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# EFFECTS OF MACROECONOMIC VARIABLES ON GROSS DOMESTIC PRODUCT IN BANGLADESH

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**ABSTRACT**

*The Gross Domestic Product (GDP), chief indicator of an economy, shows that for a long time, Bangladesh economy was backward. The years after independence, the size of Real GDP, Per Capita GDP and their growth rates was small but improved from 1990.In this study the GDP of the 64 districts in Bangladesh at current market prices are considered. The factors which have effects on the gross district product in the year 2009-2010 are measured here. Here Principal Component analysis and Maximum Likelihood method of factor analysis are used for the seventeen variables of the gross district products of 64 districts. The results show that seventeen variables contributing to our GDP have been classified into three factors. Then we rename these three factors from principal component analysis as service factor, agriculture & infrastructure factor, and fishing & mining factor. In maximum likelihood method we rename the factors as service factor, agriculture & infrastructure factor, and education factor. At last we compare the factor scores as district-wise for the three factors to reflect their significance. The study finds a clear shift of contribution by the macroeconomic variables to the GDP of Bangladesh from agriculture to 'non-agriculture' sectors.*

**KEYWORDS**

GDP, Factor Analysis, Factor Loading, Types of Factoring and Naming the Factors.

## INTRODUCTION

The economy of Bangladesh has experienced significant shifts in trade, fiscal, industrial, agricultural and financial policies over last two decade. Yet, still the growth trend and the structural changes of GDP in Bangladesh are not satisfactory. Many problems are responsible for this unsatisfactory GDP: the shortage of domestic food production, narrow structure of exports, increasing growth rate of imports, failure in the invocation of much Foreign Direct Investment (FDI), a defective banking system with cumulative interest of loans, continuous loss in the public enterprises, poor infrastructure, inefficient taxation, high inflation rate, political instability and the serious deterioration of law and order situation. Its progress can be gleaned from the country's Real Gross Domestic Product (RGDP) growth of 5 percent on average for the period 1990 to 1998 and 4.6 percent for the period 1980 to 1990. The growth rate of Real Gross Domestic Product was above 6 percent on average and in 2009 it was just above 5.5 percent. All over the world (Bangladesh inclusive) GDP has been area of interest to both policy-makers and economists. In past, Bangladesh has received annually the equivalent of close to 6% of GDP in foreign assistance, although this figure has declined to around 4% in recent years. Bangladesh is significantly dependent on external resources and at the behest of the World Bank and the IMF, Bangladesh adopted a set of the short and medium-term economic management. External factors such as export, import, remittances and foreign aid have always played important roles to Bangladesh's economy, though the relative importance of various external factors has changed over time. The economy of Bangladesh has grown 5-6 per cent per year since 1996 despite inefficient government-controlled enterprises, delays in exploiting natural gas resources, insufficient power supplies, and delayed implementation of economic reform. Bangladesh remains a poor, overpopulated, and inefficiently-governed country. Although more than half of Gross Domestic Product (GDP) is generated through the service sector, nearly two-thirds of Bangladeshis are employed in the Agriculture, fisheries and farming sector, with rice as the single-most-important product. Garment exports and remittance inflows from Bangladeshis working overseas, mainly in the Middle East and East Asia, fuel growth of the economy. The economy of Bangladesh has experienced an average of 4% plus growth per annum throughout the 1990s. Even during the year of devastating floods (FY1999), the economy grew by 4.9%. Average GDP growth in the 1990s (FY1991-2000) was 4.78%, which was one percentage point higher than that of the previous decade (i.e. 3.74% in FY1981-90). The second half of the 1990s demonstrated a more impressive growth performance (5.29%, FY1996-2000) in comparison to the first half (4.49% for FY1991-95). According to the revised estimates, GDP growth rate in FY2001 was 5.16%. The experience of the 1990s has given rise to the hope that the real GDP growth in the coming years will be higher than what has already been achieved. The real GDP growth in FY2004 and FY2005 were expected to be 6.0% and 6.3%, respectively. In view of the importance of GDP and its vital role in the economic growth of a country, especially in developing countries, a number of studies have been carried out. Shamsuddin A. F. M. (1994) found that the market size of the host country as measured by per capita GDP is found to be the most important factor in attracting foreign direct investment (FDI) for 36 less developed countries for the year 1983.Banerjee A. and Marcellino M. (2002) evaluated the relative merits of two approaches to information extraction from a large data set for forecasting, namely, the use of an automated model selection procedure versus the adoption of a factor model. Hossain S. and Cheng M. (2002) in this study, a standard regression model is used to identify factors that significantly contribute to economic growth in Bangladesh. The result indicates that with the increased in import, the GDP will decline further. As a matter of fact, more than 60 percent of the imported items are for consumption purposes which are not likely to contribute much to GDP growth. Lin J. Y. and Li Y. (2002) reexamined that the previous studies under estimate the contribution of export to GDP growth of China by overlooking the indirect impacts of exports on domestic consumption, investment, government expenditures and imports and proposed a new estimation method and as well as found that a ten percent increase in exports resulted in a one percent increase in GDP in the 1990s in China, when both direct and indirect contributions are considered. Andersen T.M. and Herbertsson T. T. (2003) used the multivariate technique of factor analysis to combine several indicators of economic integration and international transactions into a single measure or index of globalization. Gallo J. L. (2004) studied the evolution of GDP disparities among 138 European regions over the period from 1980 to 1995. The results of the analysis indicate the persistence of regional disparities, a progressive bias toward a poverty trap, and the importance of geography in the convergence process. Shelley G. L. and Wallace F. H. (2004) examined the relation between inflation, M1 money, and real GDP in Mexico using annual data from 1944 to 1991. Predictable increases in differenced inflation are found to have a significant, negative effect on real GDP growth. Unpredictable increases in differenced inflation are found to have a significant, positive effect on real GDP growth. Schneider M. and Spitzer M. (2004) utilized a generalized dynamic factor model to produce short-term forecasts of real Austrian GDP. Also, the forecasting performance of the model with a large data set of 143 variables has been assessed relative to simple univariate time-series forecasts. Craigwell R. and Maurin A. (2005) established and characterized a reference cycle and concluded that the cycles of tourism and wholesale and

