Estimation of Output Gap and Analysis of Its Determinants in Bangladesh Economy

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Abstract

The study estimates the output gap and analyzes the estimated variables to find the significant long run relationship between output gap and its determinants. The study estimates the output gap and its determinants' relationship by using the annual time series data from 1980 to 2018 for the Bangladesh economy. The HP filter method is used to estimate and analyze the output gap in the economy. The Autoregressive Distributed Lag (ARDL) cointegration method and bounds test is applied to find out the determinants of the output gap and their relationship, and the Error Correction Model is used to identify the long run relationship between the output gap and its determinants. The results show long run positive and negative co-integration relationship between the output gap and its estimated determinants variables. The results show that the output gap has a positive relationship with the public sector investment, and a negative relationship with the higher secondary enrollment and money supply. The overall findings of this study suggest that the policymakers of Bangladesh should take an effective policy to grow the public and private sectors investment, education, and money market stability.

Keywords: Output Gap, HP filter, Autoregressive Distributed Lag (ARDL), Bangladesh

1. Introduction

Bangladesh is known as the fastest growing country for its recent economic growth. Bangladesh economy has grown record 8% in 2019 and it is marked as the fastest growing economy in Asia-Pacific. The country has showed a significant increase in the domestic production level which is increased by around 37% in 2019 than previous year (Ahmad, 2019). The major economic growthtook place due to large export earnings from readymade garments, remittance, and agricultural products. The domestic agricultural and industrial sectors play an important role to increase the domestic production. The significance for the economic growth is found by the

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proper government fiscal policy and the effective monetary policy by the central bank. Due to the significant changes in the economic growth and production level, the policy makers should estimate the output gap and find the justification of economic growth. This paper helps the macroeconomic policy makers to estimate the output gap and its determinants with a significant relationship between them.

In the macroeconomic policy making, the concept of potential output and the output gap is very essential for the policy makers. Output gap is the gap between the real output and the potential output in the economy. It can be explained by the difference between the actual level of output (real GDP) and the economy at full capacity (Potential GDP).The business cycle fluctuation is responsible to lead the output gap in the economy. In times of recession the actual output of the economy will fall below the potential output known as the recessionary gap, and in times of boom the actual GDP will cross the potential GDP which is called the inflationary gap (Kiley, 2013). The output gap suggests that there is inefficiency in the economy that is the economy is either over heating or producing far below its capacity.

The important determinants of output gap are public sector investment, export earning, import expenditure, higher secondary enrollment and money supply. These are known as the main determinants of the output gap (Sherbaz, Amzad, & Khan, 2009). For the government investing decision, public sector investment always play a crucial role because all the basic resource like education, water, sanitation, electricity, and emergency services are provided by the public sector investment. An increase in the public sector investment can help to increase the production capacity and in the long run higher level of public investment can decline the public-debt to GDP ratio.

The export earning is crucial for the economic growth and more export earning can decrease the output gap in the economy. The earning from export can help to increase the export industries which is also helpful for high-quality job creation (Sallam & Neffati, 2019). This is helpful to reduce the unemployment problem in the economy. The import expenditure is another component which varies time to time whereas the export expenditure is fixed. Due to the fluctuation in the import expenditure, an increase in the import spending leads to an increase the output gap in the economy (Sherbaz, Amzad, & Khan, 2009).

In the education sector, the higher secondary enrollment is used to identify how many students can attain the next step after secondary education (Bakker, Krabbendam, Bhulai, & Begeer, 2019). The basic job level is started from the higher secondary education for any underdeveloped or developing countries. More people involvement in the job sector can lead to a decrease in the output gap. So, what happen to output gap if there is a progress in education system that is an important question for developing countries. On the other side, inflation targeting is known as the vital job for the central bank. If the money supply increases in the economy, the economy can face an inflationary pressure. If money is limited then the people decide to save the money for the purpose of investing at higher interest rate, which would help to control the inflation (Kawamoto, Ozaki, Kato, & Maehashi, 2017). Hence, the policy makers prefer the money supply as a tool to target the inflation which is also important for the output gap reduction.

The estimation of the output gap is very interesting economic measurement for the government, central banks, public institutions, and other international organizations. This is very interesting due to several causes. One of the main causes is 2008 financial crisis in the US which was spread to European Union and other many nations, responsible for the great recession that triggered the interest rate fall down nearly to zero (Hlaing & Kakinaka, 2018). The second cause is the cyclical estimation for the fiscal policy indicators where many nations use the output gap and fiscal consolidation to estimate (Summers, 2014). The third cause is the calculation of structural fiscal balance indicators where the output gap is used to calculate those indicators which are essential for the economic growth and stability measurement (Baingana, al'Absi, Becker, & Pringle, 2015). There is always a debate about public investment, and its relationship with output gap. It is always a burning question how investment influence the output gap in the long run.

