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Agriculture-Industry Inter-dependence in Bhutan

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Abstract: ***Relationship between agricultural sector and industrial sector is a debatable issue and varies between the countries. This paper is an attempt to investigate the linkage between agriculture and industry in case of Bhutan, a small and landlocked country of South Asia. Statistical technique has been applied to determine the relationship between the two sectors. A simultaneous equation model has been estimated with the data for agricultural and industrial output after formal tests of simultaneity. The test results show that agricultural sector and industrial sector are interlinked in terms of output. Implication of the interrelation is that this linkage promotes overall economic growth of Bhutan.***

Keyword: forward-linkage, identification, rank condition, simultaneity, two-stage least square

1. Introduction

Bhutan is a small, mountainous and land-locked developing country of South Asia. The economy is basically agro-pastoral economy, only 7.8 percent of land is arable due to adverse geographical conditions. Population size is also small with extremely low population density. Industrial sector consists of hydro-power industry, agro-based and forest-based industry, mineral-based industry and manufacturing industries. Agro-based industries, forest-based industries and small-scale cottage industries are closely related to agriculture. Although small, the economy is one of the fast-growing economies of the globalized world.

Agricultural sector and industrial sector are mutually interdependent despite the fact that nature of inter-dependence varies between the countries. Agriculture provides food, raw materials, labour etc. to the industrial sector, while industries provide machineries, fertilizers, pesticides etc. to agriculture sector. Savings in the agricultural sector are invested in the industrial sector.

This paper is an attempt to investigate the nature of relationship between agriculture and industry in case of Bhutan. The study is an econometric analysis based on secondary data. A simultaneous equation model has been estimated after identification and proper test for simultaneity. The results of estimated equations established the relationship between the two sectors.

2. Literature Review

Inter-sectoral linkages in an economy have been a subject-matter of serious debate in the literature of development economics. Theoretically, the early literature of agriculture-industry inter-relations was the two sector models of economic growth with surplus agricultural labour or disguised unemployment. Rosestein-Rodan (1943) in a balanced growth theory showed that agriculture and industry are inter-twined, where agriculture supplies wage goods and raw materials to the industry and industry provides market for agriculture. Hirchman (1958) in his unbalanced growth theory explained inter-relations between agriculture and industry through the so called 'forward-linkage' and 'backward-linkage'. The two-sector structural transformation models (Lewis, 1954; Ranis and Fei, 1961) of economic growth stated that transformation of surplus labour in agriculture with zero or negative marginal product to industry promotes economic growth due to capitalist reinvestment of profits in the industrial sector. Growth rates in agriculture and industry are mutually inter-dependent. If productivity in agriculture falls over time due to diminishing returns, industrial growth also becomes slacken down (Thirlwall, 1999).

Vast literature on empirical research exploring relationship between agriculture and industry is now available. In the Indian context, Rangaranjan (1982) found a strong linkage between agriculture and industry. Debnath and Roy (2012) performed a granger-causality test with the panel data for all the three sectors for the period 1981-2007 for the North-eastern states of India. They found bi-directional causality between agricultural and industrial output. In another study by Moyen Uddin (2015) with time series data from Bangladesh for the period of 1980-2013, it has been found that agriculture and industry are mutually inter-dependent for their contribution to GDP. Samir-Ul-Hassan et al. (2015) explored that industrial output increases by 4.45 percent due to 1 percent increase in total agricultural output in Jammu and Kashmir in India.

3. Data

Data have been collected for 20 years between the period 1981-2000 from the Key Indicators for Asia and the Pacific Countries (1991 and 2002) published by the Asian Development Bank (ADB). All variables have been measured in real terms. Agricultural production and industrial production series are measured on the basis of fixed prices, specifically at 1980 factor cost. In case of foreign grants and savings data, the values at current market prices have been divided by implicit GDP deflator for converting them into real variables. Due to missing of data for the foreign grants variable for the year 1987 in the above reference, it has been collected from Selected Economic Indicators (Dec. 1989) published by the Royal Monetary Authority of Bhutan, the Central Bank of the country. Although data are in fact time series data, stationarity tests have not been performed because power of the test is very low for 20 years data.

4. Methodology

Various methodologies can be used to investigate to relationship between agriculture and industry. Interrelation between agricultural output and industrial output is to be investigated with the help of an econometric model, specifically simultaneous equation model. Relationship between the variables of interest has been shown in terms of the following simple simultaneous equation system.

$$Y^1 = \alpha_0 + \alpha_1 Y_2 + X + u_1 \quad (1)$$

$$Y_2 = \beta_0 + \beta_1 Y_1 + Z + u_2 \quad (2)$$

where Y_1= agricultural production, Y_2= manufacturing production, X= foreign grants, Z= gross domestic savings, u_1 and u_2 are the two stochastic error terms. Here Y_1 and Y_2 are endogenous variables while X and Z are exogenous variables. Therefore, the model is a two equation simultaneous system.