retail closely resembles that of the aggregate business cycle, while the non-sugar agriculture and fishing cycle is counter acyclical for Barbados. Lise W. And Montfort K.V. (2005) tried to unfold the linkage between energy consumption and GDP by undertaking a co-integration analysis for Turkey with annual data over the period 1970–2003.In addition, they found evidence of a decoupling of energy consumption and economic growth in Turkey towards the end of the studied period 1970–2003.Schumacher C. (2005) studied the forecasting performance of alternative factor models based on a large panel of quarterly time series for the German economy and showed that the application of the dynamic factor models seems to provide only small forecasting improvements over the static factor model for forecasting German GDP. Troy Matheson T. (2005) focused on forecasting four key New Zealand macroeconomic variables using a dynamic factor model and a large number of predictors and found that the factor model performs particularly well at longer horizons. Raheem S.M.E et al (2006) analyzed Bangladesh's gross domestic product (GDP) data for the year 1999-2000 using factor analysis model to find out the contributing factors that affect GDP. The analysis has revealed two distinct factors-- 'non-agricultural' and 'agriculture and livestock' that are contributing to Bangladesh's GDP. Islam, T. S. et. al (2007) used the multivariate causality analysis to examine relationship between education and growth in Bangladesh using annual time series data from 1976 to 2003. The empirical results show evidence of bidirectional causality between education and growth in Bangladesh. Reininger M.T. and Fingerlos M.U. (2007) applied the econometric theory of seasonality to explain the seasonal characteristics of quarterly Belgian real GDP level time series from 1980 Q1 to 2006 Q4 by fitting a univariate model. Drăcea R. et.al (2008) have applied the methods concerning the analysis between the GDP and real tax systems within the two States: Turkey and Romania. The conclusion indicates the existence of a correlation between the real GDP and the real tax incomes, strongly manifested in Turkey as compared to Romania. Schumacher C. and Breitung J. (2008) discussed a factor model for short-term forecasting of GDP growth using a large number of monthly and quarterly time series in real-time and the factors were estimated by applying an EM algorithm, combined with a principal components estimator and proposed alternative methods for forecasting quarterly GDP with monthly factors .Ahmed H. A. and Uddin G. S. (2009) investigated the causal nexus between export, import, remittance and GDP growth for Bangladesh using annual data from 1976 to 2005. Study finds limited support in favor of export-led growth hypothesis for Bangladesh as exports, imports and remittance cause GDP growth only in the short run. Daga, et. Al (2009) examined and forecasted the trend of GDP during pre and post reform periods and tracks GDP movement for India. The sector comprising Trade, Transport, Storage and Communication were found to contribute the maximum and the sector comprising Financing, Insurance, Real Estate and Business Services were found to contribute the minimum to the GDP trend under study. Mitchell J. et. al (2009) derived monthly and quarterly series of UK GDP for the inter-war period and illustrated how the new data can contribute to the understanding of the economic history of the UK in the 1930s and have also used the series to draw comparisons between recession profiles in the 1930s and the post-war period.

Bangladesh experienced an accelerated pace of global integration of her economy in the 1990s. Economic reforms gained momentum in the 1990s and successive governments pursued an export-led growth strategy. In addition, Bangladesh was able to get increased market access with reduced tariff rates provided by some developed countries to export her commodities. Volume of foreign direct investment (FDI) gradually increased in the 1990s, and participation of Bangladeshi workers in the global labour market also increased, which resulted in increased remittances to the country. Thus, the 1990s was a decade of transition from *aid dependence* to *trade orientation* and enhanced integration of local economy with the global economy. The BBS compiled Gross Regional Domestic Product (GRDP) of twenty former regions (districts) at current and constant (1984-85) prices since 1979-80 to 1997-98. GRDP was estimated by eleven activity sectors. Recently GDP is rebased at 1995-96 prices and it includes 15 activity sectors. After the revision it is decided to estimate gross regional product and gross district product by 17 sectors both at current and constant (1995-96) prices. Due to some constraints, gross district product is estimated by disaggregating the country gross value added down to the regional and district level using certain ratios derived from case studies, survey findings population and housing census, agriculture census and various administrative records. The factors which have effect on the gross district product of the 64 districts from fiscal year 2007 to 2008 are seen in this study. The factor score for each division for the study period is also obtained here. The comparison based on factor scores between the districts for the factors for the given period is also obtained here. For the estimation of the factors, the constant prices of the gross district product of the 64 districts in Bangladesh are considered here, which includes all the activity sectors.

