Sustainable economic growth and unemployment nexus of SDG 2030: Bangladesh in Asia

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Abstract
In this study, we applied the Okun’s law to examine the current progress of sustainable economic growth and unemployment goal of the fourteen developed and developing countries of Asia. Our findings suggest in the long-run, only China has achieved the sustainable economic growth and unemployment goal until 2018. However, due to recent downward trend of economic growth and upward trend of unemployment rate, China is currently walking opposite to the said goal. Besides, Bangladesh, Kazakhstan and Thailand are progressing fast and Malaysia and Tajikistan are progressing moderately towards the sustainable economic growth and unemployment goal 2030. Despite a higher Okun’s coefficient, Turkey is walking opposite to the SDG 2030 due to a sharp rising trend of unemployment and a quick declining trend of GDP in recent time. The rest of the countries are far-off from the above-mentioned goals.

Keywords Sustainable development goals (SDG) · Okun’s law · Economic growth · Unemployment

JEL Classification J01 · O11
Introduction

In 2015, the UN member states agreed to a universal call to adopt seventeen integrated goals commonly known as sustainable development goals (SDGs) to end up poverty protect the planet and upgrade the living standard of the member country by 2030 (UNSDS, 2015). The 8th goal of the SDG is ‘Decent Work and Economic Growth’. This goal requires the following core economic milestones meet by 2030; first, to confirm sustainable economic growth, i.e., at least seven percent GDP growth rate for the least developed and developing countries through efficient use of human and natural resources so that environmental pollution can be reduced to keep the quality of future generations life intact. Second, confirm the highest economic productivity through innovation and resource diversification. And, finally, a safer job environment for the male and female workers, the right job for the employees keeping labor right intact, and reduces the unemployment rate to near zero percent.

The economic growth and unemployment expectations of the 8th SDG goal state, if a rise in the long-run economic growth leads to a proportionate decline in the unemployment rate, we can call it sustainable. According to Okun (1962) the general rule of thumbs of the economic growth and unemployment nexus is ‘a one percent increase in the GDP growth rate declines a half percent unemployment rate if the current GDP growth rate is less than to its potential growth’. From 1962 onward this rules is widely applied in the growth-unemployment analysis and becomes a textbook material since then.

However, in recent times varied findings of Okun’s law is evident in different parts of the world. For example, Soylu et al. (2018) evidenced a 1% increase in the GDP growth rate declined only 0.08% of unemployment rate in the eight Eastern European countries and Abdul-Khaliq et al. (2014) evidenced 0.16% declined in the unemployment rate of nine Arab countries. These confirmed that although regional disparities persist in the Okun’s coefficient across the world, literature firmly evidenced a causal negative relationship of the GDP growth rate and the unemployment rate. Furthermore, a more recent widely accepted studies verified, although a slight variation persists in the Okun’s coefficients across the world, this rules is still valid in the developed world economy, (Ball et al. 2019). Hence, the rule of thumbs of Okun’s law can be considered as standard for measuring the progress of sustainable economic growth.

However, the sustainable growth and unemployment feature of an economy may be better understood from Levin (2013) who finds, underutilized labor forces are persist in many economies whose are working with less than their full capacity. If demand increases, output growth is increased by increasing the labor productivity without hiring new labor which consequences no unemployment fall. Unemployment declines only when the output growth exceeds the full labor productivity in the economy. Thus, if the steadily increasing GDP growth accelerates a sharp unemployment fall, the growth is progressing towards sustainability. However, if the achieved growth is far less than the growth of what would have been with the current economic scenario, but reduced the unemployment rate sharply, we cannot call it sustainable. To be sustainable, the growth should be the outcomes of the optimum
usage of factors of production which will eventually fall the unemployment rate proportionately.

In Asia, most of the countries are in the middle-income group. Therefore, accelerating economic growth along-with reducing unemployment rate is the biggest challenge for them. In Figs. 1–14 of Annexure 1, we see, except Armenia, Turkey, and China most of the countries’ unemployment rate is approximately flat negative with huge fluctuations in their GDP growth rate in the early 2000. However, from 2015 around, the growth rate becomes more stable and increasing in many Asian

Fig. 1 GDP growth rate and unemployment rate of the sampled countries from 1991 to 2018
countries indicating sustainability at a first glance. However, increasing unemployment rate in some of these countries require further inquiry about the sustainability of the economic growth of those countries.

Moreover, ESCAP (2019) reported an overall negative trend of ensuring decent work and economic growth in the Asia and Pacific region until 2018. Particularly, north, central and southeast Asia is heading towards wrong direction of decent work and economic growth goal, whereas south and south-west Asia is progressing on the same. Hence, countrywise analysis of the impact of GDP growth rate to the unemployment rate is necessary to warrant a particular growth sustainable.

Fig. 1 (continued)
The scenario of sustainable economic growth and unemployment rate in Asia

Seven percent GDP growth rate and zero percent unemployment rate is the standard of decent work and economic growth goal of SDG 2030. Federal Reserve considers the unemployment rate less than four and a half percent is full employment. Considering these, in Table 1, only Bangladesh fulfills the SDG target in terms of both criterions in 2018.

Bangladesh, a member of the UN family since 1974, started concentrating on the given indicators of the SDGs’ immediately after the UN call and reached to the acceptable standard of many goals soon after their initiatives. The reasons of quick achievement to different milestones of the SDGs are the diverse economic reforms initiatives that were taken years before the SDG’s call and now in effect in many economic and social development projects. Furthermore, huge infrastructural development along with the construction of many economic zones led Bangladesh for a sharp rise in its economy.

