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Potential Output and Output Gap Estimates for Nepal

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ABSTRACT

Estimation of potential output and output gap is one of the key issues for the conduct of macroeconomic policies and structural reforms in the long-run. The idea of output gap helps to determine the stance of such policies and decide whether aggregate demand should be raised or structural issues should be addressed. A positive output gap, for instance, indicates that aggregate demand exceeds the productive capacity of the economy resulting into inflationary pressure. In contrast, a negative output gap is associated with recession, spare capacity, disinflation and unemployment rate above NAIRU. In case of Nepal, the potential output grew by 4.1 percent during 1976-2017. While potential output growth was higher during 1980s, fall in total factor productivity limited such growth to 4 percent on average after 1990. The output gap as percent of potential output fluctuated from -4.0 percent in 1980 to 2.1 percent to 2001. Fluctuations in output gap were larger in late 1970s and 80s but moderated during 90s and 2000s except the year 2001, 2014 and 2016 where the actual output deviated from the potential output by more than 1.5 percent. The results show that the output gaps in Nepalese case are mainly determined by the supply side shocks like weather conditions, natural disasters and supply disruptions.

JEL Classification: E23, E32, E52

Key Words: Potential Output, Output Gap, Univariate Filters, Production Function.

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I. INTRODUCTION

Estimation of potential output and output gap is one of the key issues for the conduct of macroeconomic policies and structural reforms in the long-run. The idea of output gap helps to determine the stance of such policies and decide whether aggregate demand should be raised or structural issues should be addressed. Economists define potential output as the level of output at which the economy is operating at full employment without creating inflationary pressure. Output gap, measured as the difference between actual and potential output, reflects the inflationary pressure in the economy. It allows the policymakers to understand the sustainable noninflationary growth, determine the stance of macroeconomic policies and adopt the countercyclical or neutral policy for sustainable growth and contain inflationary pressure. A positive output gap, for instance, indicates that aggregate demand exceeds the productive capacity of the economy resulting into inflationary pressure and the economy is operating above its full capacity with unemployment rate below the non-accelerating inflation rate of unemployment (NAIRU). In contrast, a negative output gap is associated with recession, spare capacity, disinflation and unemployment rate above NAIRU.

Despite the imperative role of output gap in policy decisions, there is still a lack of literature in Nepalese context on the size of such gap and its dynamics over time. This paper is an attempt for providing estimates of potential output and output gaps and suggesting the ways to increase the potential output.

The rest of the study is organized as follows. Section II reviews some of the studies done at national and international level, Section III discusses the estimation methods and data sources, Section IV summarizes the estimation results and the last section concludes the discussion.

II. REVIEW OF EMPIRICAL STUDIES

The literature on potential output and output gap is growing over time. The policy makers in government and central banks in developed economies cautiously monitor the movements in potential output to revisit the stance taken by the fiscal and monetary policies. Consequently, a vast pool of studies has been carried out by the central banks, government policy making authorities and independent researchers. Such studies have utilized the univariate statistical filters like HP filter and Band Pass Filters along with the structural approaches including the production function approach and Structural VAR to estimate the potential output.

Gerlach and Smets (1999) estimated the output gap for the European Monetary Unit area by using Multivariate Unobserved Components model and found that an increase in the output gap by one percentage point raises the inflation by 0.2 percent in the next quarter.

Clauss (2000) used the Structural Vector Autoregression (SVAR) methodology to estimate the potential output for the New Zealand economy. Moreover, Scott (2000) argues that the multivariate unobserved component model provides better estimates of potential output for the New Zealand economy.

Gerlach and Yiu (2002) estimated the output gaps for the five Asian economies: Hong Kong, Korea, the Philippines, Singapore and Taiwan employing the HP filter and unobservable-components (UC) techniques and found that the UC methods are better for estimating output gaps in Asia.

Sherbaz, Amjad and Khan (2005) estimated the potential output for Pakistan and found that actual output was below the potential for many years during 1963-2005. They concluded that that money supply and imports significantly contribute to widen the output gap while exports and public sector investment help reduce the gap.

