Some Macro- Factors Influencing Industrial Performance in Bangladesh: A Co-integration Analysis.

Mohammad Hassan

Department of Economics and Banking

International Islamic University Chittagong

Sitakunda, IIUC Rd, Kumira 4314, Chittagong, Bangladesh.

Abstract.

This study attempts to identify the key drivers of the industrial performance in Bangladesh over the period 1972-2014. ARDL (autoregressive distributed lag) and Johansen approach to co-integration are applied. Both empirical tests confirm a long-run relationship between the industrial value-added, net export of goods and services, gross capital formation, GDP per capita growth, population density and government expenditure. In both tests population density is found to have the largest positive effect on industrial performance and gross capital formation is found to be the second largest influencing factor. This study confirms that external balance of goods and services and government expenditures have the smallest effects on the industrial performance. Government expenditure is found to have a negative impact on industrial performance in ARDL approach, the coefficient is insignificant, though.

Keywords: industrial sector, population density, government expenditure, VECM, ARDL bound test, co-integration.

1. Introduction:

Industrial growth makes an important contribution to the rapid economic development. A nation with a strong and productive industrial sector has performed far better in other sectors rather than those with the lower productive industrial sector. Developing countries may not have an efficient productivity but their large and small-scale industrial units have been generating a fairly large employment share over the decades and thus, has contributed to poverty reduction. Industrial growth of emerging countries creates high demands for labor, especially for the rural disguised unemployed people. Because of the fact that industrial sector pays a relatively fair wage than agricultural sector it helps per capita income go up. According to the world bank's re- estimated poverty rate in Cruz et. Al (2015), the share of population below $1.9 a day is projected to be 9.6% worldwide and 13.5% in south Asia. In 2012, the worldwide poverty rate was 12.8% while it was 37.8% in 1990. In South Asia, the rate was18.8% in 2012 compared to 50.6% in 1991. The highly successful region in poverty reduction, the East Asia and pacific regions have made an example in poverty reduction. The poverty rate has fallen from 60.8 in 1990 to 7.2 in 2012.

The increase in productivity with rapid industrialization was one of the key drivers of this rapid poverty reduction. For instance, in china, roughly 753 million people moved above the poverty line between 1981 and 2011 which made the poverty average decrease from 53 percent to only 8 percent. Kniivilä (2007) argued that this was due to rapid industrialization, the increasing rate of savings and investment in manufacturing. Another example can be the south Korea which experienced a widespread poverty in the 1960s. The poverty rate was between 60-70%, however by the mid-1990s poverty rate sharply declined to 2-3% only. Kniivilä (2007) argued that export-oriented industrialization played the major role in the poverty reduction in South Korea. Moreover, the establishment of labor-intensive industries generated massive employment opportunities. Like South Korea other East Asian such as Taiwan and Hong Kong successfully brought economic prosperity through the growth in industry-sector. They serve to be good examples of any developing country.

Bangladesh is still an agro-based country. Although the share of the agriculture sector to total GDP is declining the agricultural sector is still a dominating sector by the share of the labor force. Bangladesh labor force survey 2013 shows that the labor force in agriculture occupation was 41.5% whereas only 20.8% of the total labor force were in the industrial sector in 2013. Concurrently, the World Bank data shows that the share of agriculture to GDP was only 16.23% percent in 2013. The lower share of the agricultural sector to GDP with a greater share of employment proves a very low productivity of agrarian labor. However, Bangladesh could manage a reasonable growth after 1980 after lots of fluctuation in the 1970s. Moreover, after 2010, the trend in industrial growth is worthy of notice. The average growth rate was 6.96 from 1972 to 2010, whereas from 2011 to 2014 the average growth rate reached 9.06 ,which was higher than that of any other South Asian country. The major industrial products of Bangladesh are cotton yarn, cotton cloth, paper, newsprint, cigarettes, oil products, food products, sugar, fertilizers, chemicals glass, sheets, iron and steel, and matches.

Most of the manufacturing industries in Bangladesh are the micro and small type. (Statistics and Informatics division (SID) Bangladesh bureau of statistics (BBS) 2013) reported that micro industries are 40.6% and small scale industries were 36.6% of total manufacturing industries. The medium and large scale industries make 14.3 and 8.5 percent of total, respectively. The contribution to gross value added (Gross value added less costs) shares are quite contrary to their number. Large type industries have the largest share 47.2% to total gross value added, where the contribution of medium, smal and micro make up 23.3%, 23.7% and 5.9%, respectively. The largest number of manufacturing establishments in the

industry are made up of textile and readymade garments, with a total of 17,967 establishments, they generate a large number of employment.

Far too little attention from researchers has been devoted to the industrial sector of Bangladesh. The majority of the researchers to date have tended to focus on the overall growth of the Bangladesh economy rather than the growth of its specific sector.