The policy markers use the output gap to determine the inflationary pressures in the economy as well as the demand and supply factors (Zhang &Murasawa, 2011). At the potential output the economy will be at the full employment level of output at the natural rate of unemployment. If the output falls below the potential, the unemployment rate will increase and vice versa so the policy makers always look at the output gap to lead the economy towards the full employment level of output (Kiley, 2013). The central bank and the government will closely watch the output gap to manufacture their policy for correcting the economy (Casey, 2018). So, there is a debate about money supply and output gap relationship. A crucial issue in modern economy is how money supply in the economy impact on output gap.

Overall analysis indicates that the analysis and estimation of output gap is playing a key role for economic progress. But there is no empirical outcome found based on output gap and its determinants (public sector investment, international trade, education, and money market) in the long run. There are limited studies based on the estimation of output gap and analysis of its determinants in Bangladesh Economy. The paper's primary contribution is investigating the output gap and its estimated determinants variables in the long run. The aim of this paper is to measure and estimate the output gap, and provides a significant outcome for policymakers to grow the public sectors investment, international trade, education, and money market stability.

The rest of the paper is organized as follows: Section 2 explores a brief review of the empirical literature, Section 3 describes methodology and the theoretical model, Section 4 presents empirical results and discussion, and Section 5 provides some policy implications.

2. Literature Review

In the economic literature, two types of methodologies can be found that are used to analyze output gap. The first one is the non-structural methodology that are based on the statistical procedures but not based on the economic theory, and the second one is the structural methodology that is based on the economic theory and foundations.

The Hodrick-Prescott Filter method is known as the most used non-structural univariate method (Shahrier & Lian, 2014).

The Hodrick-Prescott Filter method is one of the best statistical approach to estimate the output gap. This method is taken to analyze different important institutions in the world. The European commission has taken this approach due to the surveillance of the EU member countries.

Different kinds of empirical study were developed by the researcher for the developed and developing countries. Most of the studies was done based on the measurement and determinants of the output gap. These studies provide a significant insight and guideline for the macroeconomic researcher and policy makers for the economy. A study was developed for the Norwegian economy to estimate the output gap (Bjørnland, Brubakk, & Jore, 2005). The authors measured the output gap by taking the time series data from 1982-2004 by applying Hoderick Prescott (HP) Filter and Band-Pass (BP) Filter. They computed the output gap by using SVAR and MVUC. The result shows that output gap is the best estimator to explain the domestic inflation in a economy. The study provides a warning against the misjudgment in the economy and gives a guideline for the policymakers. Musso & Westermann (2005) took the Bjørnland, Brubakk, & Jore, (2005) research to another level. They analyzed the potential output growth of the different countries in Euro zone by taking the time series data from 1981-2003. The authors show some variations in the unsustainable development characteristics by estimating the potential output growth and that variations help to avoid misleading results. The result shows that output gap is the best estimator to show the impact of labor force, unemployment rate, and capital stock on market economy.

Another empirical study was found where the Hodrick-Prescott (HP) Filter method was applied to measure the output gap for the Japanese economy (Haltmaier, 2001). Same kind of research was applied by Cayen and Norden (2005) who estimated the output gap for the Canadian economy. They used verities of measures like LT, QT, HP Filter, BP Filter to estimate the output gap for the Canadian economy. The authors prove that the estimation of output gap iscrucial to reduce the measurement problem in the economy.

There were two important empirical studies found for the Nee Zealand's economy that provided the factors responsible for the output gap in the economy (Claus, Conway, & Scott, 2000; Fox, Kohli, & Warren,2003). Both studies have different methodology but the common issue they focused on was the relationship between the output gap and the general price level. They show that there is a long run positive co-integration between output gap and price level. A higher inflation increases the output gap in the economy. Claus, Conway, & Scott. (2000) show the evidence where the linkage between real economy and inflation is found by the output gap determination. These linkage determinants play a crucial indicator for the future inflationary pressures. At the same time, Fox, Kohli, & Warren (2003) indicate the general price level as an explanatory variable. They provide an evidence where the shortfall of the output from its potential level is increased in the long run and the

deviation of domestic prices are responsible for the shortfall. In the both cases, VECM is used to identify the long run relationship between domestic price level and output gap. Another investigation was made for the Chinese economy to show the relationship with the output gap and inflation (Gerlach & Peng, 2006). The research suggests that the movement in inflation can be triggered by the aggregate demand movement that is captured by the output gap. These research helps to identify the relationships between money supply and output gap. If the money supply growth is faster than real output growth then there will be an inflationary situation. If there is an excess money supply in the economy, it will lead an inflationary situation (Sabade, 2014). This inflation works as the determinant to measure the output gap relationship with the money supply. All the studies show a negative relationship with the higher money supply and output gap.

Other studies have investigated based on the output gap of developing countries and different macroeconomic variables. Menashe & Mealem (2000) investigated the measurement of the output gap and its influence on the import surplus. The import surplus is anticipated to occur if the import expenditure increases. The output gap and its influence on the import surplus was measured based on both annually and quarterly data from 1986-1999. The cyclical components of the output gap like the private sector labor input, the productivity and capital utilization are analyzed in this research. The output gap expands due to increase in the unemployment and lower level of productivity or capital utilization. The evidence shows a positive relationship between the output gap and the import surplus. This research provides an evidence where the import expenditure leads a positive outcome on import surplus which has a positive impact on the output gap.

