The Economic Journal of Nepal
Vol. IV No. 4 Oct-Dec. 1981 EIC-TU

Measurement of the Structural Shift in Asian and African Nations Regarding their Sectoral Growth Impact

Alok Bohara, Vijaya Thapa★

1. INTRODUCTION

In the long history of the world's economic growth, third world countries have always experienced a poor economic performance due to a variety of reasons. A major reason, among them is the lack of knowledge about setting priorities to the different sectors in the national planning. Different countries have different priorities in their planning. Some countries rely heavily on the agricultural sector while the others would focus on mining, trade, etc. In this regard, mention must be made of those nations, which, despite their different sectoral priorities, have been able to achieve remarkable economic growth. For example, the socialist countries have experienced marked economic growth by placing priority on heavy industries. On the other hand, newly industrilized countries like S. Korea, Hongkong, Singapor, etc. were able to have spectacular progress through sophisticated industries. But in most countries special attention to the development of only certain sectors not been compatible with overall economic growth; this is especially ture of oil- producing countries where over-emphasis on defence has been found to have adversely affected the overall economic growth. The focus of this study will be on the structural shift in Asian and African countries and its relationship with their economic growth.

★ Mr. Bohara is the member of Statistics Instruction Committee of Institute of Sc. and Tec. in T.U. Kirtipur.
Mr. Thapa is Assistant Research Officer in CERID/T.U.

2. OBJECTIVES

The main objective of this study is to examine the structural shift quantitatively as far as the statistical tools would permit. Besides this, the paper will try to answer the following questions:

(a) How important is the sectorwise growth in explaining the GNP growth in developing countries with special attention to Asia and Africa.

(b) Is there any significant difference between Asia and Africa regarding their sectoral growth impact on overall economic growth ?

(c) Is the sectoral growth impact of oil producing countries significantly different from the rest of the developing countries especially Asian countries.

(d) Which sector has been playing a relatively more important role in determining the GNP growth ?

3. METHODOLOGY

Methodological aspect of this study will try to adopt quantitative approach as far as posssible. It comprises the following.

3.1. Regression: Our methodology basically rests on the multiple linear regression model thereby providing the basis for further quantitative analysis. It assumes that the growth of GNP is the function of the growth of other sectors such as Mining, Agriculture, Trade, Manufacture, Construction, Electricity, Transportation, Public Administration and Defence.[1] However for computational simplicity, which is a basic problem of our research work, we have grouped these variables into four parts.

i) Agriculture
ii) Trade and Business: Mining Manufacturing, and Trade
iii) Infrastructure Build-up: Construction, Electricity and Transportation.
iv) Public Administration and Defence.

---

1. Abdul Quayum and Mohsen Attaram, 'Impact of Sectroal Growth Rate on the Growth.

To the best of our knowledge, with no definite economic justification, we have done the above categorization which should be taken with a grain of salt. This part will be the major limitation of our study. Our basic model will be

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + U$$

Where, Y = Growth rate of the GNP.

X_1 = Growth rate of the Agriculture.

X_2 = Growth rate of the Business and Trade.

X_3 = Growth rate of the Infrastructure Build-Up.

X_4 = Growth rate of the Public Administration and Defence.

U = The error term.

The routine statistics involved are t, F and R^2 .

3.2. Measurement of Structural Shift; The aim of this test is to investigate the stability of the coefficient estimates as the sample size increases. In this we want to find out whether the estimates will be different in enlarged samples and whether they remain stable in large crossectional samples.

The ratio is, [2]

$$F = \frac{\left\{ \Sigma R_p^2 - (\Sigma R_1^2 + \Sigma R_2^2) \right. \quad /m}{(\Sigma R_1^2 + \Sigma R_2^2)\ /n_1 + n_2 - 2m}$$

$$\sim F_{m_1 \quad n_1 + n_2 - 2m.}$$

2. Ratè of the GNP, 'The Economic Journal of Nepal, Vol. III, No. 1, Jan—Mar. 1980 BIC—TU. G.C, chow, 'Tests of Equality between sets of Coefficients in two Liniar Regression', Econometrica, Vol 28, 1960, pp. 591—605.