## DATA AND METHODOLOGY

The data used in this study were collected from "Statistical Year Book of Bangladesh (2010)" published by Bangladesh Bureau of Statistics (BBS).By summing over the districts we find the GDP of our country. The central bank has declared 17 variables or sectors as vital in GDP of Bangladesh. The factors, having effect on the GDP as well as the comparisons between the 64 districts in our country on the basis of different factors of GDP for the given period have also been studied in this paper. For the purpose of estimation of gross domestic product, it includes 17 sectors:

i. Crop and horticulture
ii. Animal farming
iii. Forestry and related services
iv. Fishing
v. Mining and quarrying
vi. Manufacturing
vii. Electricity, gas and water supply
viii. Construction
ix. Wholesale and retail trade
x. Hotel and restaurants
xi. Transport, storage and communication
xii. Financial intermediation
xiii. Real estate renting and business services
xiv. Public administration and defense
xv. Education
xvi. Health and social work
xvii. Community, social and personal services

## THE ORTHOGONAL FACTOR MODEL

The observable random vector $\mathbf{X}$, with *p* components, has mean $\mu$ and covariance matrix $\Sigma$. The factor model postulates that $\mathbf{X}$ is linearly dependent upon a few unobservable random variables $F_1, F_2, \cdots\cdots, F_m$, called *common factors*, and *p* additional sources of variation $\varepsilon_1, \varepsilon_2, \cdots\cdots, \varepsilon_p$, called *error* or sometimes *specific factors*. In particular, the factor analysis model is

$$
\begin{aligned}
X_1 - \mu_1 &= l_{11}F_1 + l_{12}F_2 + \cdots\cdots + l_{1m}F_m + \varepsilon_1 \\
X_2 - \mu_2 &= l_{21}F_1 + l_{22}F_2 + \cdots\cdots + l_{2m}F_m + \varepsilon_2 \\
&\vdots \\
X_p - \mu_p &= l_{p1}F_1 + l_{p2}F_2 + \cdots\cdots + l_{pm}F_m + \varepsilon_p
\end{aligned}
\qquad (1)
$$

or, in matrix notation,

$$\underset{(p\times 1)}{\mathbf{X}} - \boldsymbol{\mu} = + \underset{(p\times m)}{\mathbf{L}} \quad \underset{(m\times 1)}{\mathbf{F}} + \underset{(p\times 1)}{\boldsymbol{\varepsilon}} \tag{2}$$

*Where,* $\mu_i$ = *mean* of variable *i*

$\varepsilon_i$ = *i* th *specific factor*

$F_j$ = *j* th *common factor*

$l_{ij}$ = *loading* of the *i* th variable on the *j*th factor

We assume that, $E(\mathbf{F}) = \underset{(m\times 1)}{\mathbf{0}}$, $Cov(\mathbf{F}) = E(\mathbf{F}\mathbf{F}') = \underset{(m\times m)}{\mathbf{I}}$

$$Cov(\boldsymbol{\varepsilon}) = E(\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}') = \underset{(p\times p)}{\boldsymbol{\psi}} = \begin{bmatrix} \psi_1 & 0 & \cdots & 0 \\ 0 & \psi_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \psi_p \end{bmatrix} \tag{3}$$

$E(\boldsymbol{\varepsilon}) = \underset{(p\times 1)}{\mathbf{0}}$,

and that $\mathbf{F}$ and $\boldsymbol{\varepsilon}$ are independent so, $Cov(\boldsymbol{\varepsilon}, \mathbf{F}) = E(\boldsymbol{\varepsilon}\mathbf{F}) = \underset{(p\times m)}{\mathbf{0}}$

These assumptions and the relation in (2) constitute the *orthogonal factor model.*

## ANALYSIS AND DISCUSSION

From the GDP data on seventeen variables in 64 districts for the year 2009-10, let the variables are defined as:

$X_1$ = Crop and Horticulture
$X_2$ = Animal Farming
$X_3$ = Forestry and related services
$X_4$ = Fishing
$X_5$ = Mining and Quarrying
$X_6$ = Manufacturing
$X_7$ = Electricity, Gas and Water Supply
$X_8$ = Construction
$X_9$ = Wholesale and Retail trade
$X_{10}$ = Hotel and Restaurants
$X_{11}$ = Transport, Storage and Communication
$X_{12}$ = Financial Intermediation
$X_{13}$ = Real state renting and Business service
$X_{14}$ = Public administration and Defense
$X_{15}$ = Education
$X_{16}$ = Health and Social work
$X_{17}$ = Community, Social and Personal services

From our data set, the calculated correlation matrix of 17 variables from gross district product is given as follows:

$$\mathbf{R} = \begin{array}{l} \textit{Crop} \\ \textit{Animal} \\ \textit{Forestry} \\ \textit{Fishing} \\ \textit{Mining} \\ \textit{Manufacturing} \\ \textit{Electricity} \\ \textit{Construction} \\ \textit{Wholesale\&Retail} \\ \textit{Hotel} \\ \textit{Transport} \\ \textit{Financial} \\ \textit{Realstate} \\ \textit{PublicAdmin} \\ \textit{Education} \\ \textit{Health\&Social} \\ \textit{Community} \end{array} \begin{bmatrix} 1 & & & & & & & & & & & & & & & & \\ .36 & 1 & & & & & & & & & & & & & & & \\ .16 & .39 & 1 & & & & & & & & & & & & & & \\ .14 & .48 & .18 & 1 & & & & & & & & & & & & & \\ .08 & .26 & .18 & .27 & 1 & & & & & & & & & & & & \\ -.11 & -.15 & -.07 & -.01 & .01 & 1 & & & & & & & & & & & \\ -.02 & .04 & .01 & .06 & .05 & .82 & 1 & & & & & & & & & & \\ .08 & .36 & .12 & .16 & .05 & .31 & .42 & 1 & & & & & & & & & \\ .01 & .07 & -.01 & .15 & .07 & .77 & .83 & .38 & 1 & & & & & & & & \\ -.05 & -.01 & -.04 & .14 & .08 & .90 & .92 & .40 & .85 & 1 & & & & & & & \\ -.02 & .05 & -.01 & .16 & .08 & .84 & .95 & .44 & .86 & .98 & 1 & & & & & & \\ -.01 & .05 & .01 & .11 & .07 & .83 & .97 & .47 & .82 & .95 & .97 & 1 & & & & & \\ .04 & .19 & .07 & .22 & .10 & .81 & .93 & .48 & .86 & .95 & .98 & .95 & 1 & & & & \\ -.05 & -.05 & -.04 & .05 & .02 & .84 & .98 & .40 & .82 & .95 & .97 & .98 & .93 & 1 & & & \\ .08 & .37 & .16 & .29 & .11 & .75 & .56 & .34 & .53 & .64 & .58 & .60 & .63 & .54 & 1 & & \\ .11 & .35 & .12 & .34 & .18 & .74 & .89 & .52 & .83 & .90 & .94 & .91 & .97 & .87 & .68 & 1 & \\ .21 & .60 & .23 & .53 & .26 & .49 & .65 & .50 & .65 & .69 & .74 & .70 & .81 & .62 & .63 & .89 & 1 \end{bmatrix}$$

