Intersectoral Relationships Between Industrial Capital Formation and Agricultural Production: An Econometric Study

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The transformation of an agriculturally dominant economy to one having a large and increasing industrial sector is a well recognized postulate of economic development. The growth of the industrial sector may have, as its implicit corollary, the relative decline in the agricultural sector. This decline may be explained as a consequence of increased specialization in production processes which switches many non-agricultural production jobs from the farm household to urban centers of specialization, relatively lower elasticities of demand for agriculture as compared to non-agriculture commodities in an environment of rising incomes, bottlenecks of transport and the requirement of a high income agriculture of a population density lower than the existing population densities of many developing economies.

Economic development also envisages a decrease in agricultural labor force and its instantaneous transformation to non-agricultural occupations. The agricultural and non-agricultural activities in this process of transformation have extremely live linkages amongst themselves. Some of the points of interest regarding the interaction between agricultural and non-agricultural sectors are: the (1) the constituents of the labor force and their patterns undergo a definite change by a shift of labor from agricultural to non-agricultural sectors; (2) creation of non-farm jobs requires a large increase in capital in the urban areas, and agriculture is the dominant source of such capital, at least initially and (3) increased industrial output in the long run presupposes the expansion of the industrial capital base, and this output may require major consumer goods markets which may be found in the all-important agricultural sector.

The achievement of a rate of increase in agricultural productivity exceeding the current rate of increase in the demand for agricultural commodities including foodgrains will facilitate industrial development. Increasing agricultural productivity and industrial expansion have a two-way causality. Raising agricultural productivity helps to sustain the growth of the industrial sector by permitting agriculture to release part of its labor force for industrial employment while meeting the increasing food needs of the non-agricultural sector by raising agricultural incomes, which would increase the rural savings and create new purchasing power for the rural population, in the increased agricultural incomes being deployed directly or indirectly for financing industrial development and enabling agriculture to supply major wage goods (food) of industrial workers at prices favorable to the profitability of new industry.

An increase in agricultural productivity shall influence the industrial supply curve, and the simultaneous process of investment in the industrial sector need not be undermined in the process of growth. However, as the economy undergoes industrial development, it accelerates the rate of agricultural growth by increasing the demand for wage-goods of which food is all important. Industrialization also makes available to agricultural workers a wide range of consumption goods raising the over-all aggregate effective demand which will encourage greater productive effort and better agricultural production goods which directly raise the agricultural productivity per acre or per man. Agriculture seems to contribute to industry as a result of (i) changes in domestic terms of trade between agricultural and industrial sectors and/or changes in taxes, and (ii) the role of industrial raw materials from agriculture. The interactions of these contributions with technological changes in the agricultural sector and the government sector influence the industrial capital formation. The technological innovations and improvements brought about as a consequence to the industrial development will help reorganize agriculture on a more efficient, larger scale (scale depending upon institutional rigidities) and mechanized basis. These are contributors to increasing productivity. Thus, the rising agricultural productivity and industrial development are mutual benefactors in the process of economic growth.

Such dualistic models are receiving increasing attention because of the recent technological breakthroughs in agricultural production in developing countries.

The wages-goods argument implies that food contributes a high proportion of the family budgets of labor, and the labor, in turn is a major component in the cost structures of industrial production sector. This argument is partial due to the exclusion of a valid distinction between the supply of food from agriculture as a wage goods for the labor and that of raw materials for the industrial sector. Some of the limitations of the wages-goods arguments have already been investigated [1].

Flatty, the wages and salaries formed a relatively smaller proportion of the total industrial cost in some of the low-income countries. Secondly, total food expenditure comprises two-thirds of the expenditure of the industrial labor and that the industrial raw materials from agriculture such as fibers and oils constitute 50 per cent of the costs of production of industries which in turn provide over 50 per cent of the value-added in the industrial sector.