As a result, in 2018, first time Bangladesh graduated from the LDC status to the developing country status and if it upholds the same status in 2021, it would be recommended for permanent graduation of LDC in 2024 (Risse 2018). For that reason, continuous assessment of the sustainable growth and unemployment goals attainment is highly recommended at this trajectory. At the moment, Bangladesh is growing all-time fastest than before. Figure 1 of Annexure 1 shows that the GDP growth rate started increasing sharply from 2015 onward after a slow and steady increase in 2013–14 and reached to its peak of 7.86% in 2018. Thus, it seems, Bangladesh is on the right track of progressing towards the sustainable economic growth goal. Moreover, in recent times, the unemployment rate is also slightly declining which reinforcing this outlook further.

However, the rising economic growth can produce poverty if the benefit of the growth is offset by the much rising inequality (Kakwani and Pernia 2000). Precisely, if the economic growth proportionately increases the income of the existing firm owners and the labor forces and also widens the scope of the economic activities to

Fig. 1 (continued)
create more jobs in the economy, the growth is optimum. Except these the growth will consequences inequality in the income distribution only.

In Bangladesh, inequality in income distribution is common (Islam et al. 2012) and the employment elasticity plunged to 0.25 in the fiscal years 2017–18 from 0.55 in the fiscal years 2005–06 (Byron 2019). For that reason, although overall economic growth of Bangladesh is accelerating since the last decade, it is currently facing lower job creation consistently in the last few years making economists skeptical about the worth of higher GDP growth rate.

In India, the unemployment and output gap nexus is negative and insignificant during 1991 to 2016, (Bhowmik, 2018). Moreover, the Indian labor market is facing a lower participation rate of the working-age population, and the labors are continuously switching from the agricultural sector to the industry and service sectors causing a downward trend in the agricultural productivity there (Borooah, 2019) and (Desgupta and Kar, 2018). These also indicate that India is currently going through a transition phase in its labor market by staying far off from the sustainable economic growth and unemployment goal.

Recently, the labor market of China is also facing unpredictable changes in its structure. Song (2016) finds, more private-sector jobs in the urban areas of China causing more unemployment in the rural areas. This is creating wage discrimination and broadening their earnings inequality which is supposed to increase the overall unemployment rate further. Thus, although a long and short-run causal relationship of the economic growth and unemployment rate persist in China (Karikari-Apau and Abeti, 2019), and the recent unemployment rate of China is trending downward since 2010 (Fig. 13 of Annexure), its journey towards sustainable economic growth and unemployment goal is doubtful in the current economic scenario.

The Mining and Oil industry is contributing approximately half of the economic growth in Iraq which shares only 1% to their labor forces. Thus, low elasticity (−0.2) of growth and employment persists in Iraq which eventually outcomes record percentages of unemployment in the recent years (World Bank, 2014). Currently, 2.5 million jobs are needed to ensure full employment and by 2030 the projected job requirements are 5 to 7 million in Iraq (Bandiera et al. 2019). Likewise, the Lebanese labor market is also facing lower job creation and job seekers usually have to wait for a year to get a job (ILO, 2016). This is because a significant number of labor forces are engaged in the informal sector of Lebanon, where skill mismatch is common.

Elvin and Pellenyi (2007) reported various transition stages of the Azerbaijani economy. At the beginning stage, from 1991 to 1995, weak and inappropriate economic reforms initiatives outcome negative GDP growth rate and increased the unemployment rate. After taking more appropriate reform initiatives in 1996 onward, the economic growth incredibly turns to positive which continued until 2007. However, this tremendous growth process also failed to reverse their unemployment rate until 2000. However, change began in 2000 which continued until 2012 when Azerbaijan experienced a golden phase of economic growth in his history. In that period, rate of poverty reported to 6 percent in 2012 from close to 50 percent in the early 2000 (World Bank, 2015). However, this higher growth phase also failed to transform higher productive laborers and increased their participation
rate in the economic activity during that era. As a result, again in the following years, the economic growth and unemployment indicators of Azerbaijan showed a complex scenario of its economy.

The World Bank (2017) reported Armenia’s average GDP per capita was 12.3 percent between 2004 and 2009 (1st quarter) but declined to 3.2 percent amid 2009 (2nd quarter) and 2016. The unemployment rate plunged to 21.90 percent around April 2019 and remained plateau at 17 percent around December 2019. These imply that Armenia is currently outperforming the sustainable economic growth and unemployment goal.

On the contrary, in Thailand, The World Bank (2018) reported a sharp rise in the components of economic growth from 2012 to 2017. The current financial system is strong and progressive and the economic recovery was expected to start from 2018. At present, the service sector is the main driver of the Thai economy which consists of 40 percent employment, whereas the manufacturing sector is contributing the highest GDP, approximately 35 percent of total output. Besides, workforce development program enable Thailand to shape a technology-driven economy and the laborers are enjoying the highest level of job facilities compare to the other developing countries of Asia.

Overall, except Thailand, none of the sample country’s economic growth and unemployment rate seems sustainable at a first glance. Besides, inconsistency in the GDP growth and unemployment rate in the sub sample period persists in the sample countries. Therefore, concluding about the sustainable attribute of the overall economic growth and unemployment rate of any economy without examining the long- and short-run relationship between them would be unwise.

For this reason, we aim to examine the short and long-run economic growth and unemployment nexus of the sample Asian countries to verify their current progress on achieving sustainable economic growth and unemployment goal of SDG 2030. We also

| SI no. | Country      | GDP Growth Rate | Unemployment Rate |
|--------|--------------|-----------------|-------------------|
| 1      | Bangladesh   | 7.86            | 4.31              |
| 2      | Tajikistan   | 7.30            | 10.92             |
| 3      | India        | 6.81            | 2.55              |
| 4      | China        | 6.57            | 4.42              |
| 5      | Philippines  | 6.24            | 2.52              |
| 6      | Armenia      | 5.20            | 17.71             |
| 7      | Malaysia     | 4.74            | 3.36              |
| 8      | Thailand     | 4.13            | 0.67              |
| 9      | Kazakhstan   | 4.10            | 4.89              |
| 10     | Sri Lanka    | 3.21            | 4.40              |
| 11     | Turkey       | 2.83            | 10.90             |
| 12     | Azerbaijan   | 1.41            | 5.22              |
| 13     | Lebanon      | 0.20            | 6.17              |
| 14     | Iraq         | -0.56           | 7.93              |
intend to detect the presence of underutilized labor forces who are currently working in the sample economies to suggest a way to increase their participation rate in the economic activities. Finally, we want to give some policy recommendations to the progressive countries of Asia to overcome the probable barriers of attaining sustainable economic growth and unemployment goal.