The eigen values and factor analysis models for the gross district product data are discussed in the following table:

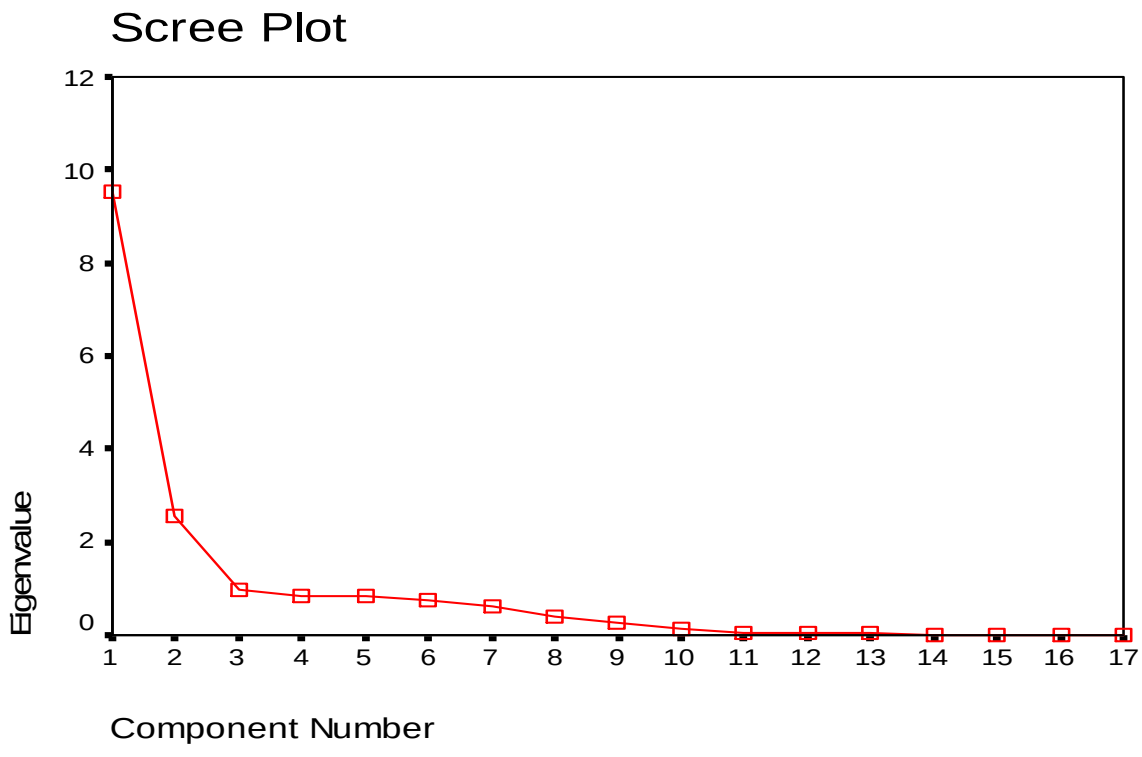
**TABLE-01: INITIAL EIGEN VALUES, % OF VARIANCE, AND CUMULATIVE % OF VARIANCE**

| Component | Initial Eigen values | | |
|---|---|---|---|
| | | % of Variance | Cumulative % |
| 1 | 9.525 | 56.031 | 56.031 |
| 2 | 2.561 | 15.064 | 71.095 |
| 3 | .977 | 5.746 | 76.841 |
| 4 | .839 | 4.933 | 81.774 |
| 5 | .828 | 4.869 | 86.642 |
| 6 | .740 | 4.352 | 90.994 |
| 7 | .604 | 3.555 | 94.549 |
| 8 | .395 | 2.325 | 96.874 |
| 9 | .246 | 1.447 | 98.321 |
| 10 | .141 | .831 | 99.152 |
| 11 | .053 | .311 | 99.463 |
| 12 | .034 | .200 | 99.663 |
| 13 | .026 | .154 | 99.816 |
| 14 | .012 | .071 | 99.888 |
| 15 | .009 | .052 | 99.940 |
| 16 | .008 | .049 | 99.989 |
| 17 | .002 | .011 | 100.000 |

The first factor has an eigen value of 9.525. Since this is greater than 1, it explains more variance than a single variable. The percent of variance explained $= (9.525/17 \text{ units of variance}) \times 100 = 56.01\%$ .The second factor has an eigen value of 2.561. Since this is greater than 1, it explains more variance than a single variable. The percent of variance explained $= (2.516/17 \text{ units of variance}) \times 100 = 14.8$ % .The third factor has an eigen value of 0.977. Since this is close to 1, it may explain variance of a single variable. The percent of variance explained $= (0.977/17 \text{ units of variance}) \times 100 = 5.75\%$ .

14 factors among 17 variables have eigen values less than 1, and therefore explain less variance that a single variable. We have found two eigen values greater than unity here and one is close to unity. Since first three factors express almost 77% of the total variance, we will consider the three factors model.