Some of the structural considerations, and sources of capital along with related aggregative relationships in the intersectoral dependences between agriculture and industry have already been investigated [2,3]. In this paper, an attempt is made to look into some of the linkages between these two major sectors in the process of development, e.g., to see empirically as to how far the changes in agricultural sector influence the changes in the industrial sector. Some of the economic aggregates like the national income, the investments both in the private and public industrial sectors and the government savings etc. may influence or be influenced by the behavior of the agricultural production. Agricultural production influences agricultural income and the national income, and the status of agricultural (or rural) income
should, therefore, be a guide to the future of industrial and manufacturing growth in the developing countries.

The industrial sector in a mixed economy comprises contributions from both private and public (government) industrial sectors. Notwithstanding the basic axiom of competition, the hypotheses under consideration underscore the relative importance of both these sectors not as two strictly separate entities but as vital parts of a single organism with rapidly multiplying interactions.

The data for the private sector for the present study are for the Indian economy covering the period 1950/51 to 1968/69, and those for the public sector to the period 1949/50 to 1969/70. These data are particularly appropriate because India has a large and diverse industrial sector (private and public) and has experienced fluctuations in agricultural production during the last two decades.

Economic Model (Private): In order to study the effect(s) that the behavior of agricultural production will have on the organized private industrial sector, the analytical framework has been set up in terms of three equations: (1) investment equation, (2) wage function and (3) price equation. The linkage of the effect(s) of agricultural production on investments has been proposed by means of wages i.e., the industrial investment, the wages of industrial workers and the prices of foodgrains are considered as three jointly determined variables of the system. The linkage would work as follows: As agricultural production falls, with the structure of demand remaining unchanged, at least in the short run, prices of industrial raw materials will rise, and so will the prices of foodgrains. Foodgrains constituting a major form of consumption of the working class will call for a higher wage. Higher wages and the prices of industrial raw materials will raise industrial costs. Increased costs will reduce profits and thus dampen the capital formation opportunities. The converse will be true if the agricultural production increased. The two of the broad approaches to the investment theory are the profit approach and the accelerator principle. Profit maximization under competition requires that the marginal physical product of capital equal the rate of interest. The accelerator theory suggests that increases in investment are not a function of income but rather of the rate of change of income. Although these are two of the variable models, the rate of interest has, somehow, been the common denominator of various theories of investment, although with varying degrees of emphasis. Traditionally, investment has been considered highly sensitive to changes in the interest rate, but some sort of skepticism of this view has, however, been developed lately and is borne out, though not conclusively, by some of the statistical investigations. Besides the interest rate, investment seems to have been affected by changes in the real income, absolute price level, and the role of expectations. The interest rate with changing price level at a given level of income will shift the marginal efficiency of investment schedule. The role of expectations, however, is random in nature.

The investment in the private industrial sector is further influenced by the availability of funds, costs of borrowing and alternative rates of return if not directly invested. Besides the bank rate, prices of securities, profitability, prices of industrial raw materials and money wages, the industrial investments would also depend on the capital stock in the previous period. The security prices (variable dividends shares) are preferred to the bank rate (even though both have similar behavior) from the points of view of the data availability and industrial production in the period and raw materials prices will influence current investment decisions whereas the converse

\[ w^m = \text{Wage rate in manufacturing sector (factory establishments)} \]

\[ N^m = \text{Employment in the manufacturing sector (factory establishments)} \]

\[ t = \text{Current time period.} \]

Industrialization involves investments in fixed capital like plant and machinery and factory buildings etc. and the working capital for payment of raw materials, wages, and other current expenses of production. Investments in factory establishments will, therefore, have a direct relationship with the labor wages and the prices of raw materials. Investment in factories will be a way to turn incomes from agricultural production into an investment for the manufacturing sector. The prices of industrial raw materials are more important cost explanatory variable. The inclusion of physical quantities of industrial raw materials in the price of raw materials would have given the total raw material bill, but, unfortunately, no such data over time for the physical inputs are available for the manufacturing industries. The investment functions would then be the following:

\[ I^m = f \left( X^m, p^m, p^w, w^m, N^m \right) \]

where

\[ I^m = \text{Investment in the organized industries} \]

\[ X^m = \text{Index of industrial production} \]

\[ p^m = \text{Index of price of industrial raw materials} \]

\[ w^m = \text{Prices of raw materials} \]

\[ p^w = \text{Prices of industrial products (manufactures)} \]

\[ p^m = \text{Prices of industrial raw materials} \]

\[ w^m = \text{Wage rate in manufacturing sector (factory establishments)} \]

\[ N^m = \text{Employment in the manufacturing sector (factory establishments)} \]

\[ t = \text{Current time period.} \]