Lee (2016) investigated the economic growth and catch-up for the Korean economy by taking the time series data from 1960-2010. The empirical studies showed that strong investment, trade openness and improvements in the human resource can help the economy to expand and reduce the output gap. The study also suggests the Chinese economy to upgrade the institutional quality like the educational progress and the improvement in the production level by the public sector investment. The result shows that GDP growth has a strong positive relationship with the investment, trade openness and quality of education. The studies further provide a clear path to estimate the output gap and justify the relationship with the output gap and those research variables. An empirical research is made by Abiad, Furceri, & Topalova (2016) where the authors show the public sector investment and the economic growth relationship. The research analyzed the macroeconomic effects of public sector investment for better policy making. By using the sample of 17 OECD economies since 1985, the authors find a significant positive relationship between public sector investment and output in the economy. The increase in public sector investment reduces the private sector investment which is called as crowding out effect. This reduction in the private sector investment helps to increase the output gap in the economy.

Sherbaz, Amzad, & Khan (2009) analyzed the output gap and its determinants based on the Pakistan time series data from 1964-2005. The aim of this study is to measure

the output gap for the Pakistan's economy and provide the significant believe on output gap against the macroeconomic variables. To estimate the output gap, public investment, export earning, import expenditure, higher secondary enrollment, and money supply are considered as determinants. The result shows that the import expenditure, higher secondary enrollment and money supply help to expand the output gap where the public sector investment and export earning help to reduce the output gap in the economy. The results provide a major significant conclusion for the Pakistan's macro management level.

Sallam & Neffati (2019) provided an empirical evidence to identify and analyze the output gap and its determinants based on the KSA with timeline 1970-2017. The study was made to provide some useful policy making decision for the Saudi economy. The policy makers can make the macroeconomic decision in the time of financial crisis and get some potential solution to reduce the output gap in the economy. The ARDL cointegration approach and bound test is applied to show the impact of output gap determinants on the output gap and the ECM is applied to find the long run equilibrium. The study finds both positive and negative outcome. The result shows government investment, expenditure for importing goods and services, and higher secondary registration have a positive outcome on the output gap where the export earnings and money supply have a negative outcome on the output gap.

Education is the component which can increase the country's labor productivity. Quality education helps to enhance the economic growth and reduces the output gap in the economy. By strong knowledge improvement the GDP can increase significantly (Donou-Adonsou, 2019). Islam, Wadud, & Islam (2007) analyzed the relationship between education and GDP growth based on the time series data from 1976 to 2003 for the Bangladesh economy. The relationship is analyzed based on the multivariate causality analysis. To examine the relationship between education and economic other two variables like capital and labor are included. The results show that education is helping the income to grow, at the same way income can be responsible to grow the education. The education is positive sign for the economy and this positive growth can help to reduce the output gap in the economy.

The analysis from the empirical literature above helps to provide an insight to find the determinants of output gap. The empirical studies show an evidence where there is a relationship with output gap and investment in the public sector, earning from exporting goods and services, expenditure for importing goods and services, higher secondary enrollment, and money supply. These are also major determinants of the output gap. Therefore, further empirical study is needed to estimate the output gap and its determinants to show the relationship between them. For this purpose, the estimation and analysis of output gap and its determinants is examined in this study for Bangladesh economy by using the econometric techniques.

3.   Methodology
3.1 Data:Nature and Source

By using the macroeconomic annual time series data from 1980-2018, this part estimates the macroeconomic variables like public sector investment (PI), export

earnings (EX), import expenditure (IM), higher secondary enrollment (HSE), and money supply (MS) which theoretically affected the output gap in the economy. For output gap calculation data is taken from actual output and potential output in the economy. The data is taken from the World Bank and the Bangladesh Economic Review statistics.

3.2 Output Gap Calculation

This part explains the HP-filter function method to calculate the output gap and also estimate the output gap determinates that was mentioned earlier.

The difference between actual output (Y_t) and potential output (Y_t^*) is called as output gap ($OutputGap_t$). The positive output gap shows the inflationary situation in the economy which means the economic growth is above the trend line. When the economy is in a downtown situation and leads an unemployment pressure in the economy, it is counted as negative output gap.

Berger (2011) applied the output gap model based on Watson (1986) & Clark (1987) as follows:

$$OutputGap_t = \frac{Y_t - Y_t^*}{Y_t^*} \qquad (1)$$

Adding $\frac{Y_t^*}{Y_t^*}$ in both side of Equation 1 as $1 + OutputGap_t = \frac{Y_t}{Y_t^*}$ and applying the logarithm we obtain:

$OutputGap_t = y_t - y_t^*$ where $y_t = LnY_t, y_t^* = LnY_t^*$.

3.3 The HP Filter for Output Gap Calculation

In the literature review, the methods of output gap calculation are discussed in a proper way. The most useful and successful method of output gap calculation is HP filter method which is applied by Shahrier & Lian (2014); Bjørnland, Brubakk, & Jore (2005); Cayen & Norden (2005); Sherbaz, Amzad,& Khan (2009); Sallam & Neffati (2019). The authors applied the HP filter method based on the economic theory approach where the advantage of this estimation is identified. For the macroeconomic performance and time series analysis, this method is known as the simplest and widely popular. The desired variable from the long-term trend is acquired by using the actual data. This method is applied based on the dependency of long run, symmetric, and moving average to decrease the real output (y_t).