Konuki (2008) found that the results from multivariate Kalman filter are more realistic for the economy of Slovakia than the conventional statistical methods and production function approach. On the basis of his findings, he argues that the multivariate Kalman Filter provides a better base for conducting macroeconomic policy in Slovakia.

In case of India, Bordoloi et al. (2009) found that India's a potential growth ranges from 8.2 to 10.2 per cent. Similarly, utilizing the SVAR method, Goyal and Arora (2012) found that the potential GDP growth for the Indian economy stood at 9 percent. Bhoi and Behera (2016) revealed that India's potential growth, which had accelerated to around 8 per cent during 2003-2008, decelerated considerably in the aftermath of the global financial crisis to about 7 per cent during 2009-2015. They used different univariate filters along with production function and multivariate Kalman filter to estimate the potential output. Other studies including Collen and Chang (1999) suggest that India's potential growth rate lies between 7 to 10 percent during the recent years.

Bank Negara Malaysia (2012) estimated potential output by using the production function approach. The results show that the output gap was positive or close to zero for most of the period during 1995-2011 except for three episodes during which the economy passed through large negative output gaps: the Asian Financial Crisis (AFC), the bursting of the technology bubble in the US (Tech Bust) and financial crisis in the advanced economies.

In case of Srilanka, Ding et.al. (2014) estimated the potential output and output gap by using different univariate filters, multivariate filter, production function approach and SVAR approach. They found that potential output growth has increased to the range of 6-7 percent during the recent years.

Felipe, Lanzafame and Zhuang (2014) estimated that potential output growth in China decelerated during the aftermath of global financial crisis (2008-2012). They argue that changes in the structure of the economy, in particular: the share of industrial employment, the working-age population, the share of net exports in gross domestic product, export growth, the share of foreign direct investment in GDP and human capital accumulation determine the potential growth rate of Chinese economy rather than the demand side factors.

Bank of Japan estimates and releases the potential growth rate and output gap on a regular basis. The May 2017 Update has found that the potential GDP growth rate has increased to 0.5-1 percent in recent years due to improvement in total factor productivity.

Bhandari (2010) estimated the potential output and output gap for Nepal by using HP filter and production function approach. He found that the output gaps remained within narrower bands after 1990s compared to the late 1970s and 80s. The result from the production function revealed that the total factor productivity continuously fell after the early 1990s.

III. ESTIMATION METHODS AND DATA SOURCES

The estimation of potential output is challenging since it is not observable and its drivers are several structural factors such as technology, capital stock and human resources that are difficult to measure. The actual output includes cyclical shock or permanent impacts to potential output. Thus, extracting cyclical factors from actual output is a challenging task. A number of techniques have been developed to estimate potential output by extracting cyclical components from actual. Such methods can be divided into two broad approaches: univariate statistical methods and multivariate methods based on economic theory. While the univariate methods decompose time series into permanent and transitory components and do not impose any economic structure in the estimation, the multivariate methods are based on the economic theory.

Using the annual data for the period 1975-2017, this paper has used the following methods for estimating the potential output and output gap for Nepal : (i) Hodrick-Prescott (HP) filter, (ii) Christano Fitzgerald (CF) filter, (iii) Beverage-Nelson decomposition, (iv) unobserved component model and (v) production function approach.

The Hodrick-Prescott (HP) Filter

HP filter is a simple and commonly used method of estimating potential output. It estimates the potential output by minimizing the gap between actual output (y) and potential output ($\hat{y}$) subject to a constraint on the extent to which potential output growth can vary. It can be written as:

$$\min_{\hat{y}} \sum_{t=1}^{T} (y_t - \hat{y}_t)^2 + \lambda \sum_{t=1}^{T} [(y_{t+1} - \hat{y}_t) - (y_t - \hat{y}_{t-1})]^2$$

Where t is the sample period, $\hat{y}$ is potential output, y is actual output and λ is the restriction parameter that determines the degree of smoothness of the trend. The choice of the value of λ is crucial since it determines how fast the cycle disappears and actual output is brought back to potential output. The higher is the penalty (the value of λ), the smoother the series since the λ reflects the maximum change allowed in the values of potential GDP in two consecutive periods. Since this study uses annual data, we have used λ =6.25 as suggested by Ravn and Uhlig (2002).