This study attempts to find out the macro factors that heavily influence the industrial sector using the co-integration analysis. The study has been organized as follows. The next section presents a brief literature review. Section 3 provides a short description of the variables with their data sources. Section 4 provides a brief overview of estimation techniques and the test for applicability of the techniques used in this study. Section 5 begins with the results of Johansen approach followed by diagnostic tests and stability tests. Section 6 deals with the results of ARDL approach followed by diagnostic and stability tests and section 7 discusses the findings of both approaches. And finally, section 8 presents the conclusion and discussion on issues emerging from these findings.

2. Previous studies:

I did not find any study that directly addressed the issue of the influential factors on industrial sector of Bangladesh. However, in recent years, this issue has attracted much more attention from the researchers of other developing countries such as Nigeria, Turkey and Syria. The most relevant studies are (Mohsen et. Al 2015, (Otalu and Anderu 2015), (Öztürk and Ağan 2014) and (Loto 2012). Each of them has chosen different variables but most of them applied the same methodology.

In a very recent study conducted on Syrian perspective, Mohsen et al. (2015) found that capital, manufactured exports, population and agricultural value added positively affect the industrial output in the long-run while oil price negatively affect the industrial output. And the study found that agricultural value added is the main determinant of industrial value added in syria.

Another recent study in turkey by Öztürk and Ağan (2014) found the effects of exports and investments on industrial production are positive while interest rate has a negative impact on industrial production. All the variables are reported to be significant.

Otalu and Anderu (2015) found that both labor and capital have a significant impact on the industrial growth of Nigeria. This study also found that the appreciation of Nigerian currency is not friendly to the growth of industrial sector.

Another study for Nigerian industrial sector found the inflation rate having the highest significant role in the expansion of the manufacturing sector in Nigeria.

In a causality analysis by Namun and Nath (2005) export and industrial production have a positive unidirectional causal relationship running from export to industrial production of Bangladesh. Uddin and Noman (2011) found a bidirectional relationship between export and industrial production in Bangladesh.

A study on the effect of public expenditure by Nigerian government on industrial sector productivity in Joseph (2012) found that government expenditure on administration and government expenditure on economic services by Nigerian government have negative impact on industrial productivity. On the other hand, expenditure on social & community services and expenditure on transfer have a positive impact on industrial productivity. However, none of the variables are significant at 95% confidence level.

Emmanuel and Oladiran (2015) found that government capital expenditure has a positive relationship with manufacturing sector output in Nigeria, but recurrent expenditure has a negative effect on manufacturing sector output.

Devarajan et. Al (1996) with panel data of 43 developing countries for 20 years found that per capita real GDP growth has a positive relation with current public expenditure and negative relation with capital public expenditure.

Akpolat (2014) used panel data of 13 developed and 11 developing countries to examine the impact of physical and human capital on GDP. The panel DOLS and FMOLS results of the study assured that impact of physical capital and education expenditures on GDP is strong in the developed countries whereas, the impact of life expectancy at birth (which was used as a proxy for human capital) on GDP is higher in the developing countries.

According to so-called Malthus population theory, population grow faster but resources grow slower so as resources per person will be less and per capita GDP will decline as he pointed out ''population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio'' (Malthus, 2007, p. 5). However, this theory has been criticized by some modern economists as it ignored the technological progress that can make the resource- productivity higher. (Todaro 2008)

A recent study by Ali (2015)on the effect of population growth on economic development in Bangladesh finds a negative impact of population on economic development. However, the coefficient is not significant as p-value is 0.25 as shown in the regression result table of the study.

3. Description of the variables and data source

3.1: variables

In this study the model consists of six variables. They are as follow:
1) Industrial value added (IND) : total output of industrial sector minus intermediate inputs in us$ constant 2005

2) External balance on goods and services (EXBAL) : value of exports of goods and service minus value of imports of goods and services in current us$

3) Gross domestic capital formation (CAP): money spent in adding fixed asset plus net changes in the level of inventories in us$ constant 2005. It is used as proxy for gross domestic capital formation in industry sector. (Otalu and Anderu 2015)

4) GDP per capita growth (annual %) (GDPCGW): annual percentage growth rate of GDP at market prices based on constant local currency (BDT).

5) Government expenditure (GEX): general government final consumption expenditure: all government current expenditures excluding military expenditure but including expenditures on national defense and security.

6) Population density (POP): midyear population divided by land area in square kilometers.

Industrial value added (IND) is dependent variable and other 5 variables are independent variables. The long run model takes the form as shown in eq.1.

$Ln\text{ind} = \beta 1 + \beta 2(\text{cap}) + \beta 3(\text{exbal}) + \beta 4(\text{gcgw}) + \beta 5(ln\text{gex}) + \beta 6(ln\text{pop}) + \varepsilon_t$ (1)

3.2 data source:

Annual time series data from 19272-2014 for all the variables have been collected from world bank that are accessible online in world bank's website.