The tendency is acquired by the cycle of actual data reduction around the trend, by minimizing the function as follows in Eq. (2):

$$\sum (ln y_t - ln y_t^*)^2 + \gamma \sum [(ln y_{t+1}^* - ln y_t^*) - (ln y_t^* - ln y_{t-1}^*)]^2$$

Where; y^* is the long-run tendency of the variable y. The coefficient λ is an exogenous detrending parameter that sets the degree of smoothness of the trend (i.e. how responsive potential output (y_t^*) is to movements of actual output (y_t)). Because the HP filter is used for annual data, λ takes the value 1002.

3.4 Output Gap Model and its specification

The main determinants of the output gap are estimated by Sherbaz, Amzad, & Khan (2009); Sallam & Neffati (2019). The equation that is used to identify the variables which affect the output gap in the economy as follows in Eq. (3):

$$OutputGap_t = \beta_0 + \beta_1 PI_t + \beta_2 EX_t + \beta_3 IM_t + \beta_4 HSE_t + \beta_5 MS_t + \varepsilon_t$$

The output gap determinants are found from the literature reviews where the authors explain the relationship between variables in the long run for investing the output gap relationship. To find out the suitable estimation methods, the unit root test is needed for all the variables so the best and suitable methods can be selected depending on the variable's integration degrees.

3.5 Testing stationary, and short run and long run relationships

For empirical evidence, it is always necessary to analyze the stationary properties. For the empirical analysis the unit root test is applicable by including ADF and PP tests. By checking all the variables' stationary properties, the investigation of the co-integration existence between variables is vital by applying Bounds Test approach. This test is developed by Pesaran, Shin, & Smith (2001) which is effective than other co-integration approach and test (Narayan & Narayan, 2004) due to the application of the small sample size in the economy.

An ARDL model is used to detect the short run and long run elasticity relationships between the variables. This approach helps to identify the impact of independent variables on the dependent variable in both short-run and long-run. For any kind of small sample analysis in the economy, ARDL is the best approach to provide superior results. The ARDL model can eliminate the endogeneity problems while assuming all the variables as endogenous by using the Engle–Granger method (Al-Mulali, Saboori, & Ozturk, 2015).

Engle& Granger (1987) argues in the long run if the co-integration exists between the variables, it will be a sign for unidirectional or bi-directional Granger-causality between these variables, while it will not be uncovered by a finite sample. At last, the Granger causality testing accordance with the VECM will be used to identify a causal relationship between output gap and its determinants variables.

Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) Test

The framework of Augmented Dickey-Fuller (ADF)which is recommended by Dickey & Fuller (1981) for the present of unit roots or non-stationarity as follow in equation (4):

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \beta t + \omega_t$$

Where μ is the drift term, t denotes the time trend, and p is the largest lag length. The test analysis which is recommended by Patterson (2000) found after relapses, test statistics, and hypothesis:

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \beta t + \omega_t$$

$\hat{\tau}_\beta, H_0 : \gamma = 0, H_a : \gamma < 0; \varphi_3, H_0 : \gamma = 0, \beta = 0, H_a : \gamma \neq 0$, and/or $\beta \neq 0$

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \omega_t$$

$\hat{\tau}_\mu, H_0 : \gamma = 0, H_a : \gamma < 0; \phi_1, H_0 : \mu = 0, \gamma = 0, \beta = 0, H_a : \mu \neq 0,$
and/or $\gamma \neq 0$

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \beta t + \omega_t$$

$\tau, H_0 : \gamma = 0, H_a : \gamma < 0$

However, Phillips and Perron (1988) propose an alternative (nonparametric) method of controlling for serial correlation when testing for a unit root. The Phillips and Perron (PP) method estimates the non-augmented DF test equation and modifies the -ratio of the coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic.

Interpretation of Unit Root Test

The results of conventional stationary tests are represented by the Table 1 below:

Table 1. Stationary test ADF test results

Output Gap	-1.3230	ΔOutput Gap	-4.4034*
PI	8.337120*	ΔPI	--
EX	0.6554	ΔEX	-3.6080**
IM	1.8756	ΔIM	-3.5606**
HSE	3.0127*	ΔHSE	--
MS	28.4384*	ΔMS	--
PP test results			
Output Gap	-1.0089	ΔOutput Gap	-4.7502*
PI	22.4236*	ΔPI	
EX	1.2512	ΔEX	-3.5623*
IM	3.3852*	ΔIM	
HSE	0.7254	ΔHSE	-6.5210*
MS	24.0806	ΔMS	--

Source: Eviews output, by Authors.

* Denote %1 significance level.