**FIGURE-01: SCREE PLOT**




From the scree plot we observe that, the first two eigen values are above 1 and the third value is 0.977 which is very close to 1. So we consider 3 factors model for our analysis.

## RESULTS OF PRINCIPAL COMPONENT METHOD WITH VARIMAX ROTATION

The results of principal component method with Varimax rotation are given below:

**TABLE-02: RESULTS OF PRINCIPAL COMPONENT METHOD WITH VARIMAX ROTATION**

| Variables | Three - factor solution | | | | | | |
|---|---|---|---|---|---|---|---|
| | Estimated factor loadings | | | Estimated rotated factor loadings | | | Communality |
| | $F_1$ | $F_2$ | $F_3$ | $F_1^*$ | $F_2^*$ | $F_3^*$ | $\hat{h}_i^2$ |
| crops & horticulture | .033 | .478 | -.551 | -.051 | .714 | -.142 | .533 |
| forestry & related services | .195 | .872 | -.133 | .026 | .786 | .445 | .816 |
| animal farming | .064 | .545 | -.041 | -.041 | .457 | .303 | .303 |
| fishing sector | .239 | .647 | .311 | .106 | .344 | .666 | .572 |
| mining & quarrying | .126 | .430 | .669 | .031 | -.061 | .803 | .649 |
| manufacturing sector | .855 | -.318 | .063 | .899 | -.164 | -.031 | .836 |
| electric, gas and water supply | .943 | -.190 | -.034 | .962 | .008 | -.019 | .926 |
| construction | .515 | .259 | -.313 | .461 | .466 | -.024 | .430 |
| wholesale & retail trade | .876 | -.114 | .008 | .881 | .031 | .051 | .781 |
| hotel & restaurants | .963 | -.190 | .056 | .981 | -.044 | .055 | .967 |
| transport, storage & Communication | .976 | -.140 | .015 | .984 | .021 | .054 | .973 |
| financial intermediation | .963 | -.151 | -.031 | .974 | .038 | .010 | .951 |
| real state renting & business service | .983 | -.009 | -.020 | .967 | .145 | .106 | .967 |
| public administration & defense sector | .940 | -.259 | -.022 | .973 | -.053 | -.052 | .952 |
| Education sector | .707 | .218 | .026 | .651 | .254 | .243 | .548 |
| health and social work sector | .972 | .166 | -.006 | .922 | .271 | .221 | .973 |
| community, social & personal service sector | .808 | .483 | .012 | .700 | .482 | .405 | .886 |
| Cumulative proportion of total sample variance explained | 56.031 | 71.095 | 76.841 | 54.513 | 66.876 | 76.841 | |

From the table above we can see that, the proportion of total variance explained by the three-factor solution (76.841) is appreciably larger than that for the one factor solution (56.03). In Varimax rotation three-factor solution expresses same proportion of total variance than one factor solution.

According to unrotated solution of principal factor analysis we can see that the last 12 variables of the gross district product loads highly on the first factor $F_1$ and might be called as *Service factor* and first 4 variables loads highly on the second factor $F_2$ and might be called as *Agriculture factor*. Only one variable "mining and quarrying" loads highly on the third factor $F_3$ and can be renaming as *Mining factor*.

After Varimax rotation we have found that the "construction" variable which had high loading on the first factor ( $F_1$ ) of unrotated solution have high loading on the second factor ( $F_2^*$ ) of the rotated solution. Similarly the "fishing" variable which had high loading on the $F_2$ before rotation have high loading on $F_3^*$. So according to the rotated solution of principal factor analysis we can rename the factors as *Service, Agriculture & infrastructure, and Fishing & mining factor* respectively.

## RESULTS OF MAXIMUM LIKELIHOOD METHOD WITH VARIMAX ROTATION

The results of maximum likelihood method with Varimax rotation are given below:

**TABLE- 03: RESULTS MAXIMUM LIKELIHOOD METHOD WITH VARIMAX ROTATION**

| Variables | Three - factor solution | | | | | | |
|---|---|---|---|---|---|---|---|
| | Estimated factor loadings | | | Estimated rotated factor loadings | | | Communality |
| | $F_1$ | $F_2$ | $F_3$ | $F_1^*$ | $F_2^*$ | $F_3^*$ | $\hat{h}_i^2$ |
| crops & horticulture | .037 | .310 | .170 | -.021 | .352 | -.049 | .125 |
| forestry & related services | .200 | .685 | .493 | .022 | .867 | .015 | .745 |
| animal farming | .059 | .278 | .207 | -.014 | .351 | .005 | .122 |
| fishing sector | .237 | .448 | .360 | .100 | .610 | .069 | .383 |
| mining & quarrying | .131 | .216 | .212 | .049 | .319 | .066 | .110 |
| manufacturing sector | .872 | -.487 | .027 | .797 | -.198 | .571 | .999 |
| electric, gas and water supply | .926 | -.041 | -.319 | .978 | -.025 | .062 | .939 |
| construction | .480 | .225 | .044 | .436 | .302 | .040 | .283 |
| wholesale & retail trade | .862 | -.039 | -.087 | .835 | .094 | .214 | .751 |
| hotel & restaurants | .960 | -.138 | -.151 | .947 | -.001 | .255 | .962 |
| transport, storage & Communication | .969 | -.011 | -.205 | .978 | .072 | .141 | .960 |
| financial intermediation | .943 | -.028 | -.286 | .982 | .008 | .083 | .972 |
| real state renting & business service | .980 | .095 | -.111 | .956 | .212 | .150 | .982 |
| public administration & defense sector | .921 | -.093 | -.364 | .988 | -.094 | .058 | .988 |
| Education sector | .733 | -.197 | .453 | .519 | .247 | .672 | .769 |
| health and social work sector | .975 | .221 | .016 | .908 | .383 | .168 | .999 |
| community, social & personal service sector | .809 | .451 | .233 | .679 | .657 | .142 | .911 |
| Cumulative proportion of total sample variance explained | 55.339 | 64.222 | 70.999 | 51.493 | 65.083 | 70.999 | |

From the table above we can see that, the proportion of total variance explained by the three-factor solution (70.99%) is appreciably larger than that for the one factor solution (55.34%). In Varimax rotation three-factor solution expresses more proportion of total variance than one factor solution.