4. Estimation techniques:

A time series is said to be non-stationary whose mean and the variance are not constant over time rather they change as time goes. Non-stationarity is quite frequent in macroeconomic series. When we have non-stationary in a regression model then we may end up having worthless results of spurious regression. If we have non-stationary variables in regression model the estimation results will show a close relationship between them although they are totally unrelated. As non-stationary variables lead a regression to misleading results they should not be used in a regression model.

However, there is a special case thought by Engle and granger (1987). That is, if two time series are not individually non-stationary but become stationary at their 1st differences and a linear combination of them is stationary then they are said to be co-integrated. That is, if (xt, yt) ~ i(1) and their linear combination zt ~ i(0), then xt and yt are said to be co-integrated. The regression using co-integrated series may not be spurious. If there is a co-integration between two or more series there would be a long-run relationship that ties those series together, hence, they do not move away from each other too far.

In this study two popular techniques have been used to inspect the long run relationships.

1) multivariate co-integration technique proposed by Johansen (1991)

2) ARDL bounds tests for co-integration proposed by pesaran et al. (2001).

Johansen co-integration test requires that all the series are integrated of the same order. While ARDL approach allows a mixed order of series I(0) and (1). However, ARDL does not allow I(2) series.

Before going forward towards the testing of co-integration, unit root test has been applied in next section to make sure that variables in this study have fulfilled the requirements of both techniques. That is, all the variables are integrated of same order (as required by Johansen approach) and none of the variables are I(2) (required by ARDL approach).

4.1 Unit root test:

The augmented dickey-fuller (ADF) test with intercept is used to check the order of integration. The Akaike information criterion (AIC) is used for lag length selection. The results of unit root tests are presented in table 1.

Table1 Augmented Dickey-Fuller (ADF) unit root test results

Variable	Augmented Dickey-Fuller (ADF) Unit Root Test		Decision
	T-Statistic	MacKinnon (1996) One - sided P-value	
*ln*IND	0.039525	0.9569	Non-Stationary
Δ *ln*IND	-6.985831	0.0000	Stationary***
CAP	5.648466	1.0000	Non-Stationary
Δ CAP	-3.552063	0.0470	Stationary***
EXBAL	0.586939	0.9877	Non-Stationary
Δ EXBAL	-5.924141	0.0000	Stationary***
GCGW	-0.864528	0.7891	Non-Stationary
Δ GCGW	-21.02785	0.0001	Stationary***
*ln*GEX	-2.278104	0.1835	Non-Stationary
*Δ ln*GEX	-6.689807	0.0000	Stationary***
*ln*POP	-1.796526	0.6867	Non-Stationary
Δ lnPOP	-2.200238	0.4762	Non-Stationary

Table 2 Phillips-Perron unit root test result for the variable *ln*POP

Variable	Phillips-Perron Unit Root Test		Decision
	Adjusted T-Statistic	MacKinnon (1996) One - sided P-value	
*ln*POP	1.786664	1.0000	Non-Stationary
*Δ ln*POP	-4.789615	0.0021	Stationary***

The ADF test result in Table 1 shows that all the variables are I(1) except lnPOP. However, ADF with trend and intercept along with lag selection criteria Modified AIC and Modified SC shows that lnPOP is I(1). Moreover, as shown in Table 2, in Phillips-Perron test with constant and and trend lnPOP is found to be I(1). So it can be concluded that all the series are I(1). As all series are I(1) the requirements of both Johansen Co-integration approach and ARDL approach to co-integration have been fulfilled and I can now proceed forward.

5.1 Johansen system co-integration test results:

Johansen systems procedure is used to test for co-integration between the variables
As i have six variables then there can be maximum 5 cointegrating vectors
There are two methods to detect the number of cointegrating vectors under Johansen approach. They are (i) Trace Test (ii) maximum eigenvalue test. Here, the expectation is that cointegrating vectors are less than 6.

5.1.1 Trace and eigenvalue tests:

Lag length 2 is selected to conserve the degree of freedom. It is clear from Table 3 that there are 4 cointegrating vectors by Trace test and 3 cointegrating vectors by Maximum eigenvalue test. Which means that there are at most 4 long run relationships or equilibrium relationship variables at 5% significance level.

Table 3 trace and eigenvalue tests results

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.921466	252.3258	95.75366	0.0000
At most 1 *	0.813076	150.5570	69.81889	0.0000
At most 2 *	0.701497	83.47485	47.85613	0.0000
At most 3 *	0.393821	35.11584	29.79707	0.0111
At most 4	0.255842	15.09267	15.49471	0.0574
At most 5	0.078557	3.272565	3.841466	0.0704

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.921466	101.7688	40.07757	0.0000
At most 1 *	0.813076	67.08215	33.87687	0.0000
At most 2 *	0.701497	48.35901	27.58434	0.0000
At most 3	0.393821	20.02317	21.13162	0.0709
At most 4	0.255842	11.82010	14.26460	0.1176
At most 5	0.078557	3.272565	3.841466	0.0704

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

5.1.2 Estimated long-run equation for industrial Value added of Bangladesh.

Johansen co-integration test shows that there is more than one long-run relationship among six variables. Since the goal of this study to determine the factors influencing industrial value added, I considered the normalized co-integration relationship displayed in Eq.2 where the real industrial value added lnIND is function of all other variables in the system.