Our contribution to the existing literature is that we extended the applications of Okun’s law to investigate the progress of sustainable economic growth and unemployment goal by the sample countries which is new in the literature. Besides, this paper was completed on January 2020, just before the CORONA pandemic, hence, the findings of this research depict the scenario of the SDG progress immediate before the world has witnessed the COVID 19 and also would be a benchmark findings for further research on the impact of CORONA pandemic to the sustainable economic growth and unemployment goal of Asian countries.

The rest of this paper is organized as follows; Sect. 3 discusses the data; Sect. 4 discusses the methodology: Sect. 5 discusses the results, and Sect. 6 concludes the paper with policy recommendations.

Data

We have collected yearly data of the real GDP (constant 2010 US$), GDP growth rate and the unemployment rate of the fourteen Asian least developed and developing countries from the World Bank data indicator for the period of 1991–2018. The sample countries are Bangladesh, Tajikistan, India, China, Philippines, Armenia, Malaysia, Thailand, Kazakhstan, Sri-Lanka, Turkey, Azerbaijan, Lebanon, and Iraq.

First, we conducted the descriptive analysis to depict the overall long run scenario of the GDP growth rate and unemployment rate of the sample countries. Next, we applied the original and changed version of Okun’s law to examine the long- and short-run nexus of economic growth and unemployment rate in those countries. For descriptive analysis we consider the GDP growth rate and the unemployment rate and to apply Okun’s law, we transformed the unemployment rate to decimal numbers denoted as (U) and log of real GDP denoted as (Y) to stabilize the variance of the GDP series.

Methodology

Descriptive analysis

In the descriptive analysis, overall, we point out that a lower average GDP growth rate does not specify lower progress of sustainable economic growth unless the recent growth movement is trending downward and the unemployment rate is trending upward. On the contrary, a higher average economic growth does not signify a higher possibility of achieving sustainable growth unless it declines the long-run average unemployment rate significantly.

In Table 2, the mean economic growth of China is highest 9.63% during 1991–2018 indicating a long-run sustainable growth persists there. Moreover, the
mean unemployment rate is <4% in the same period indicates their full employment and the standard deviation of the GDP growth rate and unemployment rate are <2% and <1% confirming lower variation prevail during the sample period. Furthermore, the positive skewness (0.68) of economic growth indicates, more often, the economic growth is found above the mean value and a negative skewness (−0.74) of unemployment rate indicates, in most of the sample years, the unemployment growth is found below the mean value. The negative kurtoses in both series confirm successive changes of both variables are lower and steady. All these portray sustainable features of the economic growth and unemployment scenario in China.

However, Fig. 13 of Annexure shows that the GDP growth rate of China is dramatically declining from 2008 and the unemployment rate is increasing since then hypothesizing an economic meltdown nearby. If this continues and China fails to reverse their economic growth and unemployment trend, it might not possible for them to uphold the current sustainable economic growth and unemployment attainment in future.

On the contrary, the mean unemployment rate of Iraq 8.96%; Lebanon 7.58%; Sri Lanka 7.84%; Turkey 9.14%; Azerbaijan 6.69%; Armenia 12.33%; Kazakhstan 7.38% and Tajikistan 11.41% indicate, in the long run, serious unemployment problem persist in these countries. Moreover, the lower mean economic growth (<5%) of Turkey, Azerbaijan, Armenia, Kazakhstan and Tajikistan are 4.56%, 4.20%, 3.34%, 2.95% and 1.94% confirm, these countries are far off from the SDG 2030. Besides, the negative skewness of GDP growth rate of Iraq, Sri Lanka, Turkey, Azerbaijan, Armenia, Kazakhstan and Tajikistan confirmed, in most of the sample years, GDP growth rate was below the mean value. In addition, the kurtosis of GDP growth rate of Iraq, Lebanon, Sri Lanka and Armenia are beyond +3 validate a non-normal growth phase sustained between 1991 and 2018. The standard deviation of the GDP growth rate of Iraq (20.95%), Lebanon (9.45%), Azerbaijan (13.15%), Armenia (11.29%), Kazakhstan (6.95%) and Tajikistan (10.84%) are much higher to warrant a higher volatile growth phase in the sample period. All these authenticate that the above countries are outlying from the sustainable economic growth and unemployment goal at a first glance.

However, in Fig. 5 of Annexure, we see the GDP growth rate of Tajikistan was negative until 1996 and started increasing from 2005 onward and reached to 7.30% in 2018 contradicting the above findings. Furthermore, the unemployment rate started falling from 16.50% in 1996 to 10.92% in 2018 gives a slow indication of progress in economic growth and unemployment goal of Tajikistan in recent times. Similarly, the recent rising trend in the GDP growth rate and a falling trend in the unemployment rate of Kazakhstan in Fig. 3 of Annexure are also showing their sustainability progress in the above indicators.

In contrast, Figs. 6 and 14 of Annexure show that the GDP growth rate of Turkey and Sri Lanka are falling and their unemployment rate is rising in recent times further showing their far-off position from the SDG. In Figs. 2 and 10, the GDP growth rate is increasing in Azerbaijan and Armenia in recent time, but their overall upward trend of unemployment rate give us no hope of achieving the SDG 2030. In Fig. 9, the unemployment growth of Lebanon is declining along with their GDP growth rate also depicts no expectation of achieving SDG 2030.
The long-run mean economic growth of India 6.36%; Malaysia 5.72%; Bangladesh 5.59%; Thailand 4.21%; and Philippines 4.50% with their mean unemployment rate less than <4% showing their higher progress on sustainable economic growth and unemployment goal at a first glance. Besides, the lower standard deviation (<1%) of unemployment rate of these countries validating their steady improvement on sustainable unemployment goal until 2018.