** Denote %5 significance level.

In the Table 1, the null hypothesis suggests for ADF and PP tests that the series include unit root. The calculated t statistics for all variables output gap, export earning, and import expenditure are lower than the critical values in I(0) and higher than the critical values in I(1). So, all variables except public sector investment, higher secondary enrollment, and money supply are stationary after differencing, i.e., integrated at $I(1)$. For public sector investment, higher secondary enrollment, and money supply variables, the calculated t statistics are larger than critical values in I(0), suggesting that public sector investment, higher secondary enrollment, and money supply variables are integrated at $I(0)$.

Except public sector investment, higher secondary enrollment, and money supply data, all variables are integrated at $I(1)$. For public sector investment, higher secondary enrollment, and money supply data, ADF and PP tests say $I(0)$. So we accepted public sector investment, higher secondary enrollment, and money supply variables $I(1)$.

Bounds Test Approach

For the bound test, the Unrestricted Error Correction model (UECM) is applied. The UECM specification is expressed in Eq. (5).

$$\Delta OutputGap_t = \gamma_0 + \gamma_1 t + \sum_{i=1}^{m} \gamma_{2i} OutputGap_{t-i} + \sum_{i=0}^{m} \gamma_{3i} PI_{t-i}$$
$$+ \sum_{i=0}^{m} \gamma_{i4} EX_{t-i} + \sum_{i=0}^{m} \gamma_{5i} IM_{t-i} + \sum_{i=0}^{m} \gamma_{6i} HSE_{t-i} + \sum_{i=0}^{m} \gamma_{7i} MS_{t-i}$$
$$+ \gamma_8 PI_{t-1} + \gamma_9 EX_{t-1} + \gamma_{10} IM_{t-1} + \gamma_{11} HSE_{t-1} + \gamma_{12} MS_{t-1}$$
$$+ \gamma_{13} OutputGap_{t-1} + u_t$$

In Eq. (5), "m" represents number of lags and "t" represents trend variables.

The process like Wald Test or F-statistics is followed to find out the existence of co-integration relationship in a generalized Dickey–Fuller type regression. This test is applied to find out the significance of lagged levels of the variables throughout the conditional UECM (Narayan & Narayan, 2004).

For the study, the F test null hypothesis is established as $H_0 = \gamma_8 = \gamma_9 = \gamma_{10} = \gamma_{11} = \gamma_{12} + \gamma_{13} = 0$ where the calculated value of F statistics is compared with table bottom and upper critical values (Pesaran, Shin,& Smith, 2001). For the co-integration relationship, the decision can be made without knowledge of the integration order of the regressors if the computed F-statistic falls outside the upper and lower bounds. For example, the null hypothesis of no co- integration is rejected if the computed Fstatistics is greater than the upper bound. At the same way, the null hypothesis of no co-integration is accepted if the calculated F statistics is

lower than the bottom bound (Narayan & Narayan, 2004). There is no proper decision that can be made if the calculated F statistics is between the bottom and upper critical values.

For the UECM model the maximum level of lag number is taken 1 and also the lag number is found 1 by applying the Akaikecriteria. The comparison is made for the computed F-statistic from UECM model with table bottom and upper criticallevels (Pesaran, Shin, & Smith, 2001). The results of the bound test are shown in Table 2 below:

Table 2. Bounds test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	4.234303	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Note: k is number of independent variable number in Eq. (1). Critical values are taken from Table C1.v at Pesaran, Shin, & Smith (2001).

In the Table 2,Fstatisticis larger than upperbound values, so we reject no co-in tegration null hypothesis. Therefore, we can get a significant co-integration relationship between Output gap and the variables based on the bound test approach.
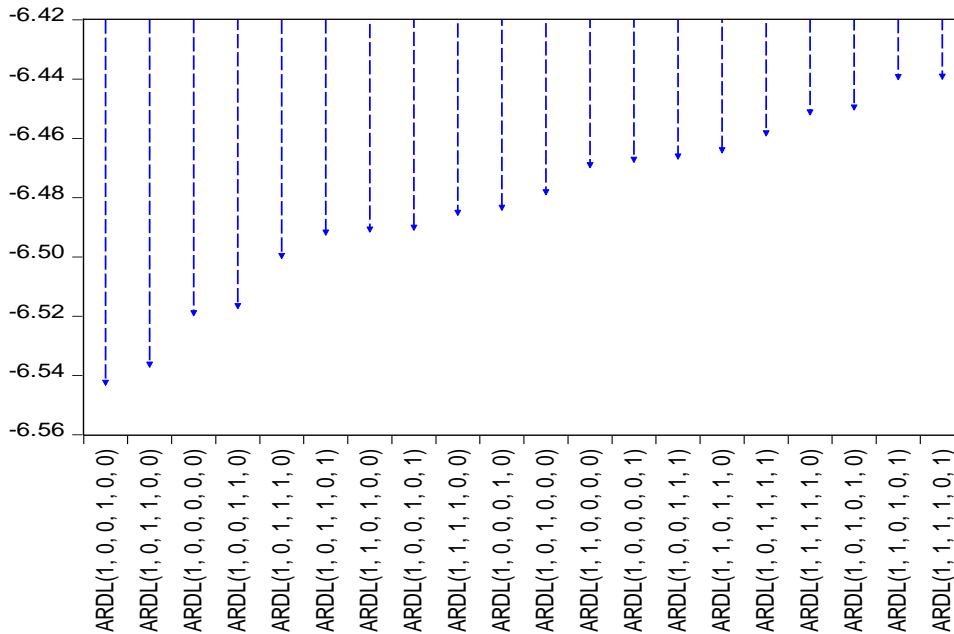
ARDL Model and Discussion