*ln*IND= 7.9+0.03*CAP+*0.02**EXBAL +0.04*GCGW+0.06**ln*GEX+1.97**ln*POP (2)

.

Eq.2. is the estimated long-run equation under VECM method. This shows the estimated long run coefficients for five explanatory variables. All coefficients are found to be positive which means that all the five variables have positive effects on the real industrial value added of Bangladesh.

- The positive coefficient of 0.03 for CAP indicates that over the long run if gross real capital formation increases by 1 billion the real industrial value added increases by 3%. In elasticity format, if CAP increases by 1 percent the real value added in industry increases by 0.30%
- The positive coefficient of 0.02 for the variable EXBAL shows that other variables remaining constant, over the long run, if net export of goods and services increases by 1 billion the real industrial value added will increase by 2%. This can be expressed in elasticity form,. that is, if EXBAL increase by 1 percent the real industrial value added increases by 0.06%. It means that there is a positive effect of export to real industrial value added.
- The positive coefficient of 0.04 for GCGW indicates that over the long run if GDP per capita Growth rate increase by 1 percent point, then real industrial value added increases by 4%. In elasticity format, if GCGW increases by 1 percent the real value added in industry increases by 0.09 percent.

- The positive coefficient 0.06 for lnGEX indicates that if real government expenditure increases by 1 percent, the real industrial value added increases by 0.06 percent elasticity is very low.
- The positive coefficient 1.97 for inPOP indicates that if population density increases by 1 percent the real industrial value added increases by 1.97 percent.

Note: To express in elasticity form, the mean of non-transformed (to natural logarithm) independent variable was multiplied by its estimated coefficient (Hill et al. 2011).

5.1.3 Vector error correction term:

The unique feature of VECM is that it has VECT (Vector error correction term). VECT tells us how much deviation of lnIND from its long run value will be corrected each year. I expect that VECT is (i) negative to insure an adjustment toward the equilibrium and also I expect that VECT is (ii) not less than -1 because VECT less than -1 means that the system is explosive. (Hill et al. 2011)

Table 3 shows VECT vector error correction term or error correction coefficient along with long run coefficients in VEC equation. Table 3 shows that VECT is -0.73 which is significant at 1% significant level. This means that a deviation from the equilibrium level of value added of industrial output in the current period will be corrected by 73% percent in the next period to restore the equilibrium.

Table 3 VECTOR error correction estimates

Cointegrating Eq:	CointEq1
LNIND(-1)	1.000000
CAP(-1)	-0.026515 (0.00272) [-9.73607]
EXBAL(-1)	-0.019890 (0.00466) [-4.26671]
GCGW(-1)	-0.040874 (0.00409) [-9.99415]
LNGEX(-1)	-0.063022 (0.02420) [-2.60415]
LNPOP(-1)	-1.970778 (0.04108) [-47.9698]
C	-7.803515
Error Correction:	**D(LNIND)**
CointEq1	-0.733988 (0.10247) [-7.16268]

5.2 Diagnostic tests:

5.2.1. Serial Correlation LM Test:

Table 4. Breusch-Godfrey serial correlation LM test

One of the CLRM (Classical Linear Regression Model) assumptions is that correlation between error terms must be zero. If the error terms over time are correlated then they are said to have serial correlation or auto correlation. Serial correlation makes the OLS estimates inefficient and misguides us to believe that the coefficients are more significant than they really are. Since the model includes lagged dependent variables as explanatory variable it is better not to rely on the Durbin-Watson test result. Instead, Breusch-Godfrey LM test is used to check the possible serial correlation.

Table 4 shows that null hypothesis of 'no serial correlation' couldn't be rejected, proving no serial correlation in the model.

5.2.2 Heteroskedasticity Test:

Another problem that makes the OLS estimators inefficient is heteroscedasticity. Heteroscedasticity means the variance of error term being unequal (not constant). Although it is more likely to happen in a regression while using cross-sectional data, sometimes it might happen while using time series too.
Breusch-Pagan-Godfrey test is used to detect heteroscedasticity.
The Breusch-Pagan-Godfrey test results, in Table 5, shows that the null hypothesis of no heteroscedasticity couldn't be rejected, implying that there is no heteroscedasticity.