Where,

R_p^2 = Polled residual sum of squares (from comined sample)

R_1^2 = Residual sum, of squares obtained individually from first sample

R_2^2 = ,, ,, ,, ,, ,, ,, second sample

m = No. of parameters.

n_1 = Size of the first group. n_2 = Size of the second group.

However, the above test is inapplicable when both the second group, whose impact has to be measured, has observations fewer than the total parameters in the model, the modified ratio would be,

$$F^* = \frac{(\Sigma R^2_{p} - \Sigma R^2_{I}) / n_2}{\Sigma R^2_{I} / n_I - m} \qquad F_{n_2,\ n_1 - m}$$

Where,

R_p^2 = Residual sum of square from augmented sample.

R_p^2 = ,, ,, ,, ,, original sample of size n_I

n_2 = Size of the augmented sample.

3.3 Testing the Structural Shift: Using the dummies: The single regression can be used to test a variety of hypothesis using dummies. Since our study involves only two groups to compared, only one dummy would be used. The new model then become

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 D_5 + b_6 (DX_1) + b_7 (DX_2) + b_8 (DX_3) + b_9 (DX_4)$$

Where, b_5 = Differential intercept coefficient

b_6 ...... b_9 = Differential slope coefficient.

Using dummies, the purposes which may be served are as follows.

1. Two different regression models for two different groups may be deduced from the single model with dummies, by simply putting D =0 and I respectively. The digit 0 is assigned to either of the samples (base group) and I for the remaining one [3].

2. Secondly, if the structural variation between two groups is significant, as supported by the Chow test, the Dummy technique would enable you to infer which exogenous variable caused the variation.

However the use of dummies increases the no. of parameters to be estimated thereby making the study computationally difficult. For the same reason, most of the research work in Nepal has not been able to make extensive use of dummies. Another merit of this is that it does not affect the original estimation.

3.4 Test for common Variances: The poolling technique used both in the Chow test and dummy method, implicitly assumes that U^i have the common variances. The test involved, among many, is as follows.[4]

$$L = \prod_{i=I}^{G} (S_i / n_i)^{n_i/2} \; / \; (\Sigma S_i / n_i)^{\Sigma n_i / 2}$$

Where, G = No. of groups.

$$S_i = \sum_{j=I}^{n_i} (Y_{ij} - Y_j)^2,$$

3. For detailed discussion see: Damoder Gujarati, 'Use of Dummy variables in Testing for Equality Between Sets of Coefficients in Two Linear Regressions: A Note', American Statistician, Vol. 24, Nos. Iand 5, pp. 50-52 and 18-21, 1970.

4. Gold Field and Quandt, "Some Test for Homoskedasticity", Journal of American Statistics Association, Vol. 60, 1966, pp, 539-547.

$$\sum_{i=1}^{G} n_i = n$$

Then M = -2 loge (L) which is distributed as Chi-square, with G-1 degrees of freedom, under the hypothesis of common variances.

3.5 **Measurement of Individual Impact of Different Exogeneous Variables: The** Problem usually involved in the econometric analysis to evaluate the impact of different exogenous variables on the dependent variable. This is done with the help of beta coefficients obtained by multiplying the net regression coefficients by the ratio of standard deviation of the different independent variables to the standard deviation of dependent variable. By reducing the net regression coefficients to a common denominator, the betavalues enable one to say which independent factor is the most important in explaining the variation in the dependent variable. That is, higher the beta values larger the effect.

Mathematically,

$$B.C._j = \hat{b}_j \frac{S_{x_j}}{S_y} \qquad (j = 2 \ldots . m)$$

3.6 **Data**: The no. of developing countries included in the study is sixtyone, of which six are oil producers: Iraq, Iran, Quait, Libya, Nigeria and Mexico. All variables involved represent compound rates of growth over the years from 1967–1977. The data for the study have been taken from the article published in this journal.[5]

4. ANALYSIS

It has always been a great concern of the planners to know about the sector of a national economy which needs much attention. This strongly depends on many factors such as national resources, geographical setting, political system etc. In the majority of the developing countries, agriculture occupies the highest priority followed by industry and commerce, albeit the

5. Abdul Quam and Mohsen Attram, "Impact of Sectoral Growth Rate on the Growth Rate of the GNP." The Economic Journal of Nepal, Vol. III, No. I, Jan-Mar. 1980 EIC-TU.

emphasis may be different from country to country. As mentioned earlier, the different sectoral expansions have different impacts on the gross national product. Here an attempt has been made to examine these sectoral growth impacts.