By the application of the ARDL model**,** the long and short run relationship between the variables are analyzed after the causality analysis. ARDL model specification is introduced for the study in Eq. (6).

$$\Delta OutputGap_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i}OutputGap_{t-i} + \sum_{i=0}^{m} \alpha_{2i}PI_{t-i} + \sum_{i=0}^{m} \alpha_{i3}EX_{t-i}$$
$$+ \sum_{i=0}^{m} \alpha_{4i}IM_{t-i} + \sum_{i=0}^{m} \alpha_{5i}HSE_{t-i} + \sum_{i=0}^{m} \alpha_{6i}MS_{t-i} + u_{2t}$$

In Eq. (6), 1 is taken for the maximum lag number and ARDL (1,0,0,1,0,0) model is selected by applying the Akaike information criterion, displayed in Figure (1) below:

Figure 1: Akaike information criteria (top 20 models)

4. Results discussion

The data for total GDP at constant prices (2010=100) (Million Taka) is used to estimate these methods. The result is summarized in the Table 3 and also displayed in the Figure 1 below:

Table 3: Summary Statistics

	OUTPUTGAP	PI	EX	IM	HSE	MS
Mean	0.001742	366.8641	5.06E+11	6.56E+11	455772.9	2.75E+12
Median	0.003199	175.7000	1.84E+11	2.71E+11	470541.0	6.87E+11
Maximum	0.064894	2071.200	1.55E+12	2.14E+12	1072028.	1.45E+13
Minimum	-0.033419	43.20000	4.16E+10	9.89E+10	59021.00	3.99E+10
Std. Dev.	0.021803	500.6354	5.55E+11	6.55E+11	273120.6	3.91E+12
Skewness	0.536633	2.058402	0.825392	0.818964	0.515733	1.649908
Kurtosis	3.340124	6.395176	2.012724	2.097011	2.604994	4.655978
Sum	0.067955	14307.70	1.97E+13	2.56E+13	17775142	1.07E+14
Sum Sq. Dev.	0.018064	9524159.	1.17E+25	1.63E+25	2.83E+12	5.82E+26
Observations	39	39	39	39	39	39

In table 3, there is total 39 observations. The output gap is measured from the difference of actual output and potential output which shows the average value 0.001742. The average values for public sector investment (PI), export earnings (EX), import expenditure (IM), higher secondary enrollment (HSE), and money supply (MS) are 366.8641, 5.06E+11, 6.56E+11, 455772.9, and 2.75E+12. Higher the average value means the higher the expectation and vice versa. All the variables have higher expectation for economic outcome. The standard deviation values for public sector investment (PI), export earnings (EX), import expenditure (IM), higher secondary enrollment (HSE), and money supply (MS) are 0.021803, 500.6354, 5.55E+11, 6.55E+11, 273120.6, and 3.91E+12.The determinant variables show that the data points are spread out over a large range of values.

Figure 2. Total Output Gap
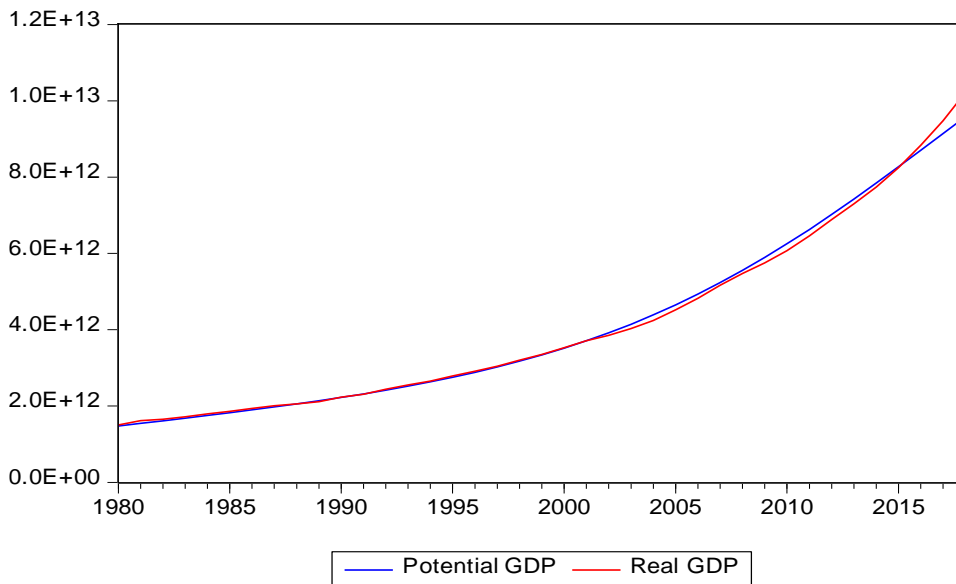
Source: EViews output, by Authors

The result obtained by using HP method and displayed in Figure 2 which accepts the main hypothesis of the study like there are gap between the real output and the potential output in the Bangladesh economy during the period (1980-2018). Figure 2 represents the output gaps which clearly represents the main hypothesis of this study like there are both positive and negative output gap in the economy of Bangladesh. The fall in the growth rate happened due to the increase of output gap in the economy. A negative output gap provides an evidence of slower economic progress. An output gap is positive, meaning the economy is operating at less than potential. A positive or negative output gap is incompatible for economic efficiency.