In addition, except India, the skewness of the unemployment rate of the rest four countries are negative which confirm that in most of the sample year’s, unemployment rate was below the mean value, a positive sign of sustainable progress. On the other hand, except Bangladesh, the skewness of the GDP growth rate of the rest four countries are also negative indicating, more often in sample years, the GDP growth rate was below the mean value, a negative signal of sustainable progress. Only Bangladesh perfectly satisfies the yearwise progress of economic growth and unemployment targets of SDG 2030.

Besides, a small and positive kurtosis (0.10) with lower standard deviation (1.12) of the GDP growth rate confirms successive changes of the growth are lower and steady in Bangladesh. Moreover, in Fig. 1 of Annexure, a sharp rising trend of economic growth with a slight but consistent declining trend of unemployment rate from 2012 onward keep Bangladesh ahead of progressing the above SDG targets among these countries.

In contrast, a slightly higher standard deviation of the GDP growth rate of Malaysia and Thailand confirm their higher variation of growth series. Moreover, the kurtosis > 3 of the economic growth of Malaysia confirms a non-normal growth phase with existence of outlier. Besides, Fig. 4 of Annexure shows that from 2012 onward the overall trend of economic growth is slightly declining with almost constant

### Table 2: Descriptive statistics of the GDP Growth Rate and Unemployment Rate (1991–2018)

| No. | Country       | GDP growth rate | Unemployment rate |
|-----|---------------|-----------------|------------------|
|     |               | Mean  | SD    | Skewness | Kurtosis | Mean  | SD    | Skewness | Kurtosis |
| 1   | China         | 9.63  | 2.31  | 0.68     | −0.40    | 3.92  | 0.78  | −0.74    | −1.07    |
| 2   | Iraq          | 6.63  | 20.95 | −1.10    | 4.82     | 8.96  | 0.73  | −0.22    | −1.34    |
| 3   | India         | 6.36  | 1.93  | −0.99    | 0.48     | 2.68  | 0.23  | 0.53     | −0.02    |
| 4   | Lebanon       | 6.32  | 9.45  | 3.76     | 16.82    | 7.58  | 1.01  | −0.40    | −1.68    |
| 5   | Malaysia      | 5.72  | 3.66  | −1.93    | 5.44     | 3.31  | 0.35  | −0.50    | 1.06     |
| 6   | Bangladesh    | 5.59  | 1.12  | 0.10     | −0.68    | 3.59  | 0.83  | −0.35    | −1.22    |
| 7   | Sri Lanka     | 5.22  | 2.06  | −0.91    | 3.32     | 7.84  | 3.43  | 0.66     | −0.76    |
| 8   | Turkey        | 4.56  | 4.59  | −1.07    | 0.32     | 9.14  | 1.55  | 0.05     | −0.64    |
| 9   | Philippines   | 4.50  | 2.31  | −0.89    | 0.02     | 3.48  | 0.37  | −1.41    | 1.85     |
| 10  | Thailand      | 4.21  | 3.69  | −1.42    | 2.78     | 1.34  | 0.79  | 1.19     | 0.69     |
| 11  | Azerbaijan    | 4.20  | 13.15 | −0.10    | 1.02     | 6.69  | 2.62  | 0.07     | −0.03    |
| 12  | Armenia       | 3.34  | 11.29 | −2.67    | 9.11     | 12.33 | 5.12  | −0.40    | −0.60    |
| 13  | Kazakhstan    | 2.95  | 6.95  | −0.81    | −0.05    | 7.38  | 3.65  | 0.11     | −0.57    |
| 14  | Tajikistan    | 1.94  | 10.84 | −1.69    | 1.75     | 11.41 | 3.36  | −1.58    | 3.08     |
unemployment growth. This requires keen inquiry about their SDG progress. In Fig. 8, from 2016 onward, although unemployment rate is slightly decreasing in India, a sharp declining trend of GDP growth clearly portray their inverse progress on the said targets of SDG 2030.

**Okun's law**

We applied Okun’s law (1962) earlier applied by Ball et al. (2019) to examine both long- and short-run relationship of the GDP gap and unemployment gap of the sample Asian countries. Following Okun’s, we assume that a higher GDP gap will lead to a lower unemployment gap. Precisely, the actual unemployment rate will depart to its natural rate if the GDP gap declines. The long-run Okun’s equation stands as

\[ U_t - U^*_t = \beta (Y_t - Y^*_t) + \varepsilon, \beta < 1 \]  

where \( U_t \) is the actual unemployment rate at time \( t \) and \( U^*_t \) is the natural unemployment rate estimated using H–P filter at time \( t \). \( U_t - U^*_t \) is the unemployment gap. Natural unemployment rate \( (U^*_t) \) represents the real unemployment rate when existing labor forces are working with their full capacity and are occupying all the available jobs in an economy. In that case, \( U_t - U^*_t \) consists of the real unemployed labor forces available in the economy with underutilized capacity of the existing labor forces.

Again, the underutilized capacity of the labor forces consists of the addition of fully unskilled labor as well as the skill mismatch of the existing labor forces in the economy. Therefore, the first proposition of our study is, if any increase in the GDP growth rate brings no changes or fails to increase the unemployment gap \((U_t - U^*_t)\) significantly, the employed labor forces are underutilized.