The multiple linear regression run for all 61 developing countries yielded the following results.

Table 4.1. Regression results of 61 developing nations including oil-producers.

Variables	Coefficients	t.-values	Beta-Values
X_1	.3173	4.552***	.2978
X_2	.2619	3.957***	.2633
X_3	.3093	4.377***	.3076
X_4	.1454	2.357**	.1530
Intercept	- ·0031	.832	–
R^2 = .97	F = 410.24**-	d.f. = 57	

Note: *** Significant at 1% level
** Significant at 5% level

From above, the growth in agriculture sector was found to have exerted greatest impact on GNP growth, followed by business and trade sector; that is one unit increase in agriculture brought about .32 unit change is GNP growth. Their highly significant t-values also supported that the sectoral expansion had greater impact on the GNP growth. As far as the individual impact was concerned, infrastructural build-up had more important role to play, followed by agricultural trade and defence. The expansion of bureaucracy and defence had the least impact indicating that present rush the for defence spending is not friutfull for growth of GNP. Well supported by higher R^2 and F, the model seemed to fit the data well.

Now to see how different are the oil-producing countries (OPC) from the rest of the developing world, multiple regression for 55 non-oil producing (NOPC) countries was run. The six oil-producing countries, Iraq, Iran, Quawait, Libya, Nigeria. and Mexico, were excluded in this exercise

Table 4.2. Re ression results of 55 non-oil producing

Variables	Coefficients	t-values	Beta-values
X_1	.0021	.336	.0020
X_2	.3365	5.001***	.3387
X_3	.4025	5.830***	.4059
X_4	.2501	3.963***	.2682
Intercept -	.0118	2.892	-
R^2 = .91,	F= 378.13***	F^*_1 =.911[6] ,	df. = 50

Though some changes were observed in the coefficients, overall structural shift remained unchanges, indicating that the exclusion of oil-producing countries had no special role to play in explaining the variation in the dependent variable in first equation. In other words, as given by the Chow test of type first (F^*_1 = .911) no significant structural shift was felt after the exclusion of oil producing countries, further signifying that the sectoral growth impact in oil-producing countries was not different from that of the 55 non-oil producing nations. But with the exclusion of oil-producing countries the defence coefficient improved significantly signifying that the expansion of bureaucracy and defence in non-petroleum developing nations had more impact on the GNP growth as compared to oil-countries.

6. The ratio was calculated using the formula outlined in Methodology 3.1 under the assumption of no difference which was accepted due to low F_1 = .911 value and high tabulated F_{6} , 50 (.05) = 2.18.

In a view of observe a similar comparison between Asian and African nations two separate regresions were fitted. First, we considered the Asian developing countries and a regression was run for 17 of them.

Table 4.3. **Regression results of 17 Asian nations including oil producing nations**

Variables	Coefficients	t-values	Beta-Values
X_1	.0825	.3790	.0644
X_2	.6808	3.478***	.6984
X_3	.2964	1.565	.2966
X_4	-.0983	.4590	-.0721
Intercept	-.0019	.1120	–
R^2 = .91,	F = 30.71***	d.f. = 12	

The high R^2 value (=.91) indicated that 91 percent variation in dependent variable was explained by the model leaving only 9 percent unexplained. Large F value also indicated the overall significance of the parameters. In case of sectoral impact none of them had any effect except the trade and commerce which was supported by highly significant t-value and high beta coefficient. Interestingly enough, the growth of administration and defence had negative impact on the GNP growth as given= by its negative coefficient. As an interpretation we might suspect the oil-producing countries seem to be infuencing our model, because they are the ones which spend cousiderable amount of money on= defence at the cost of other sectors, finally, having negative impact on overall GNP growth rate. This may be substantiated by running another regression without oil-producing countries. The results were as follows.