The causation of some factors on income originating being one of the important determinants of investment, profitability will, presumably, increase, (gross profits do increase even though the rate of profitability may not), and, among, once again being strong enough, will demand profit sharing, and one of the possible forms for such profit sharing may be increased wages.

may not be true. An upward movement in money wages will affect the business confidence which would alter the volume of real investment. By changing the demand for cash balances, a change in money wages will influence the rate of interest which, in turn, will affect the investment volume. A change in wage rate will redistribute income in favor of labor if wage rate went up. The possibilities of substitution effect when money wage goes up, of substituting other factors for labor may be rather weak because of extremely low existing labor rates and consequently, the effect of income redistribution will be rather pronounced. Therefore, money wages should be a legitimate explanatory variable for investment.

The earnings of factory workers, assumed as a jointly determined variable of the system, depend on the investment in the private industries, propped by industrial output per worker, consumer price index of working class through prices of foodgrains (the third jointly determined variable), and lagged profitability per worker.

Thus, the wage function is as follows:

\[ w^T = f\left( \frac{X^T}{Y^T}, \frac{P^T}{p^T}, \frac{X^W}{p^W}, \frac{P^W}{P^W}, \frac{X^P}{P^P}, \frac{P^P}{p^P} \right) \]

where \( w^T = \) Money earning per worker
\( p^T = \) Consumer price index of the working class
\( P^T = \) Prices of foodgrains
\( X^W = \) Industrial output
\( X^P = \) Employment in factory establishments

When the rate of profitability per worker for the previous period is predetermined and the industrial productivity during the current period is known, it provides enough basis for labor unions to demand suitably adjusted wages. Of course, this entire argument applies only to rising money wages. In other words, downward movement of wages to less than subsistence level is ruled out.

The wage function is the intermediate link of the interrelationship between private investments and agricultural (foodgrains) production. The latter explains prices, the third jointly determined variable of the system. On the demand side, the prices of foodgrains depend on the per capita real income and the wage rate. On the supply side, they depend on the foodgrains production plus foodgrains imports minus exports plus changes in stocks, making adjustments for wastages, and seed and feed requirements appropriately lagged. Therefore, the lagged real availability of foodgrains, so obtained, shall be the explanatory variable for the supply side. The effect of population increase is eliminated from both the demand and the supply sides by adopting per capita income and per capita availability of foodgrains:

Thus, the price of foodgrains can be expressed as follows:

\[ p^T = f\left( \frac{X^T}{X^T}, \frac{X^W}{X^W}, \frac{X^P}{X^P}, \frac{X^P}{X^P}, \frac{X^W}{X^W}, \frac{X^P}{X^P} \right) \]

where \( X^T = \) Net availability of foodgrains
\( Y = \) Index of national income
\( P = \) Population
\( w = \) Wage rate
\( t = \) Time period

Statistical Model:
The following model is, thus, presented:

**Investment function:**

(1) \[ I^T = a_{10} + a_{11}X^T_1 + a_{12}P^T_1 + a_{13}w^T_1 + a_{14}X^W_1 + a_{15}X^P_1 + U_1 \]

**Wage function:**

(2) \[ w^T = a_{20} + a_{21}X^T_1 + a_{22}X^T_1 + a_{23}P^T_1 + U_2 \]

**Price function:**

(3) \[ p^T = a_{30} + a_{31}X^T_1 + a_{32}X^T_1 + a_{33}w^T_1 + U_3 \]

Since our attention is concentrated on a part of the aggregate economy, some of the variables of the system are assumed to be either predetermined or exogenously given. They are: \( X^T_1, \left( \frac{X^T}{X^T} \right)_t, \left( \frac{X^W}{X^W} \right)_t, \left( \frac{X^P}{X^P} \right)_t \), and \( Y^T \). Given the values of these variables, the purpose here is to estimate the values of \( I^T, w^T, p^T \), and the structural coefficients. The latter category of variables have been assumed as jointly dependent variables of the system.