\( Y_t \) is the log of real GDP at time \( t \) and \( Y^*_t \) is the natural rate of the log GDP at time \( t \) again estimated using the H–P filter. \( Y_t - Y^*_t \) is the GDP gap. Natural GDP is the standard output when factors of production such as Labor and Capital are fully utilized in the economy. Hence, \( Y^*_t \) is the unobservable rate of output proxies as standard of economic growth. And \( Y_t - Y^*_t \) is the underutilized productivity of the capital and labor forces in the economy.

As we see, most of the countries’ are ensuring the highest productivity of their capital usage by applying a variety of scientific method and modern technology-based production system, the output gap occurs mainly due to the productivity gap of the existing labor forces which is mainly due to the presence of underutilized labor forces in the economy.

This underutilized labor force is generating the unemployment gap along-with the real unemployment. Thus, our final proposition is, if any decline in the GDP gap \((Y_t - Y^*_t)\) fails to increase or bring no changes in the unemployment gap \((U_t - U^*_t)\), underutilized labor forces exist there. Actual unemployment will fall only after confirming full labor productivity of the existing labor forces.

\( \beta \) is the Okun’s coefficient which measures the impact of GDP gap to the unemployment gap when actual GDP departs to its natural rate. \( \beta \) shall be negative
and $< 1$ to best fit Okun’s law on a sample data. $\varepsilon$ is the residuals of Okun’s equation. We consider $\lambda = 100$ in the Hodrick–Prescott filter (H–P) estimation of the GDP growth rate and the unemployment rate due to yearly sample data.

We also included up-to two lags in the output gap series considering the least developed countries require much time to adjust their GDP growth to the unemployment. This is also to compare which country is responding faster adjust in the unemployment rate to the GDP growth.

The equations stand as

$$U_t - U^*_t = \beta(Y_t - Y^*_t) + \beta_1(Y_{t-1} - Y^*_{t-1}) + \varepsilon$$  \hspace{1cm} (2)$$

$$U_t - U^*_t = \beta(Y_t - Y^*_t) + \beta_1(Y_{t-1} - Y^*_{t-1}) + \beta_2(Y_{t-2} - Y^*_{t-2})\varepsilon.$$  \hspace{1cm} (3)

Next, we analyzed the yearly change of the unemployment rate ($\Delta U_t$) due to a yearly change in the GDP growth ($\Delta Y_t$). We assume the changed version of Okun’s equation stands as

$$\Delta U_t = \alpha + \delta \Delta Y_t + \mu_t, \delta < 1 \text{ and negative,}$$  \hspace{1cm} (4)

where $\Delta U_t$ is $U_t - U_{t-1}$, $\Delta Y_t$ is $Y_t - Y_{t-1}$, $\alpha$ is the constant and $\delta$ is the short run Okun’s coefficient which measures the impact of yearly change in the GDP growth rate to the yearly change in the unemployment rate. We hypothesized that in the short-run, changes in the unemployment rate is inversely related to the changes in GDP growth. Hence, $\delta$ is also expected to be negative and $< 1$ to ascertain the changed version of Okun’s law viable.

**Results**

**Augmented Dickey–Fuller tests (ADF)**

In Table 3, the ($\rho = < 0.05$) of the ADF test at level confirms both unemployment gap ($U - U^*$) and GDP gap ($Y - Y^*$) are stationary for all countries. This also authenticates, both gaps are random and any decline in the GDP gap ($Y - Y^*$) will instantly make adjustment with the unemployment gap ($U - U^*$) at Okun’s coefficient.

Moreover, a stationary series consequences its lag differences series stationary. Therefore, we ignore further checking of stationary of the lag differences of both gap series for applying Eq. 3. Again in Eq. (4), the changed version of Okun’s law considers the first difference data of both variables which statistically satisfy the conditions of being stationary due to differencing the data set.
Long-run nexus of the economic growth and unemployment rate

In Table 4, the Okun’s coefficient ($\beta$) of Iraq is $-0.02$ implying a small impact of the output gap to the unemployment gap in the long-run. In particular, a 1% decrease in the GDP gap leads to only 0.02% increase in the unemployment gap in Iraq. The likely explanation of this tiny Okun’s coefficient ($\beta$) is, unemployment is an autonomous problem in Iraq, and therefore, the rise and decline in the GDP growth rate have only a little impact on changing their unemployment scenario in the long-run.

However, the World Bank (2014) revealed the underlying reasons for the autonomous unemployment problem in Iraq is the high inequality in income distribution as the economic growth is driven by a few crude oil and mining companies who shares only a small proportion (approximately 1%) of their earnings with the labor forces.

Besides, in Iraq, most of the laborers are occupied in the public sector jobs which are permanent in nature, and therefore, laborers usually offer less than their full capacity in economic activities. Furthermore, approximately thirty percent more incentive in the public sector jobs causes lower participation of the private sector’s employees which makes them underutilized too.

As a result, any growth in the GDP is reimbursed by the increase in labor productivity of both public and private sectors’ employees than an addition to new labor forces in the economy of Iraq.

The Okun’s coefficient ($\beta$) of Lebanon, Azerbaijan, and Armenia are $-0.08$, $-0.09$ and $-0.13$, which ensure a competitively lower impact of economic growth on the unemployment in the said countries. The probable reasons are: first, lower job creation persists in Lebanon authenticates its unemployment problem is chronic. Besides, the Lebanese labor market is service-oriented and their economy is currently following the laissez-faire policy which restricts government intervention to overcome their long-run unemployment problem.

Second, a higher unemployment rate and lower labor participation with much fluctuating GDP growth trend are persisting in Armenia and Azerbaijan since 2008. Moreover, in Azerbaijan, most of the rural labor forces are trapped with low skills due to lack of proper education, technological advancement and skill development programs. For these reasons, an increase in the output is first rewarded by the acceleration of labor productivity closer to their real capacity providing more job facilities to the existing labor forces and afterward, it creates a few job positions in the Azerbaijan economy. Considering the above, we decline Lebanon, Azerbaijan and Armenia’s progress of economic growth and unemployment as sustainable.