According to unrotated solution of maximum likelihood analysis we can see that the last 12 variables of the gross district product loads highly on the first factor $F_1$ and might be called as *Service factor* and first 5 variables loads highly on the second factor $F_2$ and might be called as *Agriculture & infrastructure factor*. And no variable has high loading on third factor.

After Varimax rotation we have found that the "education" variable which had high loading on the first factor ( $F_1$ ) of unrotated solution have high loading on the third factor ( $F_3^*$ ) of the rotated solution. So according to the rotated solution of maximum likelihood method we can rename the factors as *Service, Agriculture & infrastructure, and Education factor* respectively.

## TEST OF HYPOTHESIS

The three-factor maximum likelihood analysis of data was presented in 4.2. In the residual matrix there suggests that a three factor solution may be adequate.

$$H_0 : \underset{(17\times17)}{\sum} = \underset{(17\times3)}{\mathbf{L}}\ \underset{(3\times17)}{\mathbf{L}'} + \underset{(17\times17)}{\boldsymbol{\psi}}$$

Now we test the hypotheses , with $m = 3$ , at level $\alpha = 0.05$.

The test statistic is based on the ratio of generalized variances as we determine

$$\frac{\left|\hat{\Sigma}\right|}{\left|S_n\right|} = \frac{\left|\hat{\mathbf{L}}\hat{\mathbf{L}}' + \hat{\boldsymbol{\psi}}\right|}{\left|\mathbf{S_n}\right|} = \frac{\left|\mathbf{L_z}\hat{\mathbf{L}}_\mathbf{z} + \hat{\boldsymbol{\psi}}_\mathbf{z}\right|}{\left|\mathbf{R}\right|} = \frac{0.00000000000336}{0.000000000000796} = 4.22$$

Using Bartlett's correction, we evaluate the test statistic as below:

$$\left[64 - 1 - \frac{(34+12+5)}{6}\right]\ln(4.22) = 78.471$$

$$\frac{1}{2}\left[(p-m)^2 - p - m\right] = \frac{1}{2}\left[(17-3)^2 - 17 - 3\right] = 88$$

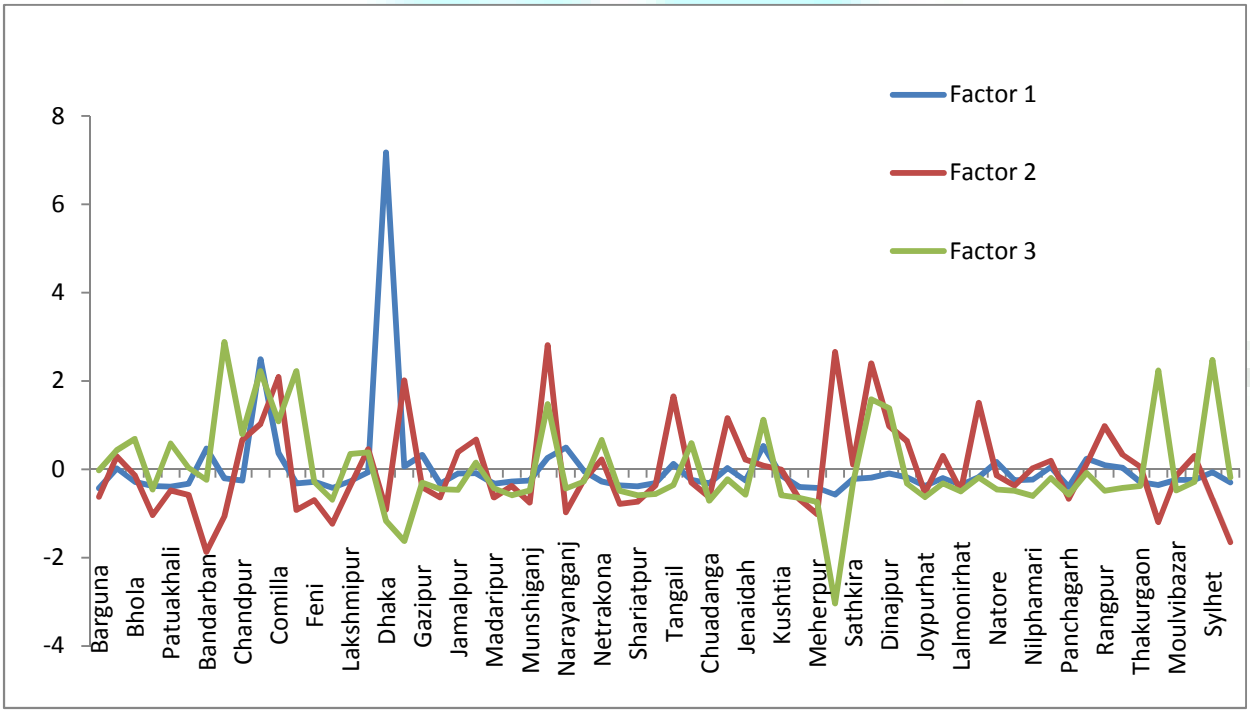
Since, , the 5% critical value $\chi^2_{88,.05} = 115.84$ is not exceeded by the calculated value 78.471, hence we fail to reject $H_0$. We conclude the data do not contradict a three-factor model.