Christiano Fitzgerald Frequency (CF) Filter

It is a band pass (BP) filter, proposed by Christiano and Fitzgerald (2003) which estimates the cycle present in the series by taking a two sided moving average of the data. It approximates the ideal infinite filter based on the assumption of cycle period from 2 to 8 years. It estimates cycle for full sample period and performs well even in lower frequency when the data follow random walk.

Univariate Unobserved Component Approach

The unobserved component model estimates the unobserved variables such as potential GDP from observed variables. After the structural or statistical relationship is stated in state space form, the unobserved series are estimated using the Kalman filter by providing the initial values of the unobserved series. This paper has used univariate Kalman filter method. More specifically, the unobserved component approach by Clark (1987) has been used for estimating potential output. This model decomposes a series y_t into a stochastic trend component (y_t^*) and cyclical component (c_t). The output can be written as:

$$y_t = y_t^* + c_t \quad \text{.......... (1)}$$

The stochastic trend component is modelled as:

$$y_t^* = y_{t-1}^* + d_{t-1} + w_t \quad \text{.......... (2)}$$

$$d_t = d_{t-1} + u_t \quad \text{.......... (3)}$$

$$\phi(L)C_t = v_t \quad \text{.......... (4)}$$

Where, w_t, u_t and v_t are independent white noise processes and $\phi(L)$ is a finite polynomial in the lag operator L. And, d_t stand for potential growth and the equation (4) is the cyclical component following stationary and autoregressive process.

Beveridge-Nelson (BN) Decomposition

The BN decomposition decomposes a non-stationary time series into the trend and cycle component by applying the Box-Jenkins methodology that uses an ARIMA (p, d, q). It assumes that the observed series is ARIMA process such that its growth is stationary. Moreover, the permanent and cyclical components are assumed to be affected by unidentified shock. This method assumes both unobserved and temporary components in output and has no end-point problems in the estimation of cycles. An ARIMA model is used to forecast the series over a time horizon and the cycle is estimated for each time period as:

$$C_t = E_t\,(\Delta Y_{t+s} + \Delta Y_{t+s-1} + \ldots\ldots\ldots + \Delta Y_{t+1}) - s\hat{\alpha}$$

$Where, s$ is the time horrizon and $\hat{\alpha}$ is the constant to be estimated.

Production Function Approach

One of the widely used methods to estimate potential output is the production function method (PF). In contrast to the statistical filters mentioned above, the PF approach takes into account the availability of production factors in the economy. Its focus is the supply potential of the economy and assumes the potential output as a function of potential labor, capital inputs and total factor productivity (TFP). The PF approach uses the Cobb-Douglas production function with constant returns to scale, that is,

$$Y_t^* = A_t^* K_t^{*\alpha} L_t^{*(1-\alpha)}$$

Where, Y* is potential output, L* and K* refer to potential (or full-employment) labor and capital inputs respectively, A* is potential TFP, and α and 1-α are the share of capital and labor respectively.

The information on capital stock is not readily available in Nepal as such the study has utilized Perpetual Inventory Method (PIM) to arrive at such figures. Following the PIM, the series of capital stock has been constructed as:

$$K_t = (1-\delta)K_{t-1} + I_t$$

Where, capital stock at year t is derived as the previous period capital stock net of depreciation plus the investment flows in the current year. The rate of depreciation (δ) has been assumed to be 6 percent per annum on the basis of literature. The initial capital stock (K_{1975}) has been computed as $K_{1975} = I_{1975}/(\delta + g)$; where g is the average growth rate of investment (fixed capital formation) for the sample period 1975-2017.