Table 5. Breusch-Pagan-Godfrey test results

F-statistic	**0.683700**	**Prob. F(19,20)**	**0.7942**
Obs*R-squared	**15.75044**	**Prob. Chi-Square(19)**	**0.6739**
Scaled explained SS	**10.17348**	**Prob. Chi-Square(19)**	**0.9485**

5.2.3 Normalitytest :

One of the key assumptions of CLRM is that residuals are normally distributed. Non Normality of residuals may affect the validity of t-statistics and F-statistics especially in a small sample.

The figure1.shows that P value is 0.24 the null hypothesis of ''residuals are normal'' couldn't be rejected. It means that the residuals of the model are normally distributed.

Figure1. Results of normality test for the residuals.

5.3: CUSUM and CUSUM square stability tests.

CUSUM and CUSUM Square tests are used to check whether the parameters in the regression model are stable across the sample period. In figure 2 and 3, the blue lines are of CUSUM and CUSUM Square. The red and green lines are the 5% critical lines.

The CUSUM and CUSUM Squared lines are within the 5% critical lines. This clearly indicates the stability of the coefficients of the estimated equation (Eq.2).

Figure 2. CUSUM stability test results

Figure3. CUSUM square stability test results

6. ARDL approach To Cointegartion:

ARDL stands for Autoregressive Distributed Lag. This is a kind of dynamic model that mixes the features of Autoregressive Model and Distributed Lag Model, which includes both lagged dependent variable and lagged independent variable as regressors. Pesaran and Shin (1996); Pesaran and Smith (1998) and Pesaran et al. (2001) showed that ARDL model could be used to examine long-run and cointegrating relationships between variables.

Because of some advantages in Pesaran ARDL approach, many researchers have been using it for a couple of years. The advantages are 1) unlike Johansen approach it doesn't require same order I(1) of time series. 2) It has been proved to yield consistent results in a small sample. 3) It does not require same lag length for all the regressors, rather based on model selection procedures such as AIC and SC etc. Some of the regressors even can have no lagged terms.

By making lnIND as dependent variable the ARDL procedures have been used. Maximum 4 lags have been chosen to conserve the degree of freedom because the sample of this study is not too large. And model was selected based on SC Schwarz Criterion as suggested by Pesaran and Shin (1999).

6.1.1 ARDL Bounds Test:

Bounds Test under ARDL approach is used to check whether the ARDL model has a long run relationship between dependent and independent variables**.**

Table 6. ARDL bounds test result

Test Statistic	Value	K
F-statistic	31.1805	5

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.08	3
5%	2.39	3.38
2.5%	2.7	3.73
1%	3.06	4.15

Table 6. shows F-statistic. It also shows 10%, 5%, 2.5% and 1% critical value bounds. Since F-statistics value is 31.18 which is larger than I1 bound value even at 1% level of significance, it is possible to conclude that co-integration is present.

6.1.2 ARDL Error Correction Term and Long run form: Table 7 demonstrates that error correction term -0.759 has expected sign (negative) and also significant at 1% significance level. The error correction term of ARDL tells us that any disequilibrium from long run value will be adjusted by 0.76% each year. If there is 1% random shock in the model, the equilibrium will adjust itself by 0.76% each time period so it will take roughly 1.3 years for any policy to take effect. Furthermore, table 7 clears up that the long run coefficients for each variable are significant and came out with expected signs except the real government expenditure which has a negative sign and also the coefficients are not significant at any level of significance.

Table 7. ARDL cointegrating and long run form.

Cointeq = LNIND – (0.0320*CAP + 0.0302*EXBAL + 0.0510*GCGW + 0.0104 *LNGEX+ 2.2513*LNPOP + 7.0959)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistics	Prob
CAP	0.03205	0.002779	11.514964	0.0000
EXBAL	0.030239	0.005876	5.146165	0.0001
GCGW	0.050987	0.004939	10.324023	0.0000
LNGEX	-0.010392	0.056085	-0.185297	0.8553
LNPOP	2.251256	0.037103	60.676031	0.0000
C	7.095884	1.002384	7.079008	0.0000

The positive coefficient of CAP 0.03 indicates that over the long run if the real capital formation increases by 1 billion the real industrial value added will increase by 3%. The magnitude of coefficient is small relative to the coefficient of EXBAL. In elasticity form, if CAP increase by 1 percent the real industrial value added increases by 0.35%

- The positive coefficient 0.03 for EXBAL indicates that other variables remaining constant, over the long run if EXBAL increase by 1 billion the real industrial value added will increase by 3%. . In elasticity form that is if EXBAL increase by 1 percent the real industrial value added increases by 0.09% which means that there is a positive effect of export on real industrial value added.