Table 4.4 Regression results of 13 non-oil producing nations of Asia

Variables	Coefficients	T-values	Beta-Values
X_1	.3895	1.759	.3799
X_2	.1214	1.428	.3248
X_3	.2662	1.839**	.3146
X_4	.0235	.151	.0207
Intercept	.0031	.257	--
R^2 = .95,	F = 38***	d.f. = 8	

Even with the 13 observation 95 percent of the variation was explained by the model leaving only 5 percent unexplained, and F, value also indicated the significance of overall impact.

There was some improvement in the direction as well as magnitude of the defence coefficient providing us enough ground to infer that the negative impact of defence expansion was due to oil-producing nations. That is, heavy defence spending in oil-countries had a net negative impact on overall national economic growth. As far as the individual sectoral impact was concerned, agriculture was on the highest rank, as given by its high value of coefficient, and its corresponding beta value; and the expansion of administration and defence was found to have exerted positive impact, though nominal. The only significant variable in the model was 'infrastructural build-up' which indicated that the infrastructural exapansion accounted for the largest part of the GNP in Asian nations without oil-producers.

However, the question whether the negative sectoral growth impact was due to oil-producing countries was proved by an empirical test. This was done by calculating F_2 [7] ratio

7. The ratio was calculated by using the formula outlined in methodology 3.2 under the assumption of no difference which was rejected due to high F_2 = 6.493 calculated value and low tabulated $F_{4,12}$ (.05) = 3.26.

which came out to be as high as 6.93 enabling us to reject the hypothesis of no difference. In other words. Whatever results found in the first regression (including oil-producers) were due to oil-producing nations since those changes in the second regression (without oil-producer) were significent as given by the F ratio.

Similarly, a separate regression for 24 African nations was run and the results were as follows.

Table 4.5 **Regression results of 24 African nations including oil-producers**

Variables	Coefficients	T-Values	Beta-Values
X_1	.3787	5.166***	.3659
X_2	.1596	1.889**	.1950
X_3	.2715	3.695***	.2959
X_4	.2643	3.298***	.3054
Intercept	-.0072	-	-
R^2 = .91	F = 71.76***	,d.f. = 19	

The high R^2 value indicated that the model fitted was excellent as it was able to expalin 91 percent of the variation and overall impact of parameters was also highly significant. Here also the agriculture was found to be most important sector in bringing about the major changes in GNP growth, as supported by its highly significant t and beta values followed by infrastructural build-up, administrations and defence, and finally trade and business.

In order to compare the Asian (17) and African (24) nations-including OPC[8] regarding their sectoral impact we ran another regression pooling both the Asian and African countries.

8. OPC = oil producing countries.

However, the pooling would be valid only if the assumption of common variance were satisfied. For this, the test given by Quandt and Gold Field was applied. The procedure was to calculate the X^2 [9] and compare it with the tabulated X^2 for desired level of significance and with one degree of freedom (since we have only two groups). The calculated X^2 [10] was as low as 1.275 enabling us to accept the assumption of common variance at given 5 percent level of significance.

Since the pooling of two samples (Asia and Africa) was justified by the above test procedure are went ahead with our regression analysis. The following were the results

Table 4.6. **Regression results of pooled sample (41) including OPC**

Variables	Coefficients	t-Values	Beta-Values
X_1	.4017	4.574***	3.462
X_2	.3195	3.685***	.3442
X_3	.2548	3.028***	.2633
X_4	.1445	1.661	.1358
Intercept	-.0128	–	–
R^2 = .89,	F = 73.04,***	d.f. = 36	

Necessary test statistics like R^2, F and t values were satisfactory offering us enough ground to accept the results being given by the regression. As usual the agriculture sector occupied the highest rank in explaining the variation in the GNP growth, followed by business

9. Calculation is based on the formula given in methodology 3.4.

10. X^2 1, (.05) = 3.84.

and trade, infrastructural build-up and defence. Again expansion of bureacecracy and defence was found to have insignificant impact. To compare the overall structural impact between to continents three separate residual sums of squares (two for each individual group and one for pooled one) need-d for the chow test were calculated. As given by the high $F_2^* = 2.28$[11] marked difference regarding sectoral growth impact was observed between two groups.