**TABLE-04: SORTED FACTOR SCORES TABLE OF TOP TEN DISTRICTS**

| Factor 1 | | Factor 2 | | Factor 3 | |
|---|---|---|---|---|---|
| District | Factor Score | District | Factor Score | District | Factor Score |
| Dhaka | 7.17612 | Mymensingh | 2.8142 | Brahamanbaria | 2.88663 |
| Chittagong | 2.49538 | Narail | 2.65717 | Sylhet | 2.47533 |
| Khulna | 0.52531 | Bogra | 2.39893 | Habiganj | 2.23617 |
| Narayanganj | 0.49076 | Comilla | 2.09287 | Chittagong | 2.2207 |
| Bandarban | 0.46775 | Faridpur | 2.01663 | Cox's Bazar | 2.22058 |
| Comilla | 0.36773 | Tangail | 1.65246 | Bogra | 1.58574 |
| Gazipur | 0.32167 | Naogaon | 1.5098 | Mymensingh | 1.47769 |
| Mymensingh | 0.25718 | Jessore | 1.1575 | Dinajpur | 1.38043 |
| Rajshahi | 0.23588 | Chittagong | 1.02814 | Khulna | 1.12377 |
| Natore | 0.1626 | Rangpur | 0.97971 | Comilla | 1.08484 |

This table represents the 64 districts according to their scores on each factor in descending order. Each district has individual scores on each factor. We can see that the district Dhaka have highest score on the first factor whether the districts Mymenshing and Brahmanbaria have highest scores on second factor and third factor respectively.

**FIGURE-02: FACTOR SCORES OF 64 DISTRICTS**




This graph is plotted by districts against their scores on each factor. Scores of districts on each factor can be compared from this figure such as district Dhaka have highest score on factor 1, but have low score on 2nd factor and negative score on 3rd factor.

We have renamed the three factors in principal component analysis as *Service factor*, *Agriculture & infrastructure factor*, and *Fishing & mining factor*. The first factor consist manufacturing sector, electric, gas and water supply, wholesale & retail trade, hotel & restaurants, transport, storage & Communication, financial

intermediation, real state renting & business service, public administration & defense sector, education sector, health and social work sector, community, social & personal service sector. Second factor consist crops & horticulture, forestry & related services, animal farming, construction and the third factor consist fishing sector, mining & quarrying. We used two methods principal component and maximum likelihood to calculate the factors and both methods gives the almost equal but not the same result. In maximum likelihood method we rename the three factors as *Service factor*, *Agriculture & infrastructure factor, and Education factor*. The first factor consist manufacturing sector, electric, gas and water supply, construction, wholesale & retail trade, hotel & restaurants, transport, storage & Communication, financial intermediation, real state renting & business service, public administration & defense sector. Second factor consist crops & horticulture, forestry & related services, animal farming, fishing sector, mining & quarrying; and the third factor consist education sector. The common variables of service factor both in MLM and PCM are same except education variable and construction variable. Education, which was in service factor in PCM, is in third factor (*Education factor*) in MLM. Construction, which was in agriculture & infrastructure factor in PCM, is in the service factor in MLM. In PCM third factor (*Fishing & mining factor*) is constructed by fishing variable and mining variable only whereas in MLM both these variables are included in the second factor (*Agriculture & infrastructure factor*). In MLM third factor (*Education factor*) consists only a single variable "education" of gross district product. According to the test of hypothesis we found that three-factor model is adequate for the data. We calculate the scores of districts on each factor and found that the district Dhaka have highest score on the first factor whether the districts Mymenshing and Brahmanbaria have highest scores on second factor and third factor respectively as shortly stated.

From the above analysis, it is evident that three major factors are influencing Bangladesh's GDP. The first factor explains the service related activities in industrial and business of the country while the second factor is purely dominated by agricultural and livestock sectors and the last factor is purely dominated by agricultural and livestock sectors. Out of the analysis of GDP data, we find industrial and business sector to be more dominating than the agricultural sector as far as contribution to the GDP is concerned. This indicates a clear shift of contribution to the GDP from agriculture to 'non-agriculture' sectors. The study suggests further analysis of successive year's of GDP data (if available) to investigate if there is any trend in the shift of contributing factors from agriculture to industrial and business sectors.