The Okuns coefficient ($\beta$) of Thailand and Malaysia are -0.12 and -0.15, respectively, and their unemployment rates are <1% and <4% with stable trend since 2010 showing a moderate nexus of long-run economic growth and unemployment in these countries. Besides, the healthy labor markets with overall rising trend in the economic growth in recent times confirming their labor productivity are progressing for long. In addition, if it continues further, the GDP growth will exceed the labor productivity immediately which is expected to result in a sharp unemployment fall in these countries. Thus, from long-run perspective, Thailand and Malaysia are progressing towards the sustainable economic growth and unemployment goal.
In India, different types of data are seen about their unemployment rate which consequences diverse hypotheses about the Indian economy. World Bank data indicator, ILO labor statistics, and macrotrends are showing the Indian unemployment rate is steadily declining since 2010 and were 2.56 percent in 2017 and 2.55 percent in 2018. However, the Centre for Monitoring Indian Economy (CMIE, 2020) and Trading Economics are showing the unemployment rate of India was more than 6 percent in 2017 and reached to 8.1 percent in October 2019. A recent newspaper report (Kumar, 2020) is also supporting CMIE and Trading Economics data which discussed the unemployment rate of India is skyrocketing, more than seven percent now a day. In that case, attaining sustainable economic growth and unemployment goal by 2030 seems impossible for India. Therefore, Okun’s coefficient of India -0.14 is misleading the exact unemployment and GDP growth nexus as it is estimated using the World Bank data which is mostly alike to the findings of Bhowmik (2018) discussed in Sect. 2.

The Okun’s coefficient (β) of Tajikistan is -0.19 and their recent rising trend in the GDP growth and slow declining trend in the unemployment rate gives a moderate hope of meeting SDG goal. However, the economy of Tajikistan is vulnerable and currently going through a transition process of being a market economy from the centrally planned economy. At present, several economic reforms initiatives are taken by the Tajikistan government which is creating more jobs in the economy. Thus, these reforms initiatives are adding more people in the labor forces and enabling the existing labor forces to match their skills in selecting a new job. Thus, Tajikistan is also expected to meet sustainable economic growth and unemployment goal.

| Sl. no | Country      | $U - U^*$ ADF T-statistics at level | $p$ value | $Y - Y^*$ ADF test statistics at level | $p$ value |
|--------|--------------|-------------------------------------|-----------|----------------------------------------|-----------|
| 1      | Azerbaijan   | -2.11                               | 0.04      | -3.17                                  | 0.00      |
| 2      | Kazakhstan   | -2.14                               | 0.03      | -2.41                                  | 0.02      |
| 3      | Sri Lanka    | -2.68                               | 0.01      | -3.68                                  | 0.00      |
| 4      | Malaysia     | -3.21                               | 0.00      | -3.45                                  | 0.00      |
| 5      | Tajikistan   | -4.17                               | 0.00      | -4.17                                  | 0.00      |
| 6      | Turkey       | -2.98                               | 0.00      | -3.23                                  | 0.00      |
| 7      | Thailand     | -4.02                               | 0.00      | -2.68                                  | 0.01      |
| 8      | India        | -2.02                               | 0.04      | -3.26                                  | 0.00      |
| 9      | Lebanon      | -2.85                               | 0.01      | -2.72                                  | 0.01      |
| 10     | Armenia      | -2.75                               | 0.01      | -6.38                                  | 0.00      |
| 11     | Iraq         | -5.01                               | 0.00      | -3.69                                  | 0.00      |
| 12     | Bangladesh   | -4.44                               | 0.00      | -1.84                                  | 0.05      |
| 13     | Philippines  | -4.12                               | 0.00      | -3.54                                  | 0.00      |
| 14     | China        | -2.86                               | 0.01      | -1.95                                  | 0.05      |
Kazakhstan (−0.46), Bangladesh (−0.36) and Turkey (−0.34) have best fit Okun’s coefficients (β) in our sample. The likely explanation of these acceptable coefficients is the presence of strong labor markets which consists of a rational combination of permanent and temporary employment in these countries. Besides, skill matching in employing labor forces is higher in these countries which results in efficient labor forces who are working with full capacity. Therefore, a little percentage of increase in GDP growth rate is supposed to decrease the unemployment rate sharply by creating more jobs in these countries.

According to the World Bank (2016), the economic growth of Kazakhstan was sufficient to create the required job for their labor forces in the last decade. As a result, robust economic growth and fair unemployment rate is accelerating the pace of economic development in Kazakhstan showing their higher prospects of attaining the sustainable economic growth and unemployment goal by 2030.

Okun’s coefficient (β) of Bangladesh (0.36) is near to the rule of thumbs of original Okun’s law which indicates a highly promising long-run economic growth and unemployment nexus. However, despite a tremendous growth phase continued in the last decade, Bangladesh failed to reduce the unemployment rate proportionately which is raising questions about the worth of the achieved growth. The possible reasons are, yearwise inclusion of population in the labor forces is much higher than the overall job creation in the economy and currently emphasize are giving more on the technology-driven production system than labor-intensive production process which results in more output but a small number of employments. Hence, more GDP is attaining keeping a significant percentage of labor forces unemployed and underutilized, a barrier for sustainable growth achievement.

| Sl. no. | Country     | β    | p value | Adjusted $r^2$ |
|---------|-------------|------|---------|---------------|
| 1       | Azerbaijan  | −0.09| 0.00*   | 0.42          |
| 2       | Kazakhstan  | −0.45| 0.00*   | 0.71          |
| 3       | Sri Lanka   | −0.37| 0.00*   | 0.40          |
| 4       | Malaysia    | −0.15| 0.00*   | 0.47          |
| 5       | Tajikistan  | −0.19| 0.00*   | 0.60          |
| 6       | Turkey      | −0.34| 0.00*   | 0.31          |
| 7       | Thailand    | −0.24| 0.00*   | 0.68          |
| 8       | India       | −0.14| 0.01*** | 0.25          |
| 9       | Lebanon     | −0.08| 0.03**  | 0.16          |
| 10      | Armenia     | −0.13| 0.04**  | 0.15          |
| 11      | Iraq        | −0.02| 0.05*** | 0.13          |
| 12      | Bangladesh  | −0.36| 0.06*** | 0.12          |
| 13      | Philippines | −0.06| 0.19    | 0.06          |
| 14      | China       | −0.02| 0.40    | 0.03          |

