

SAMA Working Paper:

Estimating the Output Gap for Saudi Arabia

February 2016

By

Ryadh M. Alkhareif

Economic Research Department

Nayef A. Alsadoun

Economic Research Department

Saudi Arabian Monetary Agency

The views expressed are those of the author(s) and do not necessarily reflect the position of the Saudi Arabian Monetary Agency (SAMA) and its policies. This Working Paper should not be reported as representing the views of SAMA.

Estimating the Output Gap for Saudi Arabia*

Abstract

The objective of this paper is to estimate annual potential output growth and the output gap for the Saudi economy over the period 1980 to 2015, looking at both total output and non-oil output. The focus on the latter is so that the progress in diversifying the economy might be examined and the possible impact of diversification on potential output might be measured. We use three methods for estimating potential output proposed in the macroeconomic literature. The methodologies include the Hodrick-Prescott filter, Kalman filter, and the production function approach. We compare the three over the entire sample and the last five years. Our findings suggest that the output gap (the difference between actual and potential output, as measured by real GDP) is positive on average over the entire period (i.e., actual output has on average exceeded potential); however, the gap has turned negative and has shrunk in recent years, as fiscal expenditures, particularly in infrastructure, have acted to better align actual and potential. Our analysis also indicated that growth in both potential GDP and total factor productivity have accelerated in the 2011-2015 period. In contrast, growth in these factors has slowed in many other countries, particularly the advanced economies. This better performance of the Saudi economy is possibly due to the development of a resilient financial sector in the Saudi economy.

Keywords: potential output, output gap, total factor productivity, and inflation.

JEL Classifications: E31, E32, O20, O23, O47.

* Authors contacts: Ryadh Alkhareif, Economic Research Department, Saudi Arabian Monetary Agency, P. O. Box 2992 Riyadh 11169, Email: ralkhareif@sama.gov.sa. Nayef Alsadoun, Email: NAlsadoun@SAMA.GOV.SA.

1. Introduction

Potential output can be defined as the maximum sustainable level of output, given full utilization of all factors of production, under conditions of stable inflation. In other words, it is considered to be the level of output that can be achieved by the economy at a constant inflation rate if all its resources were fully employed. While this paper focuses on the Saudi economy, it has been argued that oil exporting countries, GCC countries in particular, have among the world's highest non-oil potential growth.¹ The Saudi economy, along with other GCC countries, has enjoyed strong growth over the past decade on the back of high oil prices and expansionary government fiscal policy for economic development. Inflationary pressures have emerged and presented a challenge to economic welfare.

Recently economic growth has weakened with the recent fall in oil prices, indicating a possible widening of the gap between potential and actual output, particularly for the non-oil private sector. However, lower oil prices may also lower potential growth because of lower levels of capital investment, due to less government oil revenue for infrastructure development. In addition, the Saudi government has undertaken a major initiative at labor market reforms, which has a direct impact on the supply of expatriate labor. Under these circumstances, the lower oil prices and their impact on economic activity might present a challenge, especially given the high unemployment rate among Saudi nationals. However, the major education initiatives over the past decade are resulting in a better match of the skills of the young Saudi labor force, which would tend to counter the negative aspects.

In order to analyze the impact of these various factors on the Saudi economy, it is necessary to estimate both the potential output of the Saudi economy and the gap between the actual output and this potential. The study estimates potential output using Hodrick-Prescott filter, Kalman filter, and the production function methodologies. The sample period is annual from 1980 to 2015. The paper is structured as follows. Section two gives a brief on the importance of estimating potential output and output gap. The third section provides a review of the main estimation methodologies

¹ See for instance: Mitra P, Hosny A, Abajyan G and Fischer (2015): "Estimating Potential growth in the middle east and central Asia". IMF working paper.

used in the literature and paper. Section four presents the results, and the final section concludes and discusses policy implications.

2. Estimating potential output and output gap

Potential output is determined by the supply side of the economy (i.e., the factors of production, such as capital stock, labor force and technology). It is determined by trend growth in the supply of both labor and capital, combined with how efficiently these factors of production can be utilized (i.e., total factor productivity). In the short run, fluctuations in aggregate demand can lead to significant deviations in actual real output (both positive and negative) from potential output. However, in the long run, actual economic output will show the same trend growth as will potential output. Estimating potential output is an important exercise for fiscal and monetary policy makers. The importance of estimating potential output reflects its critical role in understanding the determinants of economic growth, planning fiscal and budgetary policies, and anticipating inflationary dynamics and measurement. From a monetary policy standpoint, knowing potential output is crucial in order to strike a balance between output and inflation. Positive output gaps (i.e., where actual output exceeds potential) are typically associated with excess demand in goods and labor markets and increasing inflation, either actual or expected. Under these circumstances, central banks, particularly those targeting interest and/or inflation rates, will need to adopt contractionary policies. Policy coordination with the government to reduce domestic demand can complement monetary policy. If there is a negative output gap and inflation is low, then expansionary monetary policy, coordinated (if needed) with fiscal policy, can return the economy to its potential.