The ARDL model coefficients for the long and short term are represented in Table 4, and the Error Correction Regression in Table 5 below:

Table 4. ARDL model long and short-term parameter estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
OUTPUTGAP(-1)*	0.652096	0.143120	4.556279	0.0001
PI*	0.000126	4.53E-05	2.770668	0.0095
EX	-3.69E-14	4.58E-14	-0.805580	0.4268
IM	6.92E-15	2.50E-14	0.276828	0.7838
IM(-1)	3.70E-14	2.40E-14	1.540311	0.1340
HSE**	-3.29E-08	1.34E-08	-2.453413	0.0202
MS**	-1.42E-14	7.03E-15	-2.018587	0.0525
C	0.001109	0.005174	0.214404	0.8317

Source: Eviews output, by Authors.

* Denote %1 significance level.

** Denote %5 significance level.

Table 5. Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001109	0.005174	0.214404	0.8317
OUTPUTGAP(-1)**	-0.347904	0.143120	-2.430852	0.0213
PI*	0.000126	4.53E-05	2.770668	0.0095
EX	-3.69E-14	4.58E-14	-0.805580	0.4268
IM(-1)	4.39E-14	3.79E-14	1.159045	0.2556
HSE**	-3.29E-08	1.34E-08	-2.453413	0.0202
MS**	-1.42E-14	7.03E-15	-2.018587	0.0525
D(IM)	6.92E-15	2.50E-14	0.276828	0.7838

Source: Eviews output, by Authors.

* Denote %1 significance level.
** Denote %5 significance level.

In the ARDL model by employing the diagnostic check, the results show noserialcorrelation (Table 6), heteroscedasticity (Table 7), misspecification and normality (Figure 3) problems in this model. Also, the coefficients of ARDL model are stable based on the CUSUM and CUSUM-square tests (Figure 4).
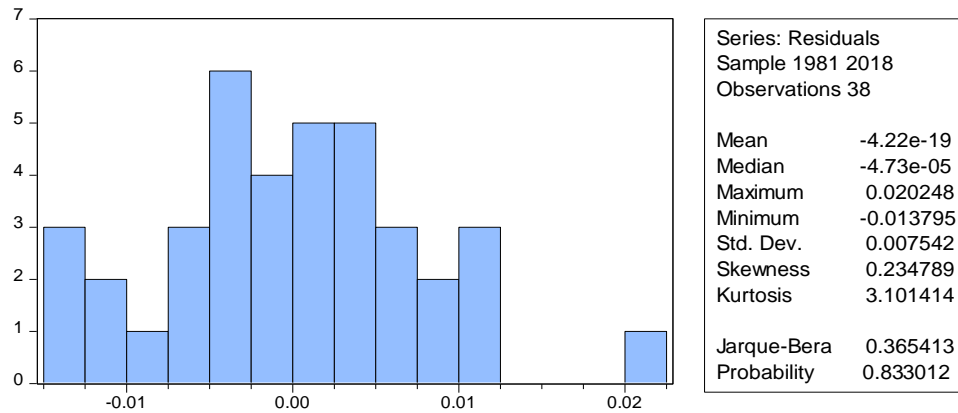
Table 6. Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.318493	Prob. F(2,28)	0.7298
Obs*R-squared	0.845252	Prob. Chi-Square(2)	0.6553

Table 7. Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.119086	Prob. F(7,30)	0.3773
Obs*R-squared	7.868058	Prob. Chi-Square(7)	0.3444
Scaled explained SS	5.152576	Prob. Chi-Square(7)	0.6413

Figure 3. Normality Test

Source: Eviews output, by Authors.

Figure 4. CUSUM test
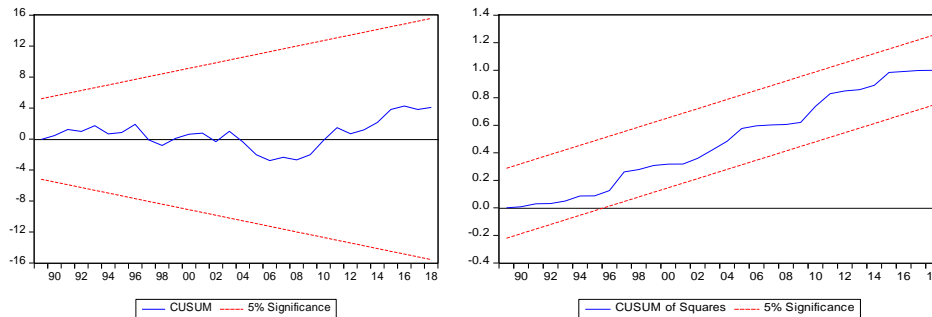
Source: Eviews output, by Authors.