**Analysis of the Statistical Model**

Each equation contains more than one endogenous variable. This along with their simultaneity will lead to statistical bias if estimated by OLS. The endogenous variables in the structural equations are not independent of the error term of the equation and each equation is overidentified. Therefore, 2SLS method has been employed. This method is based on reducing the correlation between the error term and the jointly dependent variables expressed as explanatory variables. "The idea is to 'purge' the explanatory variables of the stochastic component associated with the disturbance term." The structural form gives the interactions of the different variables within the system. To study the explicit dependence of the endogenous variables on the predetermined and exogenous variables and the error disturbances, the structural form is solved for the jointly dependent variables to get the reduced form. This is done by taking the least-squares regressions of the dependent variable simultaneously on all the predetermined and exogenously given explanatory variables of the system. The reduced form of this model is linear in parameters as well as linear in variables. This is the first stage. The second stage of the 2SLS method is to substitute computed values of the dependent variables for the observed values where the dependent variables appear in the structural equations as explanatory variables. The transformed structural equations are, again, estimated by least squares. The estimated structural coefficients have the property of consistency, although this method, like many others used for equation systems, increases multicollinearity.

The structural equations estimated by 2SLS are:

(4) \[ I^T = 143.76 + 8.46 X^T_1 + 10.90 P^T_1 + 50.05 \left( \frac{X^T}{X^T} \right)_t + 30.53 \left( \frac{X^W}{X^W} \right)_t - 19.09 \left( \frac{X^P}{X^P} \right)_t - 7.64 \left( \frac{X^T}{X^T} \right)_t - 8.92 w^T_1 - 2.83 \left( \frac{X^P}{X^P} \right)_t \]

\[ R^2 = .92 \]

(5) \[ w^T = -6.89 + 0.27 p^T_1 + 0.09 \left( \frac{X^T}{X^T} \right)_t + 0.54 \left( \frac{X^W}{X^W} \right)_t \]

\[ R^2 = .97 \]

(6) \[ p^T = 171.78 - 2.17 \left( \frac{X^T}{X^T} \right)_t - 0.37 \left( \frac{X^T}{X^T} \right)_t - 2.02 w^T_1 + 0.17 \left( \frac{X^T}{X^T} \right)_t \]

\[ R^2 = .94 \]

The signs of the estimated structural coefficients in the above equations conform, by and large, to the logical theoretical formulations. In the investment equation, the level of industrial production and the prices of variable dividend securities, both lagged by one period
have a positive correlation with the level of current investments, i.e., their upwards movements will promote higher investments. The negative coefficient of $\omega^*_{\text{W}}$ shows that as money wage rate increases, cost components also increase and profits decrease—a disincentive for further investments. The negative sign before the coefficient of $\hat{N}^*$ indicates that the money wage rate and the level of employment in the industrial sector are competitive. The signs of the coefficients of both $\omega^*_{\text{W}}$ and $\hat{N}^*$ also substantiate another fact that there is a positive correlation between the wage bill and the level of investment, since larger the wage bill, the larger the output activity and thus would be the corresponding investments. The prices of industrial products $p^*_n$ a negative coefficient, the former increasing revenues with higher prices and the latter increasing the costs. Any increase in the prices of raw materials, like the raises in money wage earnings, would add to production costs, thus reducing profits, and hence would dampen the investments. The coefficients for $\hat{X}^*_n$, $\frac{\hat{X}^*_n}{L}$, $\frac{\hat{P}^*_n}{p^*_n}$, $p^*_n$, and $\omega^*_{\text{W}}$ in the investment equation are all highly significant at the conventional level (5 per cent) of statistical significance. Beta coefficients, which measure the relative contribution of each explanatory variable in influencing the predicted value of the dependent variable, were also worked out. The various independent variables in this equation in descending order of their importance in terms of their contribution to the total variation of $p^*_n$ are $\hat{X}^*_n$, $\frac{\hat{X}^*_n}{L}$, $\frac{\hat{P}^*_n}{p^*_n}$, $\omega^*_{\text{W}}$, and $\hat{N}^*$ and explained as much as 92 per cent of the total explainable variation of investment in the private organized sector. These above conclusions corroborate an earlier result that the raw materials are more important than wages and salaries in the cost structure of Indian industries.