Recently, central banks have become more transparent in effectively and credibly communicating monetary policy. As a result, most inflation-targeting central banks now regularly publish estimates of their country's output gap along with inflationary expectations. However, there are others who claim that the relationship between an individual country's output gap and inflation has weakened due to the increasing globalization and trade and economic openness of countries around the world.²

² See for instance Romer (1993) and Loungani et.al (2001).

Despite the importance of estimating potential output and the output gap, there has been little research into this subject for Saudi Arabia and the GCC region in general. This is partially due to the difficulties in measuring potential output for countries that are dependent on oil exports, where a substantial portion of their real economic growth is determined by their actual oil production. Furthermore, for the GCC countries that are OPEC members, their actual oil production at any point in time is largely determined by strategic decisions that have little to do with the “potential output” of their oil sectors; rather, it is determined by world oil supply and demand conditions. For these countries, it would make more sense to look at the potential output of the non-oil sector, where there is a closer correlation between actual and potential output at any point in time. The oil sectors of their economies interact with the non-oil sectors primarily through the governments’ spending of oil revenues on local goods and services and on the salaries of government workers.

3. Review of Methodologies

Potential output and the output gap are economic concepts which are not actually observed. Their actual measurement is subject to a considerable amount of debate. Different estimation methodologies have been devised to divide output into trend and cyclical growth components. The most widely used methodologies are based on either statistical approaches that use various time series analysis and decomposition techniques or econometric approaches that employ production functions. Below we describe the different methods: the Hodrick-Prescott filter, Kalman filter, and the production function methodologies.

Hodrick-Prescott (HP) filter

The Hodrick-Prescott (HP) filter is one of the most commonly used technique due to its simplicity and flexibility.³ It is normally used to smooth output fluctuations by extracting the trend component, in which a tradeoff is made between a good fit to the actual data series and the degree

³ See Nelson, Charles R. and Heejaon Kang, 1981, “Spurious Periodicity in Inappropriately Detrended Time Series,” *Econometrica*, 49, 741-751.

of smoothness of the trend series [See Mitra et.al (2015)]. The HP filter minimizes the difference between actual and potential output as follow:

$$\sum_{t=1}^T (y_t - y_t^*)^2 + \gamma \sum_{t=2}^{T-1} [(y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*)]^2$$

where γ is a weighting factor that determines the degree of smoothing of the trend. A low value of γ produce a trend output that follows actual output more closely. A high value, on the other hand, reduces the sensitivity of output trend to short-term fluctuations in actual output.

The simplicity and flexibility of the HP filter makes it an ideal tool for research involving emerging and developing countries, where data present a major challenge. On the negative side, statistical filters are purely statistical, and hence lack any economic intuition (i.e., statistical filters are not based on economic theory [Kuttner (1994)]). In addition, statistical filters are not usually suitable for capturing high output volatility that is common in commodity exporting countries. For this reason, the HP filter estimate is a complement to the Kalman filter.

Kalman filter

The Kalman filter model can be simply explained by two types of processes, known as the measurement equation and transition (state) equation.⁴ The measurement and transition equations are defined respectively as following:

$$y_t = \beta_t x_t + \varepsilon_t$$

$$x_t = T_t x_{t-1} + G_t u_t$$

where y_t is the observed process (actual GDP), x_t represents the state vector, β_t is the transformation matrix that maps x_t into the measurement domain, T_t is the state transition matrix,

⁴ See Hamilton (1994) for more details.

and finally ε_t and u_t are the error terms. In addition, we assume that the error terms ε_t and u_t are independent and normally distributed with zero means and covariance matrices R_t and Q_t .⁵

$$\begin{bmatrix} \varepsilon_t \\ u_t \end{bmatrix} \sim N\left(0, \begin{bmatrix} R_t & 0 \\ 0 & Q_t \end{bmatrix}\right)$$

The Production Function Method

The production function method describes the supply side and shows the relationship between output and its factor inputs. Potential output is represented by a combination of factors: the inputs, labor and capital, multiplied by total factor productivity. The assumptions are based on economic theory and commonly described using the Cobb-Douglas specification:

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

where Y_t is actual output in period t , L_t is the labor that is employed as input, K is the capital stock, A is the total factor productivity (TFP), and α is the share of capital in the national economy.⁶ An improvement in total factor productivity is associated with a more efficient use of labor and capital, thus resulting in higher output. TFP is unobservable; therefore we calculate it by taking out the contribution of labor and capital to actual output as follow:

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

Compared with the various statistical approaches, the production function is considered to be a better option in that it overcomes the statistical approaches' drawbacks. This is because production function estimates are more transparent, consistent over time, and conform to economic theory [Cotis et al. (2005)]. However, the need for reliable data is a major drawback of the

⁵ We refer to Alkhareif and Barnett (2013) for additional assumptions and details.