- The positive coefficient 0.05 of GCGW indicates that over the long run if GDP Growth rate increase by 1 percent point, then real industrial value added increases by 5%. In elasticity form, if CAP increase by 1 percent the real industrial value added increases by 0.11%
- The negative coefficient -0.01 for lngex indicates that if the real expenditure of Bangladesh Government increases by 1 percent the industrial value added decreases by 0.01 percent. However, the coefficient is not significant at any level of significance.
- The positive coefficient 2.25 for lnpop indicates that population density increase by 1 percent then over the long-run real industrial value added will increase by 2.25 percent. The population density has the largest positive effect on real industrial value added.

Note: To express in elasticity form, the mean of non-transformed (to natural logarithm) independent variable was multiplied by its estimated coefficient (Hill et al. 2011)

6.2 Diagnostic tests:

6.2.1 Serial correlation LM test:

Breusch-Godfrey Test for serial correlation is used to check serial correlation. The null hypothesis of no serial correlation is rejected, so there is serial correlation problem. But HAC (Newey-West) coefficient covariance matrix is chosen before estimating the model. So the coefficients of variables and their standard errors in the results are not misleading.

Table 8. Breusch-Godfrey Serial correlation LM test result

F-statistic	**4.971615**	**Prob. F(2,14)**	**0.0234**
Obs*R-squared	**16.19606**	**Prob. Chi-Square(2)**	**0.0003**

6.2.2. Heteroscadasticity Test:

Breusch-Pagan-Godfrey test is used for heteroscadasticity detection, the eveiews result in table 9 clearly shows that null hypothesis of homoscedasticity couldn't be rejected, proving no heteroscadasticity in the model.

Table 9. Breusch-Pagan-Godfrey test results

F-statistic	**1.060092**	**Prob. F(22,16)**	**0.4605**
Obs*R-squared	**23.13103**	**Prob. Chi-Square(22)**	**0.3944**
Scaled explained SS	**3.693405**	**Prob. Chi-Square(22)**	**1.0000**

6.2.3 Normality Test

It is clear from Jarque-Bera and p-value in figure 4 that the null hypothesis of normality could not be rejected. it means that the residuals are normally distributed.

Figure4. Results of normality test for the residuals.

6.3 CUSUM and CUSUM square stability tests.

The CUSUM and CUSUM Squared lines (blue) are within the 5% critical lines. This clearly indicates the stability of the coefficients during 1972-2014

Figure5. CUSUM stability test result.

Figure6. CUSUM square Stability Test results

6.3.2 Remsey reset rest :

Table 10. Remsey reset test result

Variable	Coefficient	Std. Error	t-Statistic	Prob
Fitted^2	**-0.033555**	**0.040138**	**-0.835979**	**0.4163**

Table 10 shows that the square of fitted is not significant which indicates that model is protected from any misspecification error proving unbiasedness and consistency of the model.

7. Discussion on findings.

- External Balance on goods and service, that is, total earning from export less total payment for import, was found to have a positive impact on industrial performance with a very low elasticity. This implies that export has a positive effect on industrial performance. This finding appears to be consistent with Export-Base Theory. According to the export base theory region's growth rate depends on external demand for its output (Pike et al. 2006). However, very low elasticity might be linked to the fact that Bangladeshi industries especially large industries have to rely on imported raw materials for the production process.
- The gross national capital formation was found to positively affect industrial performance. This finding is not contradicted with the fundamental economic theories of production where capital serves as one of the main components of the production process.

The elasticity of gross national capital formation is found to be very high (0.30% in VECM and 0.35% in ARDL) compared to the elasticities of the balance of payment and government expenditure.

- The elasticity of GDP Per Capita Growth was found to be 0.9% and 0.11%. The positive sign indicates that overall GDP growth helps in industrial expansion. Moreover, GDP consists of three sectors namely the agricultural, industrial and service sector. Growth in the other two sectors contributes to industrial performance. This is because growth in agriculture helps in supplying raw materials for the small scale industries and can bring down the dependency of Bangladesh on food imports from neighboring nations. And growth in both agriculture and service sector with growth in industrial sector can cause the domestic income to rise which in turn, can raise the investment in the industry sector. However, elasticity seems to be very small The possible reason for that might be that the other two sectors especially service sector attracts employment from the industry sector.
- The elasticity of Government Expenditure is found to have a positive effect on industrial performance in VECM result. The elasticity is found to be 0.06%. It indicates that government expenditure on infrastructural development helps the industrial performance. However, the elasticity is very low. The possible explanation for this can be found in the mismanagement of government expenditure. Moreover, the corruption might distort the expected outcomes of government expenditures. -0.01% elasticity according to ARDL long run form indicates that government expenditure has a negative impact on industrial performance. The conceivable reason for this can be the tax that is imposed on producers. Imposing tax hinders the saving growth, which in turn cuts down the investment. Diamond theory (1965) stated that people will consume less if a tax is imposed. Nonetheless, the negative coefficient of government expenditure in ARDL long run form is not significant.
- The elasticity of Population Density is 1.97% and 2.25%. Population density has the most significant effect on industrial performance. There can be several reasons for this. The first reason is that if population density grows domestic consumers rises, hence the demand for industrial output. Demand shapes the supply of industrial output. The increased demand encourages the producers to produce more products. The second reason is that most of the industrial products in Bangladesh are labor intensive. Population growth helps to increase labor force for the industrial production process. Diamond theory (1965) stated that each individual in a society supplies one unit labor in his young age and one unit consumer in his old age (Romer 2012) . This result further supports the findings of Mohsen et al. (2015).