5. Estimation

Identification Identification is important because it determines the method of estimation to be followed among all the alternative methods under simultaneous equation system. There are two types of conditions of identification-order condition and the rank condition. Order condition is necessary condition, while the rank condition is sufficient condition for identification. The order condition is satisfied for both the equations under consideration. The rank condition for identification, in a two equation system, requires that at least one of the exogenous variables excluded from the first equation must have a non-zero population coefficient in the second equation (Wooldrigde, 2009). Here, equation (1) excludes Z variable and equation (2) excludes X variables which have non-zero coefficients in equation (2) and (1) respectively. Thus the rank conditions for identification are also satisfied by these two equations. Test for Simultaneity: When there is no simultaneity in an equation system, the OLS estimators are consistent and efficient. But if there is simultaneity, OLS estimators are not consistent. In a situation of no simultaneity, if we apply simultaneous equation methods, the estimators thus obtained are consistent but not efficient (Gujarati and Sangeetha, 2007). Therefore, tests for simultaneity have been performed before estimating the equations. The test followed here is the popular Hausman's specification error test. For this test, Y1 has been regressed on all exogenous variables (X and Z) to obtain estimated Y1 ($\hat{Y}1$) and the residuals (Vt). Then Y2 has been regressed on estimated Y1 and the residuals. Since the coefficient of Vt in this regression is statistically significant with t- statistic 7.757, there is simultaneity between Y1 and Y2. The results of this regression have been shown in Table-1.

Table 1: Results of Hausman's Test

Regressors	Unstanderdized coefficients		Standardized coefficients		
	B	Std.Error	Beta	t	Sig.
Const.	-7.373	1.284		-5.74	.000
Z	0.72	0.104	0.438	6.919	.000
$\hat{Y}_1$	1.778	1.888	0.614	9.444	.000
v_t	2.019	0.26	0.328		.000

Dependent variable Y_2

6. Results

Both the equations in this model are exactly identified. In case of the exactly identified equations under simultaneous system both Indirect Least Square (ILS) and Two Stage Least Square (TSLS) methods are applicable for estimation and both methods would produce identical results. The estimation method followed here is the TSLS because it is easy to apply.

From these reduced form equations, we get estimated Y_1 (i.e.$\hat{Y}_1$) and estimated Y_2 (i.e.$\hat{Y}_2$), which are used as the regressors in the second stage of the TSLS. For applying the TSLS method, we first derive two reduced form equations from the given structural equations. The reduced form equations are:

$$Y_1 = \hat{w}_0 + \hat{w}_1 Y_2 + \hat{w}_2 X + \bar{u}_1 \quad (3)$$

$$Y_2 = \hat{w}_3 + \hat{w}_4 Y_1 + \hat{w}_5 Z + \bar{u}_2 \quad (4)$$

In the second stage, the original structural equations are estimated by replacing Y_1 and Y_2 by their estimated values obtained in the first stage regression i.e. replacing Y_1 by $\hat{Y}_1$ and Y_2 by $\hat{Y}_2$. The results of the TSLS have been shown in Table-2.

Table 2: Results of TSLS

Dependent variables	Regressors	Unstandardized coefficient		Standardized coefficient		
		B	Std. Errors	Beta	t	Sig.
Y1	Cont.	5.33	0.247		21.577	0
	X	0.206	0.118	0.268	1.741	0.1
	$\hat{Y}2$	0.253	0.058	0.67	4.355	0
Y2	Cont.	-4.517	2.605		-1.734	0.101
	Z	0.864	0.217	0.526	3.985	0.001
	$\hat{Y}1$	1.365	0.382	0.471	3.571	0.002

7. Discussions and Conclusion

For the first equation, the regression coefficient of $\hat{Y}2$ is positive (0.253) and statistically significant (t-statistic = 4.355). Therefore, industrial production in Bhutan positively affects its agricultural production. A one unit increase in industrial production increases the agricultural production by 0.253 times more. Similarly, for the second equation, the regression coefficient of $\hat{Y}1$ (1.365) is also positive and statistically significant (t-statistic=3.517). Thus, one percent increase in agricultural production raises industrial production by 1.4 percent. The results show that, for the economy of Bhutan, agricultural development and the industrial development are mutually interdependent, which promotes overall economic growth. It is also interesting to notice that the coefficient of grant variable in the first equation is positive (.206) and significant (t-statistic=1.741) at .01 level.

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