The coefficients of all variables $p^*_n$, $\frac{\hat{X}^*_n}{L}$ in the wage equation are all positive. An increase in industrial profits will encourage the labor class, with the help of organized labor unions, to demand higher wages. Similarly, the positive coefficients of $p^*_n$ and $\frac{\hat{X}^*_n}{L}$ imply that an increased level of prices of foodgrains and labor productivity will necessitate a demand for higher money wages by the working class. In this equation, the industrial output per worker and the prices of foodgrains are both highly statistically significant, while the lagged profits per worker are not. Their relative importance in this relationship in descending order was $\frac{\hat{X}^*_n}{L} > p^*_n > \frac{\hat{P}^*_n}{p^*_n}$ and were able to explain 97 per cent of the total variation in $\omega^*_{\text{W}}$.

The wage rate is the force on the demand side and the per capita net availability of foodgrains is the chief force on the supply side to determine the level of prices of foodgrains in the price equation. The positive correlation of $\omega^*_{\text{W}}$ and negative correlation of $\frac{\hat{X}^*_n}{L}$ lagged by one period prove these points. Availability of per capita foodgrains is the most important explanatory variable in this function. However, all the independent variables, $\frac{\hat{X}^*_n}{L}$, $\frac{\hat{P}^*_n}{p^*_n}$, and $\omega^*_{\text{W}}$ are statistically significant, and have explained about 94 per cent of the total variation of $p^*_n$.

The estimated set of relations were also treated for the presence of autocorrelation. When the assumption that the sample values of the residuals (error terms) are independently distributed is violated, error terms are said to be autocorrelated. The Durbin-Watson test revealed that the wage and the price equations have no significant autocorrelation and for the investment equation, the test was inconclusive i.e., in the latter case, the hypothesis of zero-order autocorrelation could neither be accepted nor rejected.

Multicollinearity, correlation between explanatory variables, was high in the case of some of the variables. This property seemed inherent in a timeseries data. Efforts were made to reduce it by working, as far as possible, with per capita foodgrains availability, national income and industrial production rather than with the totals.

The partial transformation elasticity coefficients of the 3 endogenous variables with respect to the predetermined or exogenous variables are presented below.

### TABLE I

<table>
<thead>
<tr>
<th>Elasticity Coefficients (at the Mean Values):</th>
<th>Industrial</th>
<th>Wage Grains</th>
<th>Foodgrains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security prices $p^*_n$</td>
<td>0.5</td>
<td>-0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Manufacturer’s prices $p^*_n$</td>
<td>0.1</td>
<td>-0.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Raw material prices $p^*_n$</td>
<td>0.3</td>
<td>-0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Employment: $\hat{N}^*$</td>
<td>1.1</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Industrial production: $\hat{X}^*_n$</td>
<td>1.4</td>
<td>0.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Wage rate: $\omega^*_{\text{W}}$</td>
<td>-1.0</td>
<td>1.7</td>
<td>-1.0</td>
</tr>
<tr>
<td>Profit: $\hat{P}^<em>_n/p^</em>_n$</td>
<td>0.1</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Interest: $\hat{P}$</td>
<td>0.5</td>
<td>-2.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The industrial production seems to influence industrial investments directly as well as through money wages. The industrial capital formation was significantly affected by the prices of manufactures. A rate of increase in these prices, resulting in larger revenues, was outweighed by the accompanying rate of increase in the volume of investments. Since we are dealing with absolute and not relative prices, the tacit assumption of "all other prices being held constant" is implied in this analysis. The prices of raw materials, as mentioned earlier, were with stronger influence as against the wage bill in the industrial cost structure; a 1% increase in the former resulted in about 1.7% increase in foodgrains’ prices (wage goods), and a 1% increase in the availability of foodgrains, however, resulted in depressing the foodgrains’ prices by more than 2%. The increased availability of foodgrains in the previous period did result in an increased capital formation via the wage rates, although true lags in these relationships were not fully explored.