8. Conclusion and recommendation.

This study set out to determine influential factors on industrial performance in Bangladesh during the period 1972-2014. Using annual time series data from WDI for six variables Industrial Value added (IND), External balance on goods and services, Gross Domestic Capital Formation (CAP), GDP growth (annual %), Government Expenditure (GEX), and Population Density (POP). All the variables are in real value except External balance on goods and services. Johansen Co-integration and Pesaran ARDL methodologies show that there is a long-run relationship between dependent variable Industrial Value

added (IND) and all other independent variables. The long run coefficients showed that Population Density (POP) has the largest effect on industrial performance among other independent variables. And the results also showed that government expenditures have the least effect on industrial sector expansion. The residual diagnostics and stability diagnostic have been used to examine the reliability of the coefficient results obtained from each model. VECM has passed all the diagnostic tests used, but ARDL model is found to be suffering from serial correlation. To that end, HAC (Newey-West) approach is used to correct the misguiding conclusion caused by serial correlation.

The results of this study support the idea that population growth plays the main role in the overall performance of the industrial sector. According to this study, export couldn't contribute much to the expansion of the Bangladesh industrial sector. Bangladesh has a large market with a large number of consumers. The Bangladesh industry sector can grow solely by meeting demands of local people. domestic demand is found to be more effective for industrial product growth rather than foreign demand. this study suggests that the Bangladesh industry sector needs to give priority to local demand. Moreover, this study couldn't find any evidence on the effectiveness of government expenditure. A question remains on the wisdom of the way money is being spent by Bangladesh government.

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Figure 1. Results of normality test for the residuals.