Table 4 and Table 5 show the results of ARD Lmodel in long and short-term parameter estimation and Error Correction Regression in the long run. Both results show that the lag output gap, public sector investment, higher secondary enrollment and money supply are statistically significant at the 5% level of significance. The ARDL Error Correction Regression fits very well at $R^2 = 0.88$ which means the output gap is properly explained 88% by the model's exogenous variables. Both short run and long run shows that public sector investment has positive relationship with output gap, while the higher secondary enrollment and money supply have a negative relationship with the output gap. Both models show the insignificant result for the export earnings and import expenditure. The results of the public sector

investment justify the result of Abiad, Furceri, &Topalova (2016); Sallam & Neffati (2019). By the public sector investment, the crowding out effect helps to decrease the private sector investment which leads to an increase in the output gap in the economy. In this concern for the Bangladesh economy, the public sector investment has accelerated the output gap in the economy. The results of the higher secondary enrollment justify the result of Islam, Wadud, &Islam (2007). For Bangladesh economy, higher secondary enrollment is an important indicator for the labor market entry. Most of the job in Bangladesh requires minimum secondary level pass. The secondary enrollment is measured as the job market opportunity level which helps the people to get entry in the labor market. More entry in the job market creates the employment opportunity. It will help to decline the unemployment problem in the economy which will leads to a fall in the output gap. The results of the money supply justify the outcome of Sallam & Neffati (2019). The Bangladesh Bank conducts the monetary policy by influencing the money supply. The increase in the money supply leads to fall in the interest rate which helps the investment to expand. This will help the business to increase the selling of their goods and services which helps to increase the production in the economy. The expansion of the business raises the demand of the labor which creates job opportunity. More investment in the economy creates the opportunity of more production and job creation. Increase in the output level and job creation will help to reduce the output gap for Bangladesh economy. The results of the export earnings and import expenditure are found as insignificant which means in the Bangladesh economy perspective, the export earnings and import expenditure do not have enough evidence to influence the output gap in the economy. For the export level, the country is mostly depended on the readymade garments and agricultural products. In 2019 the growth of the export earning is only 2.69% and due to lower growth rate in the export earning the influence of the output gap is found as insignificant. The foreign aid dependency and gradual decrease in import help to find the insignificant outcome for the import expenditure.

The overall analysis shows that there is an output gap in the Bangladesh economy which is positive in the short run and negative in the long run. The results show that there is a positive relationship with output gap and public sector investment, and a negative relationship with the higher secondary enrollment and money supply. The other output gap determinants like export earnings and import expenditure found with insignificant outcome.

5. Conclusion and Policy Implication

The purpose of the study is to make an estimation and analysis of the output gap and its determinants. The study is made by using the macroeconomic variables and annual time series data from 1980-2018 based on the World Bank and the Bangladesh Economic Review statistics data sets. The HP filter method and theoretical model is used to estimate the output gap and its determinants in the economy. The result of output gap shows the positive result in the short run and negative in the long run. The unit root test by including ADF and PP test is utilized to verify the stationary for all the variables. Also, an investigation is made based on the

ARDL model and bound test for a long run co-integration relationship. The result of the ECM from ARDL tells that public sector investment, higher secondary enrollment and money supply are statistically significant in both short run and long run, but the export earnings and import expenditure are statistically insignificant. In both short run and long run, the public sector investment has positive relationship with the output gap, and higher secondary enrollment and money supply have negative relationship with the output gap.

The estimation of the output gap and analysis of the output gap determinants is helpful for the policymakers in Bangladesh to identify which determinants reduce or increase the output gap in the economy. The positive relationship between the output gap and public sector investment indicates that more public sector investment in the economy limits the opportunity for the private sector investment which is responsible for the output gap expansion. The government should give enough space for the private sector to grow by considering the importance of private sector contribution to the economy. Another way, the central bank should take contractionary monetary policy by lowering the interest rates so the private sector investment expands. In the study, the higher secondary enrollment and money supply have negative relationship with output gap indicating that by increasing the education level and money supply in the economy, the output gap is reduced. By this study, the government should be more careful about the education investment, notably the secondary level education. An effective monetary policy can help to grow the output in the economy by giving the opportunity to the private sectors to make investment in the capital market. Increasing money supply helps to lower the interest rate which appeals the investors to come in the market due to easier borrowing money option for their business. When there is a business growth in the economy, more people find new jobs which helps to increase the employment rate in the economy. The policy makers of Bangladesh Bank should apply an effective monetary policy in case of output gap reduction in the economy. The results of the export earnings and import expenditure are found as insignificant due to lower growth in this sector and trade deficit. To get an effective outcome from the export earnings, the government should expand the country's export by implementing effective export-oriented policies which can help to reduce the output gap in the economy. In the same way, the government can apply the quantitative restriction on imported goods to save the domestic producers which is helpful to increase the domestic investment and a fall in the output gap in the economy.

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