Also, annual data of labor force is not readily available in Nepal. As such, population aged 15-64 years as published in World Development Indicators by the World Bank has been used as a proxy for labor force. TFP is calculated as a residual contribution to GDP after taking into account the contribution of physical capital and labor.

All of these approaches have their own strengths and limitations. There is no single superior approach in the estimation of potential output. For example, univariate filters do not incorporate information from other variables and ignore economic theory. And, some of them also suffer from end-point bias. The production function approach includes various drivers of potential output, but needs some smoothed series for the estimation. Therefore, this paper uses both univariate and multivariate methods for the estimation of potential output.

Data

The study is based on annual data from 1975 to 2017 as the national account figures are not available on a quarterly basis. Information on real GDP and fixed capital formation have been taken from Economic Survey (various issues) published by Ministry of Finance and national accounts data published by Central Bureau of Statistics, Government of Nepal . Inflation statistics have been taken from Quarterly Economic Bulletins published by Nepal Rastra Bank and information on active population has been taken from World Development Indicators published by the World Bank.

IV. EMPIRICAL RESULTS

This section presents the results of potential output and output gap based on the methods used for this study. In order to address the problem of end-point bias, the real GDP series has been extended up to 2020 by using the growth projection of 7.2 percent for 2018 as stated in the Government Budget of Nepal for fiscal year 2017/18 and the growth forecasts by IMF for the period 2019 and 2020. This extended sample has been used in case of univariate filtering techniques sensitive to end point bias.

Table 1: Potential GDP Growth Rate

Methods	1976-1980	1981-1990	1991-2000	2001-2010	2011-2017	1975-2017	(Before Liberalization)	(After Liberalization)
HP Filter	1.1	5.3	4.9	3.7	4.0	4.1	3.8	4.2
Univariate UC	2.0	4.8	4.7	3.8	4.1	4.1	3.8	4.2
CF Filter	2.1	4.8	4.7	3.8	4.1	4.1	3.8	4.2
BN Decomposition	2.0	4.9	4.8	3.8	4.0	4.1	3.8	4.2
Production Function	0.6	5.1	4.9	3.7	4.0	4.2	4.3	4.2
Average	**1.6**	**5.0**	**4.8**	**3.8**	**4.0**	**4.1**	**3.9**	**4.2**

Table 1 and figure 1 present the potential GDP growth rates and the historical observed GDP growth rate. The results about the growth of potential GDP derived from all the techniques confirm with each other. During 1976 to 2017, Nepal's potential GDP grew by 4.1 percent on average. The potential growth was 3.9 percent on average before liberalization period that increased slightly to 4.2 percent in the post-liberalization period. The potential growth was low in the late 1970s that improved to 5.0 percent during 1980s. However, such a growth averaged to 4.8 percent only during 1990s. After 2000, the growth of potential GDP remained stable around 4 percent. Furthermore, such a growth rate was low during 2000-2007. The potential growth which increased after 2004 slowed down again after the global financial crisis of 2007. In 2017, the potential GDP growth rate is 4.4 percent implying the moderate recovery of the economy.

Figure 1: Real GDP and Potential GDP Growth (1976-2017)