Hodrick–Prescott filter $\lambda = 100$

*Significance at 1%

**Significance at 5%

***Significance at 10%
Nonetheless, the economy of Bangladesh is expanding now a day and several economic development projects are ongoing including the construction of Padma Bridge which is expected to connect the country’s south–west region with the capital and other parts by 2022. Thus, a huge number of jobs are expected to create in that region with a major contribution to domestic production from 2022 onward. Given that, Bangladesh is expected to be the role model for achieving sustainable economic growth and unemployment goals in Asia.

Although Okun’s coefficient ($\beta$) of Turkey ($-0.34$) is good which indicates the labor forces are skilled and working with their almost highest capacity, its overall downward trend in the GDP growth rate causes an upward trend in the unemployment rate displayed in Fig. 6 of Annexure 1 confusing their ability to meet up sustainable economic growth and unemployment goal by 2030.

**Short-run nexus of the economic growth and unemployment rate**

In Table 5, the short-run coefficient ($\delta$) of Azerbaijan, Malaysia and Tajikistan are $-0.11$, $-0.13$ and $-0.16$ and statistically significant implying labor forces are moderately underutilized in those economies. Especially in Malaysia and Tajikistan, the labor market is progressing and reformation is taking place slowly. Hence, the economic growth is fairly increasing the labor productivity in the short-run which moderately transforming their labor market healthy. On the other hand, the Okun’s coefficient ($\delta$) of Azerbaijan is also implying a reasonable impact of economic growth on the unemployment rate in the short-run. However, their weak economic structure compelled us to refute Azerbaijan’s short-run coefficient as a progress of SDG achievement.

Thailand, Kazakhstan, Turkey, China, and Sri Lanka have significant short-run Okun’s coefficient ($\delta$) ranging from $0.26$ to $0.43$. This implies most of the labor forces of these countries are contributing around their full capacity in the short run and their skill matching in current position is relatively higher. Moreover, temporary workforce requirement is also higher in these countries since long for which an increase in the output causes a significant percentage of unemployment to fall in the short-run.

Overall, in Table 4, the long-run Okun’s coefficient ($\beta$) of the Philippines, China and Sri Lanka and in Table 5, the short-run coefficients ($\delta$) of the India, Lebanon, Armenia, Iraq, and Bangladesh are statistically insignificant and for that reason we declined these coefficients in our result discussion. The rest of the countries’ coefficients are negative signifying Okun’s law is applied there. The coefficients vary across the countries mainly due to the idiosyncratic features of the labor forces employed in the sample countries as found by Ball et al. (2019).

**Long-run nexus of economic growth and unemployment with lag**

In Table 6, only Tajikistan is showing last year’s output gap has a significant impact on the unemployment gap along with current year impact. The rest
countries have no significant impact on unemployment of last year’s output except India. However, when we add one lag of output in Table 7, the Indian current year impact of the output gap turns to insignificant. However, when we add two lags, a significant impact of the output gap on the unemployment gap is observed in India and Azerbaijan. This implies GDP has a long-prevailing impact in reducing the unemployment in those countries. No other countries have long-run consistent impacts are evident in reducing the unemployment by the acceleration of GDP.

### Conclusion and policy recommendations

Overall, Kazakhstan, Bangladesh and Thailand are fast progressing and Malaysia is modestly progressing towards sustainable economic growth and unemployment goal. Subject to their prolongation of the present economic growth and unemployment trend until 2030, they are expected to reach the SDG milestone. Although the present progress of progress of Tajikistan is not satisfactorily aligning with the sustainable economic growth and unemployment goals, but their moderate Okun’s coefficients suggests that taking up more labor intensive economic reforms initiatives, they can also reach the sustainable economic growth and unemployment milestones by 2030. Sri-Lanka, Azerbaijan, Iraq, Lebanon and Armenia are running opposite to the given growth and unemployment goals of SDG. Even though China has already achieved the SDG milestones in the long run but might unable to keep their positions intact due to their downward GDP trend, upward unemployment trend and low Okun’s coefficient in the long run. However, as the short-run Okun’s coefficient of China is higher (− 0.40), there is a possibility of achieving the above goals if China able to overturn their current GDP growth rate and slowdown their unemployment rate in the future.

Table 5  Summery statistics of the changed version of Okun’s law ∆Ut = α + β∆Yt + μt

| Sl. no. | Country   | α   | p value (α) | β    | p value (β) |
|---------|-----------|-----|-------------|------|-------------|
| 1       | Azerbaijan| 0.00| 0.03        | −0.11| 0.00        |
| 2       | Kazakhstan| 0.01| 0.00        | −0.43| 0.00        |
| 3       | Sri Lanka | 0.00| 0.22        | −0.33| 0.01        |
| 4       | Malaysia  | 0.00| 0.00        | −0.13| 0.00        |
| 5       | Tajikistan| 0.00| 0.03        | −0.16| 0.00        |
| 6       | Turkey    | 0.01| 0.01        | −0.31| 0.00        |
| 7       | Thailand  | 0.00| 0.01        | −0.26| 0.00        |
| 8       | India     | 0.00| 0.15        | −0.06| 0.14        |
| 9       | Lebanon   | 0.00| 0.64        | −0.06| 0.18        |
| 10      | Armenia  | 0.01| 0.07        | −0.04| 0.46        |
| 11      | Iraq      | 0.00| 0.44        | −0.01| 0.35        |
| 12      | Bangladesh| 0.00| 0.40        | −0.06| 0.58        |
| 13      | Philippines| 0.00| 0.12        | −0.09| 0.04        |
| 14      | China     | 0.02| 0.00        | −0.40| 0.00        |

