1)) + 0.41 \Delta \log(Y_{ind}(-2)) \]

\( R^2 = 0.579, \text{ adj-R}^2 = 0.509, \text{ DW} = 1.72 \)

Note: figures in the brackets are the t-ratios. 
* indicates significance at 1 percent level.  \(^{*}\) indicates significance at 5 percent level.

The results from Wald coefficient test:

<table>
<thead>
<tr>
<th>Variables</th>
<th>F-statistic</th>
<th>prob.-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td>10.21</td>
<td>0.0000</td>
</tr>
<tr>
<td>[c(2)=c(3)=c(4)=0]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>industrial income</td>
<td>7.67</td>
<td>0.0004</td>
</tr>
<tr>
<td>[c(5)=c(6)=c(6)=0]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: All the variables are in the log-difference form.

\( c(i), i=2,3,4,5,6; \) refers to the respective coefficient of the variable to be tested.