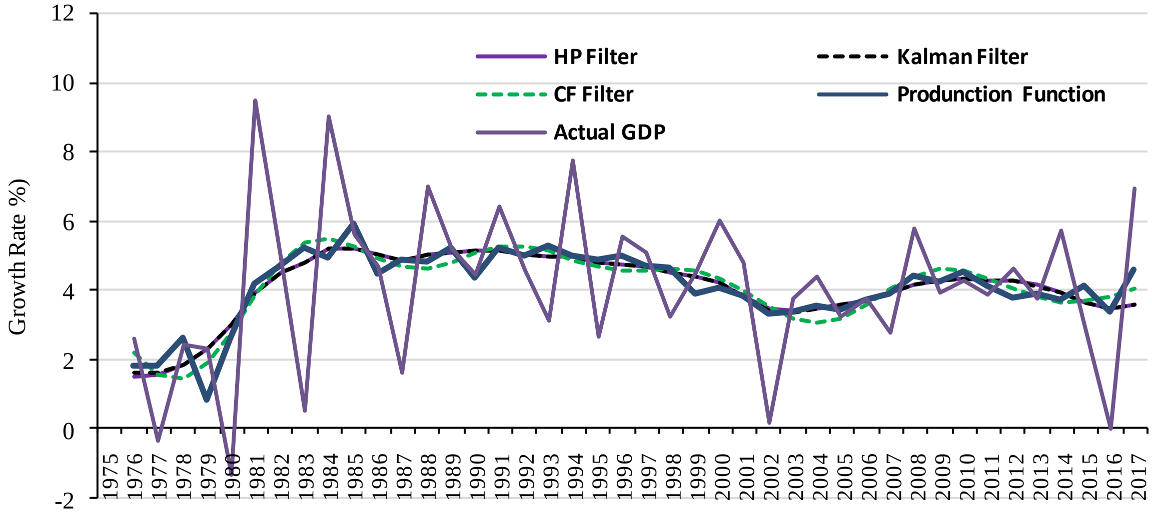
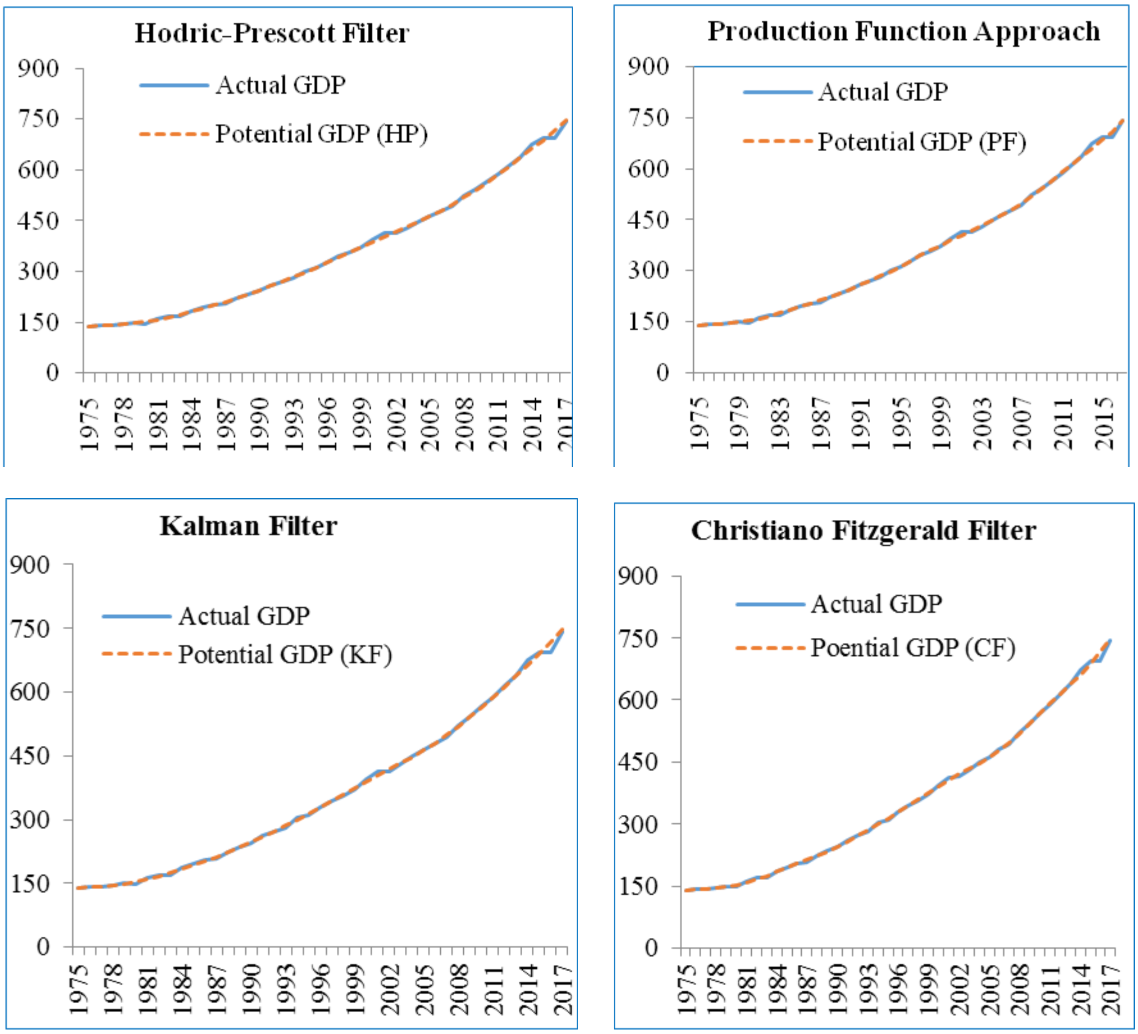
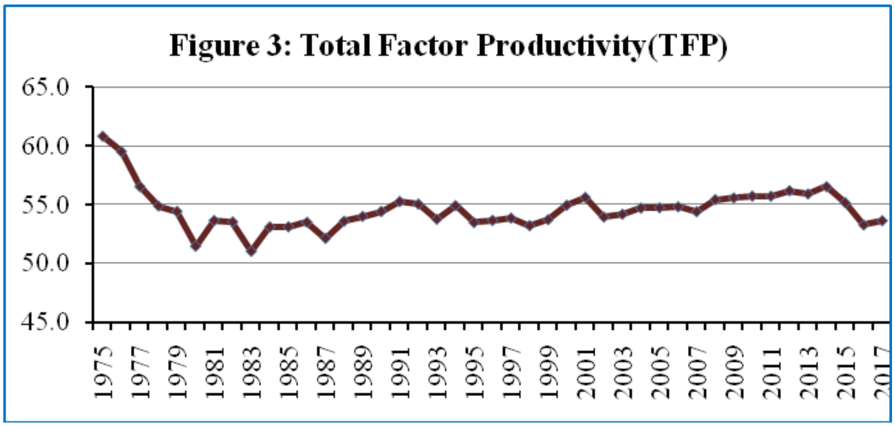