⁶ We assume $\alpha = \frac{2}{3}$, as capital stock is certainly playing a prominent role in the Saudi economy.

production function methodology, particularly in its application to developing countries. As specified K and L appear individually homogeneous. Most modelers try to adjust for (average) educational attainment and skills where data are available. Also, in this specification A (total factor productivity), affects K and L proportionately. Technology may also affect these two inputs non-homogenously. In addition, A can be strongly influenced by institutions (governance and market orientation) and absorptive capacity of capital accumulation and technology.

Box 1: Computational Exercise

The following standard Cobb-Douglas form of the production function is applied:

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

where Y_t represents real GDP in period t, K_t is the stock of capital, L_t is the labor force, A_t represents TFP, and α is the share of capital in output.

The following steps are applied to estimate potential GDP:

1. Obtain historical TFP using the formula:

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

2. Apply the HP filter to L, and A, which gives the trends of each variable.
3. Derive potential growth by applying trend L, and A to the Cobb-Douglas production function.
4. Calculate the growth rates of potential output.

4. Results for the Estimation of Potential Output and Non-oil Output

Table 1 shows the average estimated potential GDP growth for Saudi Arabia over the period 1980-2015 and over the last five years using the different methodologies. The findings suggest that the average estimated potential GDP growth is 2.4 percent, higher than the average actual GDP growth of 2.2 percent. However, during the last five years where massive government spending took place, the average estimated potential GDP growth at 3.9 percent is below the average actual GDP growth of around 5 percent.

Table 1: Average Estimated Potential GDP Growth

Estimation Method	1980-2015	2011-2015
HP Filter	2.2%	4.3%
Kalman Filter	1.1%	2.9%
Cobb Douglas	4.1%	4.5%
Average	2.4%	3.9%

Source: Authors estimations.

Unfortunately, the various approaches showed widely different estimates of productivity growth, suggesting that there may be problems with the data used in this analysis. This is undoubtedly due to the large contribution of the oil sector to total output, which is affecting the accuracy of the statistical methods used.⁷ This conclusion is obvious when we consider that actual oil production throughout most of the 1980-2015 period was well below the 10 million barrels per day (mbd) capacity that was maintained over most of the period, increasing to 12.5 mbd toward the end. This fact would make the various time series estimation techniques of little value in calculating potential output. Even the Cobb-Douglas production function approach would produce spurious results, considering that there was little relationship between the labor employed by the oil sector and the sector's output. Employment in this sector more than tripled over the 1980-2015

⁷ Hasan and Alogeel (2008), for instance, argue that the large contribution of the oil sector in Saudi Arabia's output affects the accuracy of statistical methods.

period, whereas the sector's crude oil output, which reached 9.9 mbd in 1980, was not exceeded until 2015, when it reached an estimated level of 10.2 mbd.

The analysis is much more straightforward if non-oil GDP is analyzed. Table 2 shows the results of applying the various methodologies to this time series. The average estimated potential growth was 5.1 and 6.0 percent over the periods 1980-2015 and 2011-2015, respectively (Table 2). The average actual non-oil GDP growth reached 4.8 and 6.1 percent for the corresponding periods. Hence, the non-oil sector was performing above its potential only during the sub-period from 2011-2015, and then only slightly. More importantly, all of the estimation methods showed relatively consistent and convergent values, indicating that the data being used are accurately measuring the actual relationship between the various inputs (i.e., capital and labor) and the real output of the non-oil sector.

Table 2: Average Estimated Potential Non-Oil GDP Growth

Estimation Method	1980-2015	2011-2015
HP Filter	4.6%	6.0%
Kalman Filter	4.9%	5.9%
Cobb Douglas	5.7%	6.1%
Average	5.1%	6.0%

Source: Authors estimations.

The acceleration in potential non-oil GDP growth over the last five years is a particularly encouraging development and is in sharp contrast to many countries, particularly those in the developed world, where potential GDP growth has slowed sharply. The positive development of the financial sector has also promoted financial stability and supported this healthy growth. A successful implementation of the National Transformation Program is expected to spur the potential growth, as it will further encourage the diversification of the Saudi economy and the development of the Kingdom's indigenous labor force.