Hodrick–Prescott filter $\lambda = 100$
Table 6  Summery statistics of the Okun’s equation $U_t - U^*_t = \beta (Y_t - Y^*_t) + \beta_1 (Y_{t-1} - Y^*_{t-1}) + \epsilon$

| Sl. no. | Country     | $\beta$  | $p$ value | $\beta_1$ | $p$ value | $\beta_2$ | $p$ value | Adjusted $r^2$ |
|---------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| 1       | Azerbaijan  | $-0.05$   | 0.21      | $-0.04$   | 0.34      | 0.33      |           |                |
| 2       | Kazakhstan  | $-0.38$   | 0.00*     | $-0.13$   | 0.20      | 0.75      |           |                |
| 3       | Sri Lanka   | $-0.27$   | 0.02**    | $-0.18$   | 0.12      | 0.44      |           |                |
| 4       | Malaysia    | $-0.15$   | 0.00*     | $-0.03$   | 0.28      | 0.56      |           |                |
| 5       | Tajikistan  | $-0.09$   | 0.08***   | $-0.15$   | 0.00*     | 0.79      |           |                |
| 6       | Turkey      | $-0.31$   | 0.01*     | $-0.06$   | 0.58      | 0.29      |           |                |
| 7       | Thailand    | $-0.26$   | 0.00*     | 0.04      | 0.30      | 0.65      |           |                |
| 8       | India       | $-0.06$   | 0.13      | $-0.20$   | 0.00*     | 0.62      |           |                |
| 9       | Lebanon     | $-0.12$   | 0.04**    | 0.02      | 0.67      | 0.20      |           |                |
| 10      | Armenia     | $-0.20$   | 0.04**    | $-0.04$   | 0.56      | 0.18      |           |                |
| 11      | Iraq        | $-0.01$   | 0.27      | $-0.01$   | 0.46      | 0.05      |           |                |
| 12      | Bangladesh  | $-0.53$   | 0.03**    | 0.32      | 0.23      | 0.14      |           |                |
| 13      | Philippines | $-0.07$   | 0.21      | 0.02      | 0.72      | 0.02      |           |                |
| 14      | China       | $-0.01$   | 0.92      | $-0.02$   | 0.64      | 0.00      |           |                |

Hodrick–Prescott filter $\lambda = 100$
*Significance at 1%
**Significance at 5%
***Significance at 10%

Table 7  Summery statistics of $U_t - U^*_t = \beta (Y_t - Y^*_t) + \beta_1 (Y_{t-1} - Y^*_{t-1}) + \beta_2 (Y_{t-2} - Y^*_{t-2}) + \epsilon$

| Sl. no. | Country     | $\beta$  | $p$ value | $\beta_1$ | $p$ value | $\beta_2$ | $p$ value | Adjusted $r^2$ |
|---------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| 1       | Azerbaijan  | $-0.22$   | 0.01*     | 0.25      | 0.03**    | $-0.15$   | 0.02**    | 0.35          |
| 2       | Kazakhstan  | $-0.26$   | 0.12      | $-0.38$   | 0.13      | 0.16      | 0.28      | 0.72          |
| 3       | Sri Lanka   | $-0.26$   | 0.04**    | $-0.20$   | 0.21      | 0.02      | 0.90      | 0.42          |
| 4       | Malaysia    | $-0.17$   | 0.00*     | $-0.02$   | 0.60      | $-0.04$   | 0.21      | 0.59          |
| 5       | Tajikistan  | $-0.16$   | 0.02**    | $-0.01$   | 0.93      | $-0.08$   | 0.10      | 0.73          |
| 6       | Turkey      | $-0.31$   | 0.02**    | $-0.07$   | 0.61      | 0.02      | 0.90      | 0.26          |
| 7       | Thailand    | $-0.21$   | 0.00*     | $-0.06$   | 0.27      | 0.08      | 0.06***   | 0.73          |
| 8       | India       | $-0.10$   | 0.01*     | $-0.13$   | 0.00*     | $-0.11$   | 0.00*     | 0.72          |
| 9       | Lebanon     | $-0.08$   | 0.26      | $-0.05$   | 0.63      | 0.03      | 0.68      | 0.20          |
| 10      | Armenia     | $-0.59$   | 0.00*     | 0.43      | 0.01*     | $-0.07$   | 0.24      | 0.44          |
| 11      | Iraq        | $-0.01$   | 0.30      | $-0.01$   | 0.15      | 0.00      | 0.97      | 0.14          |
| 12      | Bangladesh  | $-0.77$   | 0.02**    | 0.69      | 0.12      | $-0.34$   | 0.32      | 0.16          |
| 13      | Philippines | $-0.07$   | 0.21      | 0.03      | 0.64      | 0.01      | 0.92      | $-0.01$       |
| 14      | China       | $-0.10$   | 0.28      | 0.16      | 0.27      | $-0.13$   | 0.11      | 0.10          |

Hodrick–Prescott filter $\lambda = 100$
*Significance at 1%
**Significance at 5%
***Significance at 10%
Based on our findings, the policy recommendations are: first, the prospective countries should develop knowledge based economy through improving the education and skill profile of their rural workers. Second, skill monitoring program should be implemented with priority basis, third, more labor intensive industries in the urban areas and agro-based private owned firms in the rural areas need to establish and finally, a sectorwise controlled migration of workers need to ensure for the optimum labor productivity.

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Data availability The World Bank data indicator from 1981 to 2018.

Declarations

Conflict of interest The authors declare that they have no competing interests.

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