Figure 2 shows the potential and actual GDP for the period 1975-2017 using various methods. The potential GDP seems to fit with actual GDP. There are larger deviations of actual GDP from the potential in 1980, 2001 and 2016.

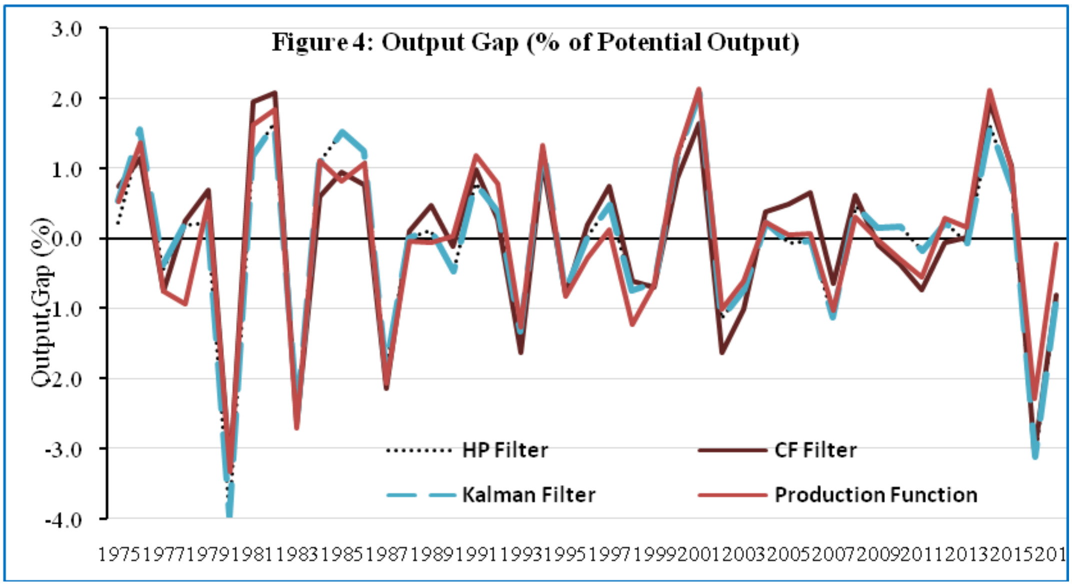
Figure 2: Potential and Actual GDP (1975-2017)