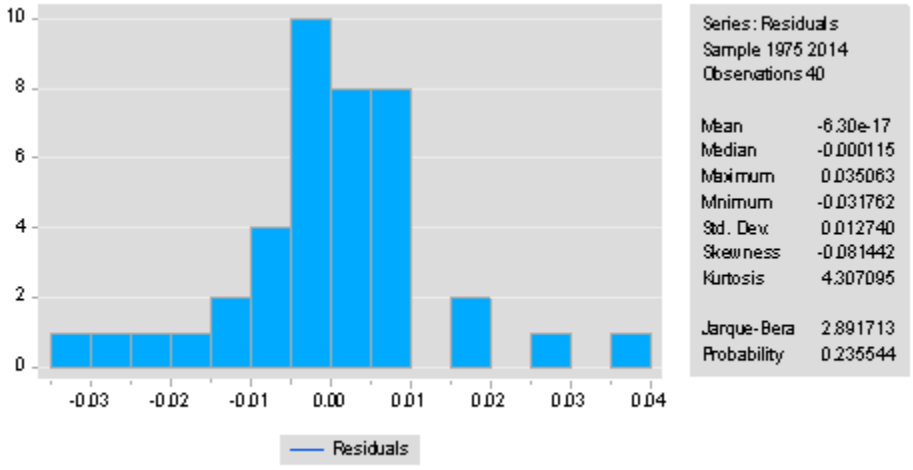

Figure 2. CUSUM stability test results

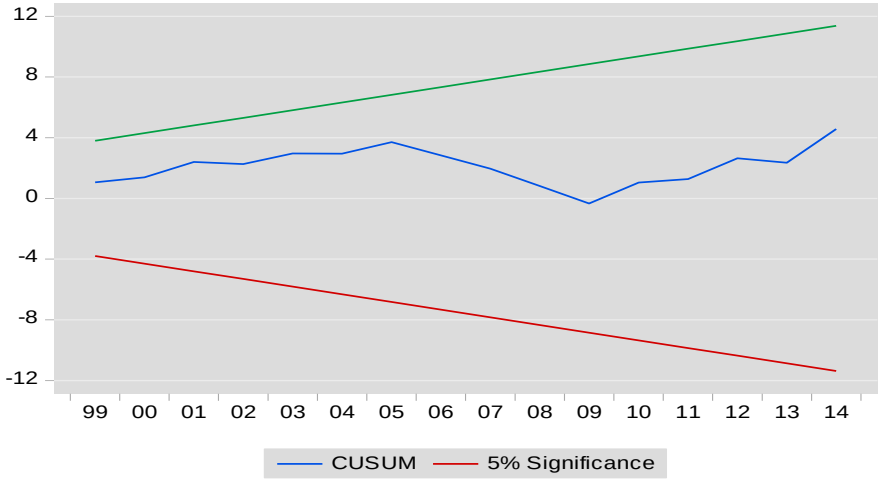

Figure3. CUSUM square stability test results

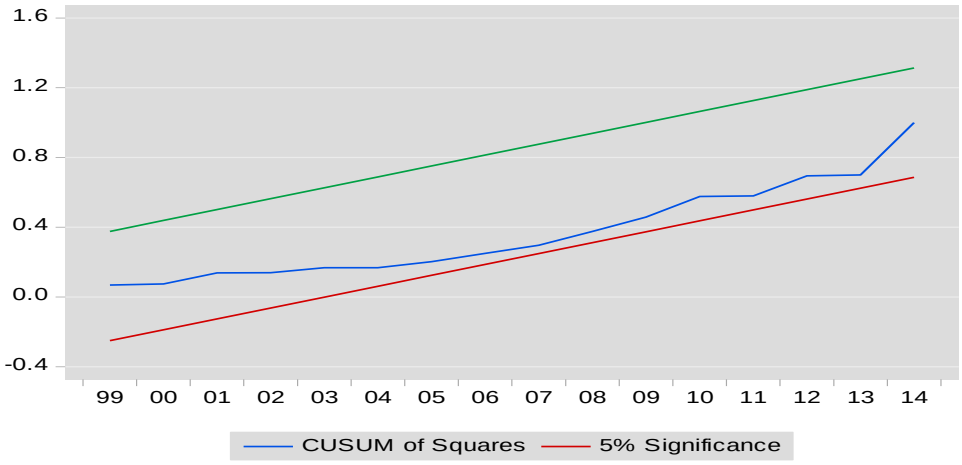

Figure 4. Results of normality test for the residuals.

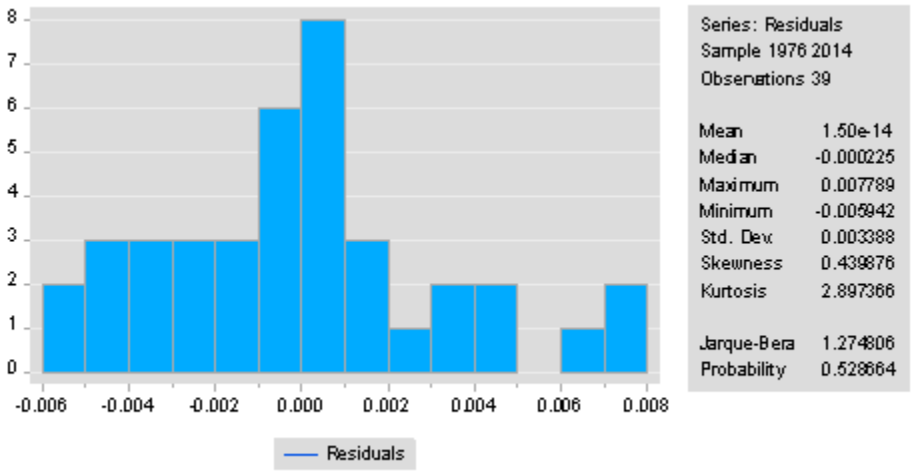

Figure 5. CUSUM stability test result.

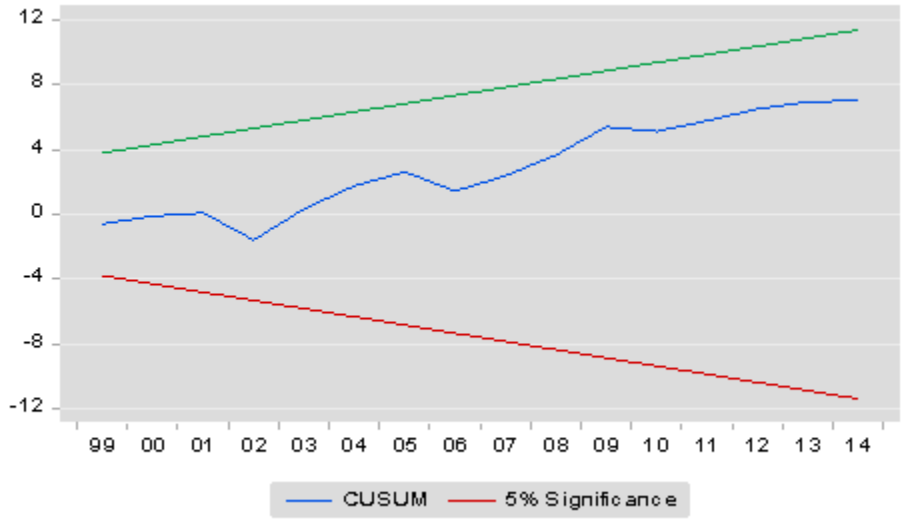

Figure 6. CUSUM square Stability Test result