**Public Industrial Sector**

Investments in the public industrial sector has a larger proportion of autonomous investments and a relatively smaller component of induced investment than in the private sector. Autonomous implies that the investment is given exogenously, and assumes that the investment and the random disturbance in independent. Nonetheless, an attempt has been made to formulate an investment function.

**Economic Model:**

The causal transitional relation originates from the changes in agricultural production, proxied by the prices of foodgrains. The ‘wage bill’ is the product of the employment level and the wage rate. The latter will be a function of foodgrains prices, foodgrains expenditures constituting a larger part of the budgets of industrial workers. Wage income includes wages and salaries other wage benefits to employees. Wage and non-wage incomes—the latter including profits, taxes, and rents, etc.—contribute the set value added (income generated) and will explain the capital stock. The investments in this sector, defined as the increment between the capital stocks at the end and the beginning of the period, will depend on the status of capital stock in the private period and the current availability of foreign exchange.
The chain of events is traced as follows:

\[ P^w = f(K^n, F, W^n) \]

\[ W^n = f(P^w, N^n, p^f) \]

where

\( W \) = wages and \( Y \) = net value added

\( F \) = foreign labor

\( K^n \) = capital stock

\( P^w \) = wages

\( N^n \) = employment

\( p^f \) = foodgrains

\( I \) = Capital formation

The superscript "\( n \)" refers to the public industrial undertakings.

**Statistical Model:**

In this system, the variables such as employment in public sector undertaking \( N^n \), foreign wages \( F \), capital stock in the previous period \( K^n \), and the foreign exchange utilized \( P^w \) are assumed to be predetermined or exogenously given. From the observed data on these variables, the values of wage income \( W^n \), the investment \( I \), and the foodgrains prices \( p^f \), assumed endogenous, have been estimated from the following equations:

**Investment equation:**

\[ I = b_0 + b_1 T + b_2 X \]

**Wage income equation:**

\[ W^w = b_0 + b_2 X + b_4 Y + b_5 X + W \]

**Price equation:**

\[ p^f = b_0 + b_5 Y + b_4 X + V_5 \]

This system of equations with 3 jointly dependent variables expressed by 3 relations

Analyses of the statistical model:

The structural equations so estimated are as follows:

\[ I = 98.54 - 3.18 K + 0.64 F + 2.06 W \]

\[ R^2 = 0.81 \]

\[ W = -214.11 + 1.96 N + 1.58 p^f + 1.12 I \]

\[ R^2 = 0.98 \]

\[ p^f = 86.56 + 0.06 Y + 0.27 W \]

\[ R^2 = 0.97 \]

The signs of the estimated coefficients in all of these equations, by and large, are in line with the theoretical formulations. In the wage-income equation, the prices of foodgrains, because of their positive relationship with money wages, and the level of employment have positive correlations with the wage bill. The foreign exchange (and the capital stock at the beginning of the period) has a direct relationship with the current investment demand. In each of the estimated equations, most of the structural coefficients are statistically significant at the 5 per cent level, and the coefficients of multiple determination were fairly high, implying that the included independent variables have explained a major portion of the total variabilities in the endogenous variables.