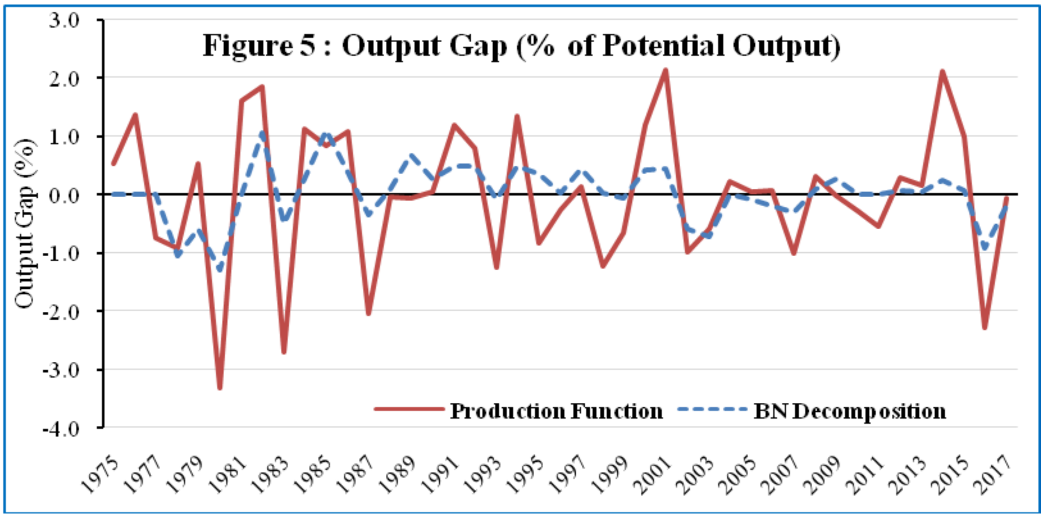
The results from production function approach shows that the growth in total factor productivity (TFP) of Nepalese economy is very low (figure 3). During the late 1970s, TFP declined by 3.3 percent on average while it increased by 0.6 percent during the 1980s. Such growth rate remained about 0.5 percent during the 1990s and 2000s. However, TFP declined by 0.5 percent on average after 2011. This result confirms the findings of Khatiwada and Sharma (2002) and Bhandari (2010) for Nepalese economy. This imply for a necessity of raising the TFP in order to accelerate the growth of potential output. Studies (e.g. Khatiwada and Sharma (2002)) show that real exchange rate, trade openness and weather condition significantly affect the total factor productivity in Nepal. Minimizing the adverse effect of unfavorable weather condition, intensifying the trade openness and preventing the appreciation of real exchange rate would, thus, prevent TFP from further declining and may accelerate the growth of potential output.



The output gap estimates are presented in figure 4 and figure 5. The output gap estimates are highly correlated across the methods with identical peaks and troughs. The results show that output gaps most often seem to follow the monsoon cycle in Nepal that repeats every four years. This result is convincing as the share of agriculture in GDP is significantly large during the period and the agricultural production in Nepal highly depend on monsoon. Thus, the output gap mostly reflects the monsoon cycle: the positive output gap associated with favorable monsoon and negative gap due to unfavorable monsoon.