Now in order to see whether the above difference was due to different sectoral growth impact of OPC we ran another set of regression excludingOPC-1 from Africa and 4 from Asia. The total number of countries included was 36. The results were as follows.

Table 4.7 Regression results of 36 Asian and African NOPC

Variables	Coefficients	t-values	Beta-Coefficients
X_1	.3823	5.231***	.3746
X_2	.2712	3.845***	.3096
X_3	.2105	3.196***	.2407
X_4	.1807	2.0100**	.1881
Intercept	-.0066	.639	--
R^2 = .93,	F $\overset{***}{=}$96.76	d.f. = 31	

The model had an excellent fit with good values of all necessary test statistics In this case also agriculture occupied the highest rank with bureaucracy expansion having the least impact as usual. Interestingly, as given by the low F_2^*[12] ratio = .36, no significant difference was observed when the OPC were encluded. Hence whatever significant structural shift was

11. $F_2^* = 2.28$, $F_{17, 19}$ (.05) = 2.16.

12. $F_{5, 26}(.05) = 2.6$

found in the earlier comparison (including oil producess) they were due to OPC. Hence we conclude t at NOPC of Asian and Africa are alike with respect to their sectoral growth impact.

4 1 Measurement of Structural Shift using Dummies

In the preceding analysis the test statistic given by Chow provided ample evidence that the two continents–Asia and Africa–had similar sectoral growth impact (excluding OPC). For this we combined two continents. Here an attempt has been made to compare these two continents using only one regression. For this both the samples were pooled, and intercept and slope dummies were incorporated in the model. Thus the parameters to be estimated increased from five to ten. However the common variance property of the two groups was an initial condition for polling, this was substantiated by using the test statistic outlined in the methodology 3.4. The calculated value of X^2 was low enough to allow us to accept the assumption of common variance. The computer print out of the pooled regression was as follows.

Table 4.1.1. Regression results of pooled sample excluding OPC

Variables	Coefficients		t-values
X_1	.37		2.39**
X_2	.35		3.31***
X_3	.36		2.24**
X_4	-.02		-.08
D	.02		.11
DX_1	.04		.46
DX_3	-.15		.78
DX_4	.15		.69
Intercept	-.00		
R^2 = .90	R^{-2} = .87	F = 32,***	d.f. = 31

Where D = 0 for Asian non-oil producing nations (NOPC).
= 1 for African non-oil producing nation (NOPC).

As in the earlier analysis, the agriculture coefficient had the highest impact in the countries of Asia and Africa (combined together); while the burearecracy and defence had negative impact on the there GNP growth rate. The high R^2 and F values indicated the excellent fitting of the large model.

The insignificant t–value of the differential intercept coefficient supported the hypothesis that the Asian non–oil producing countries do not differ from their counterpart African countries regarding sectoral growth impact on GNP growth. This was supported by the Chow test also. All the insignificant differential slope coefficients also supported the above hypothesis of no–difference.

Now, using the above single equation the two different equations, each for Asia and Africa, may be derived by simply putting D = 0, and 1 respectively.

D = 0, the estimated equation for Asian non–oil producing countries is as follows.

Table 4.1.2. **Regression results of NOPC of Asia derived from dummy–equations**

Variables	Coefficients
X_1	.37
X_2	.35
X_3	.36
X_4	.02
Intercept –	.00

As compared to earlier separate estimated equation of NOPC of Asian, the above results were closer; as in both the cases agriculture occupied the highest rank, with defence the least. The coefficients were also similar.

Similarly, the estimated line for African nations (NOPC) was derived by putting D = 1.

Table 4.1.3 **Regression results of NOPC of Africa derived from dummy equation**

Variables	Coefficients
X_1	.39
X_2	.39
X_3	.21
X_4	.13
Intercept	-.01

Here also, highest impact was that of agriculture with defence having the least.

5. MAJOR FINDINGS AND CONCLUSIONS

On the basis of above analysis some major findings obtained are outlined as follows.-

[a] On average, agriculture sector accounted for largest part of the GNP growth in Asia, Africa and also in all developing nations.