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## APPENDIX

### APPENDIX-A

**TABLE-05: SORTED FACTOR SCORES TABLE BY DISTRICTS**

| Factor 1 | | Factor 2 | | Factor 3 | |
|---|---|---|---|---|---|
| District | Factor Score | District | Factor Score | District | Factor Score |
| Dhaka | 7.17612 | Mymensingh | 2.8142 | Brahamanbaria | 2.88663 |
| Chittagong | 2.49538 | Narail | 2.65717 | Sylhet | 2.47533 |
| Khulna | 0.52531 | Bogra | 2.39893 | Habiganj | 2.23617 |
| Narayanganj | 0.49076 | Comilla | 2.09287 | Chittagong | 2.2207 |
| Bandarban | 0.46775 | Faridpur | 2.01663 | Cox's Bazar | 2.22058 |
| Comilla | 0.36773 | Tangail | 1.65246 | Bogra | 1.58574 |
| Gazipur | 0.32167 | Naogaon | 1.5098 | Mymensingh | 1.47769 |
| Mymensingh | 0.25718 | Jessore | 1.1575 | Dinajpur | 1.38043 |
| Rajshahi | 0.23588 | Chittagong | 1.02814 | Khulna | 1.12377 |
| Natore | 0.1626 | Rangpur | 0.97971 | Comilla | 1.08484 |
| Tangail | 0.1194 | Dinajpur | 0.97467 | Chandpur | 0.79669 |
| Rangpur | 0.09109 | Kishoreganj | 0.67029 | Bhola | 0.68717 |
| Faridpur | 0.06538 | Chandpur | 0.6674 | Netrakona | 0.66669 |
| Pabna | 0.04615 | Gaibandha | 0.63937 | Bagerhat | 0.59465 |
| Sirajganj | 0.03536 | Noakhali | 0.45517 | Patuakhali | 0.58555 |
| Jessore | 0.02575 | Jamalpur | 0.39354 | Barisal | 0.43122 |
| Barisal | 0.0237 | Sirajganj | 0.33135 | Noakhali | 0.38458 |
| Narsingdi | -0.03693 | Kurigram | 0.30428 | Lakshmipur | 0.34513 |
| Sylhet | -0.06606 | Sunamganj | 0.30117 | Kishoreganj | 0.14973 |
| Noakhali | -0.06943 | Barisal | 0.29681 | Pirojpur | 0.03695 |
| Kishoreganj | -0.08844 | Netrakona | 0.22071 | Barguna | -0.02618 |
| Dinajpur | -0.09739 | Jenaidah | 0.21759 | Rajshahi | -0.0777 |
| Jamalpur | -0.09867 | Pabna | 0.19445 | Rangamati | -0.18032 |
| Kushtia | -0.13818 | Rajshahi | 0.11858 | Naogaon | -0.19237 |
| Naogaon | -0.17417 | Sathkira | 0.10526 | Pabna | -0.20066 |
| Gaibandha | -0.18 | Khulna | 0.08088 | Jessore | -0.22712 |
| Bogra | -0.19088 | Thakurgaon | 0.05781 | Bandarban | -0.24326 |
| Kurigram | -0.19965 | Nilphamari | 0.02831 | Narsingdi | -0.2801 |
| Brahamanbaria | -0.20539 | Kushtia | -0.00911 | Sunamganj | -0.2871 |
| Sathkira | -0.21703 | Bhola | -0.13278 | Feni | -0.29041 |
| Nilphamari | -0.22979 | Natore | -0.13674 | Gazipur | -0.30827 |
| Bagerhat | -0.24018 | Moulvibazar | -0.14277 | Sathkira | -0.31612 |
| Moulvibazar | -0.24253 | Narsingdi | -0.24363 | Kurigram | -0.31835 |
| Sunamganj | -0.24384 | Bagerhat | -0.3011 | Gaibandha | -0.32437 |
| Nawabganj | -0.24706 | Sherpur | -0.36407 | Tangail | -0.35983 |
| Munshiganj | -0.25397 | Nawabganj | -0.3727 | Thakurgaon | -0.37529 |
| Chandpur | -0.25626 | Manikganj | -0.37682 | Sirajganj | -0.42194 |
| Jenaidah | -0.25838 | Lakshmipur | -0.38033 | Madaripur | -0.4261 |
| Lakshmipur | -0.27109 | Gazipur | -0.40632 | Narayanganj | -0.43665 |
| Manikganj | -0.27324 | Patuakhali | -0.48154 | Gopalganj | -0.44832 |
| Netrakona | -0.27936 | Lalmonirhat | -0.48569 | Natore | -0.45574 |
| Bhola | -0.28435 | Joypurhat | -0.52823 | Jhalokati | -0.45732 |
| Feni | -0.28516 | Pirojpur | -0.58184 | Jamalpur | -0.46792 |
| Thakurgaon | -0.29291 | Barguna | -0.62627 | Munshiganj | -0.47908 |
| Rangamati | -0.29711 | Chuadanga | -0.62892 | Moulvibazar | -0.48242 |
| Sherpur | -0.31127 | Gopalganj | -0.63965 | Nawabganj | -0.48472 |
| Chuadanga | -0.31721 | Madaripur | -0.64243 | Rangpur | -0.48824 |
| Cox's Bazar | -0.32338 | Panchagarh | -0.66674 | Rajbari | -0.4906 |
| Madaripur | -0.32392 | Sylhet | -0.6737 | Lalmonirhat | -0.50125 |
| Gopalganj | -0.32499 | Magura | -0.67539 | Sherpur | -0.56088 |
| Pirojpur | -0.32952 | Feni | -0.70032 | Jenaidah | -0.57145 |
| Habiganj | -0.35424 | Shariatpur | -0.73415 | Panchagarh | -0.57349 |
| Lalmonirhat | -0.35594 | Munshiganj | -0.75623 | Shariatpur | -0.58526 |
| Rajbari | -0.36415 | Rajbari | -0.78737 | Manikganj | -0.5879 |
| Jhalokati | -0.37892 | Dhaka | -0.9146 | Kushtia | -0.58866 |
| Joypurhat | -0.37993 | Cox's Bazar | -0.92138 | Nilphamari | -0.60151 |
| Shariatpur | -0.38492 | Narayanganj | -0.96977 | Joypurhat | -0.63406 |
| Patuakhali | -0.38929 | Meherpur | -1.01905 | Magura | -0.64515 |
| Magura | -0.40067 | Jhalokati | -1.04143 | Khagrachhari | -0.69028 |
| Panchagarh | -0.40152 | Brahamanbaria | -1.06787 | Chuadanga | -0.71068 |
| Meherpur | -0.41885 | Habiganj | -1.19565 | Meherpur | -0.74324 |
| Khagrachhari | -0.42479 | Khagrachhari | -1.23365 | Dhaka | -1.16945 |
| Barguna | -0.42957 | Rangamati | -1.6537 | Faridpur | -1.62186 |
| Narail | -0.57667 | Bandarban | -1.87309 | Narail | -3.03866 |

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