**Table**

<table>
<thead>
<tr>
<th>of</th>
<th>Wage</th>
<th>Foodgrains</th>
</tr>
</thead>
<tbody>
<tr>
<td>with respect to</td>
<td>( P^w )</td>
<td>( W^n )</td>
</tr>
<tr>
<td>Foreign exchange</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Capital stock</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Wage bill</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Value added</td>
<td>5.9</td>
<td>5.9</td>
</tr>
<tr>
<td>Investment</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Employment</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Investments in the public sector are fairly elastic with respect to the capital stock of the previous period, wage bill and the foreign exchange as were the prices of foodgrains significant responsive to changes in income generated.

**Conclusions:**

This analysis has shown that there are live and significant linkages between the agricultural production and the capital formation both in the public and private segments of the industrial sector in a developing economy. Agricultural production in some of the agrarian economies affects substantially the national income and is also a source of supply of industrial raw materials. A decline in agricultural production is likely to raise agricultural prices, including those of industrial raw materials. The cost of industrial production is pushed up with reduced profits, a disincentive for increasing investments. Raising the prices of industrial products, particularly the consumer goods, might have depressant effects on their demand. With food prices going up as a consequence of a decline in food production, it would tell upon the budgets of industrial workers for whom food was so important. Under these conditions, if the wages of the industrial workers were raised, this increased wage bill along with already high prices of industrial raw materials would further reduce the profits and the capital formation and may be instrumental in retarding the process of economic development. Hence, increased agricultural production is crucial to the industrial capital formation and to the growth process.

Besides, there are certain policy implications. The unusually large emphasis on production of foodgrains alone even in the initial stages of development would have to be broadened in order to increase the supply of non-foodgrains items such as milk, eggs, and vegetables, etc. as well for the consumer, and raw materials from agriculture for industrial production. As the transfer of capital—natural labor initially—takes place, the productivity of the transfers will increase along with their incomes. They will demand superior quality of foods. In the meanwhile, overall industrial output should also have increased due to the increased productivity and new production technology, the demand for raw resources for this sector will increase too. The partial elasticities do represent a certain behavior of the system during the initial years of development. They should be interpreted to reflect general guidelines rather than literal translators of the situation because the model built is in based only on a part of the information about the system.

A definite interdependence has been established between the two sectors, and more important, the intermediate linking determinant having been identified as the wage rate of the industrial worker. It may, however, be pointed out that the intention in this study has not been to establish the uniqueness of such interdependence but only to explore one of many such possibilities. Secondly, such interrelationships do involve complex lagged behavior. This has been looked into but a detailed work is deferred for further investigation.

ALBERT E. SMIGEL, FRANCISZEK KRAWIEC and STANISLAWA KRAWIEC

Introduction

Electricity is the most preferred form of energy because it is versatile in its application, clean in its use, relatively safe and readily controlled. The United States currently utilizes about 33% of its energy in the form of electricity. This is expected to increase to 54% by 1980, and to 44% by 1990.

A recent study [21] pointed out that the consumption of electricity in Pennsylvania in 1971 was more than double that of 1956 and would almost double from 1971 to 1985. It seemed worthwhile to follow up with an examination of the reasons for this vigorous growth.

The three basic objectives of the present study are:

— to characterize the manner in which changes in output occur apart from changes in the specified inputs, and
— to investigate the question of returns to scale.

The explanation of the growth of total electric power production in Pennsylvania, 1956–1971 rests on the assumptions that, in the terminology of the theory of production, if quantities of output and input are measured accurately, growth in total output is largely explained by growth in total input and that the complexities and interdependencies between them can be described by the aggregate production function.

Previous studies of similar problems have concentrated their attention on analysis of technological progress in terms of the production function and have attempted to find out how much, if any, of the decline in the input requirements is attributable to each of the following three factors: (1) economies of scale; (2) factor substitution; and (3) the shift in the production function. These studies include those of Nerlove [14], Krais [12], and Dutchmen and Kuzn [5]. However, they are concerned exclusively with the nature of the production function itself as it relates to the United States' steam electric power industry.

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