[b] Expansion of bureancracy and defence had always insignificantly least impact on GNP growth, and sometimes even negative especially in Asia when oil-producers were included in the model. Thus excessive defence spendings in GULF Countries had a negative impact on GNP growth of those nations.

[c] The sectoral growth impact of Asian oil-producing countries was significantly different from that of other 13 non-oil producing Asian nations.

[d] No significant difference was observed between Asia and Africa (with NOPC) regarding the structural shift.

[e] When Asian oil-producing countries where included in the analysis marked difference was observed.

[f] Dummy technique also proved that the non-oil-producing countries of Asia and Africa had similar sectoral growth impact, as given by the pooled-models insignificant differential intercept coefficient.

[g] Two separate regression lines, each for Asia and Africa, derived from the single dummy equation also placed agriculture at the highest rank with defence and administration expansion at the lowest.

Data: Growth Rates of GNP and other sectors

AFRICA	X1	X2	X3	X4	Y
Algeria	.097	.009	.111	.077	.068
Central Afrecan Republic	.067	.026	.078	.131	.052
Republic of Congo	.142	.100	.188	.081	.094
Ethiopia	.091	.050	.100	.076	.064
Gabon	.071	.034	.139	.140	.113
Gambia	.034	.074	.070	.041	.071
Chana	.101	.118	.100	.110	.103
Ivory Coast	.141	.076	.107	.118	.114
Kenya	.110	.067	.081	.086	.083
Liberia	.075	.022	.100	.052	.060
Mauritania	.059	.027	.174	.150	.080
Mauritius	.080	.104	.076	.071	,082
Nigeria	.173	.070	.220	.133	.119
Rhodesia	.081	.059	.084	.053	.073
Rwanda	.163	.095	.191	.116	.146
Senegal	.033	.072	.095	.086	.058
Sudan	.104	.020	.127	.031	.052
Switzarland	.059	.130	.134	.197	.125
Tanzania	.093	.054	.082	.126	.084
Togo	.071	.064	.141	.117	.092
Tunisia	.094	.074	.133	.110	.093
Uganda	.059	.084	.096	.063	.083
Zaire	.267	.195	.296	.241	.268
Zambia	.128	.050	.119	.110	.080

Asia	X1	X2	X3	X4	Y
Bangladesh	.100	.078	.129	.138	.086
Cambodia	.060	.019	.000	.058	.036
Republic of China	.135	.076	.136	.164	.139
Cyprus	.110	.063	.082	.096	.090
Figi	.176	.045	.091	.145	.094
India	.117	.088	.096	.125	.094
Indonesia	.123	.113	.126	.125	.109
Iran	.165	.076	.179	.136	.151
Iraq	.117	.095	.100	.105	.094
Republic of Koria	.213	.226	.276	.307	.260
Kuwait	.093	.137	.152	.101	.161
Libyan Arab Republic	.182	.131	.244	.236	.265
Malaysia	.081	.049	.087	.098	.071
Pakistan	.200	.077	.125	.147	.098
Philippines	.123	.144	.161	.105	.139
Sri Lanka	.069	.053	.093	.075	.064
Thailand	.096	.086	.148	.062	.107
Europe					
Greece	.120	.103	.133	.136	.120
Portugal	.116	.062	.107	.117	.104
Spain	.154	.090	.135	.153	.144

Latin America	X1	X2	X3	X4	Y
Bolivia	.155	.100	.128	.146	.125
Brazil	.465	.434	.461	.472	.462
Chile	.639	.525	.581	.589	.588
Colombia	.210	.171	.162	.208	.184
Ecnador	.134	.077	.161	.141	.131
El Salvador	.064	.053	.064	.071	.065
Guatemala	.035	.052	.046	.080	.058
Nicaragua	.039	.062	.062	.091	.064
Panama	.098	.073	.117	.118	.109
Paregua	.097	.107	.111	.127	.104
Peru	.067	.016	.061	.080	.055
Sierra Leone	.063	.037	.065	.100	.106
North America					
Domonican Rep.	.076	.075	.109	.133	.098
Honduras	.067	.073	.098	.103	.078
Jamaica	.176	.070	.107	.105	.102
Mexico	.149	.079	.108	.127	.115
Trinidad Tebago	.128	.012	.019	.121	.082