The gap ranges from -4.0 to 2.1 percent under various methods: the largest negative gap occurred in 1980 due to the severe drought and the largest positive gap occurred in 2001 due to favorable weather conditions. Such gap is estimated around -2.5 percent in 2016 due to the devastating earthquake of April 2015 and disruption in supply situation from the border obstructions. The average output gap from the various methods is around -0.5 percent in 2017 indicating that the economy is still running below potential. All these methods indicate that the output gap was close to zero after the global financial crisis (2008-2013). The gap became significantly positive only after 2013 and later turned negative due to supply shocks arising from the earthquake and the supply disruptions appeared thereafter.



Output gap based on BN decomposition has been presented separately along with the results from production function approach. The gap from BN Decomposition shows less volatility fluctuating between -1.3 in 1980 to 1.1 percent in 1985.

Table 2: Output Gaps from Various Methods

Year	HP Filter	CF Filter	BN Decomp.	Productio n Function	Univariate UC	Average	Major Cause
1980	-4.2	-3.7	-1.3	-3.6	-4.2	-3.1	Upward Revision in Petroleum Prices, Severe Drought
1993	-1.5	-1.9	-0.1	-1.4	-1.5	-0.9	Unfavorable Weather, Devaluation of Nepalese Currency with Indian Currency
1994	1.3	0.9	0.5	1.3	1.3	1.0	Favorable Weather Condition, Base Effect on Agricultural Growth
2001	2.4	1.8	0.4	2.4	2.4	1.6	Favorable Weather Commission of Kaligandaki A Hydropower Project
2016	-3.2	-3.3	-0.9	-1.9	-3.2	-2.3	Earthquake and Supply Disruption
2017	-0.7	-1.2	-0.2	-0.2	-0.7	-0.5	Favorable Weather Condition, Government Spending for Reconstruction

In order to address the problems associated with cycle extraction filter and BN decomposition, the gaps have been estimated by using the production function approach that too shows similar results. In comparison to other methods, it shows the lowest negative output gap of 0.1 percent in 2017. The negative output gap has been narrowing and going to close with a sustained high growth in the next fiscal year.

Table 3: Output Gap Correlation Matrix

	HP Filter	CF Filter	Univariate UC	BN Decomposition	Production Function
HP Filter	1.00	0.96	1.00	0.74	0.95
CF Filter		1.00	0.96	0.69	0.95
Univariate UC			1.00	0.74	0.95
BN Decomposition				1.00	0.72
Production Function					1.00

The estimated output gaps using various methods are highly correlated. Table 3 shows the correlation matrix. The high correlation coefficients show that the output gap estimates under various methods move together. However, the magnitude of the gaps differs in some periods under these methods. The results of Bevridge-Nelson decomposition differ to some extent than other methods, indicating low volatility in the output gap.

V. CONCLUSION

This paper is an attempt to estimate the potential output and output gap for Nepal using standard methodologies including HP filter, Beveridge-Nelson decomposition, Christiano-Fitzgerald filter, univariate unobserved component model and production function approach. The estimation results indicate several interesting facts. First, the growth of potential GDP is relatively low (around 4 percent) for the period 1975-2017. While such growth rate was higher during 1980s and early 1990s, it was limited to around 4 percent in the later periods. The lower growth of potential output is associated with the fall in total factor productivity pointing towards the necessity for raising total factor productivity of the economy. Second, the fluctuations in the output gap have smoothened after 1980s except for few exceptional episodes in 2001, 2015 and 2016. Third, the output gap is found to be affected by supply sides factors including the weather conditions, natural disasters and supply side shocks. Fourth, the decrease in negative output gap in 2017 seems to indicate that the economy is in recovery phase.

These results provide important implications for macroeconomic policy. However, the results should be treated with caution given the specific feature of Nepalese economy. The end point bias in the case of univariate filters and annual data with a relatively short time period is also a caveat of this paper. More importantly, the fluctuations in output in the context of Nepal are somehow different than developed countries mostly driven by the supply shocks such as weather, natural disaster and other geo-political conditions rather than driven by the fluctuations in aggregate demand.

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