In addition, the estimates above are in line with estimates in research on oil producers in the GCC. For instance, Mitra et.al (2015) estimated non-oil output for GCC countries to be around 7 and 6 percent for the period 2003-07 and 2008-14, respectively. The argument behind the GCC's high potential growth is due to the strong tie of non-oil sector to oil revenues and government spending.

Measuring productivity is of particular importance for policymakers. This paper shows that productivity in the overall economy has been negative during the period of 1980-2015, but positive during the period 2011-2015 (Table 3). The negative growth over the 1980-2010 period is primarily due to the impact of the decline in crude oil output combined with the tripling of employment in that sector which was mentioned earlier. It is also driven, in part, by major economic downturns associated with the 1980s oil glut, 1998 oil price decline, and the 2008 financial crisis. However, productivity in the overall Saudi economy recorded a 1.3 percent growth during the last five years on the back of higher government expenditure and massive infrastructure projects. It was also aided by growth in Saudi oil production over that period.

Productivity growth for the non-oil sector has been positive at 1.6 and 2.5 percent for the periods 1980-2015 and 2011-2015, respectively. On the labor side, the last five years witnessed higher labor participation, which increased by more than 13 percent. The increase in the participation rate is partly due to labor market reforms, which indeed contributed to higher productivity. Capital expenditure, on the other hand, is certainly playing a prominent role in the Saudi economy and the stability of non-oil output. This is an indicative of the relatively higher efficiency in the utilization of the factors of production in the non-oil sector of the economy. However, it should be noted that expansionary fiscal policy and capital expenditure may take time in order to translate into higher productivity as can be observed during the expansionary period from 2005 to 2007.

Table 3: Total Factor Productivity Growth Estimates

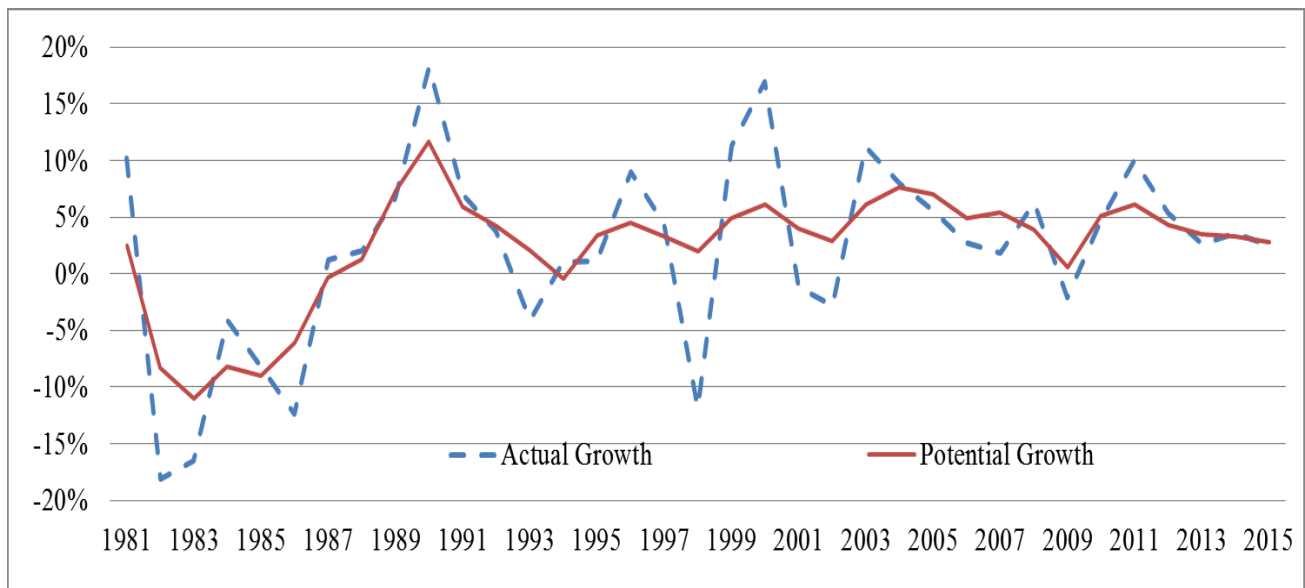
	1980-2015	2011-2015
Overall Economy	-1.1%	1.3%
Non-oil Sector	1.6%	2.5%

Source: Authors estimations.

The faster growth in total fact productivity mirrors the same pickup that was observed in potential GDP growth in Table 2. Again, this boost in productivity is in sharp contrast to the slowdown in other countries, particularly in the developed world. Much of this slowdown is undoubtedly due to the lingering effects of the financial crisis, which had little impact on the Saudi economy and its financial system, other than its transitory impact on world oil markets.

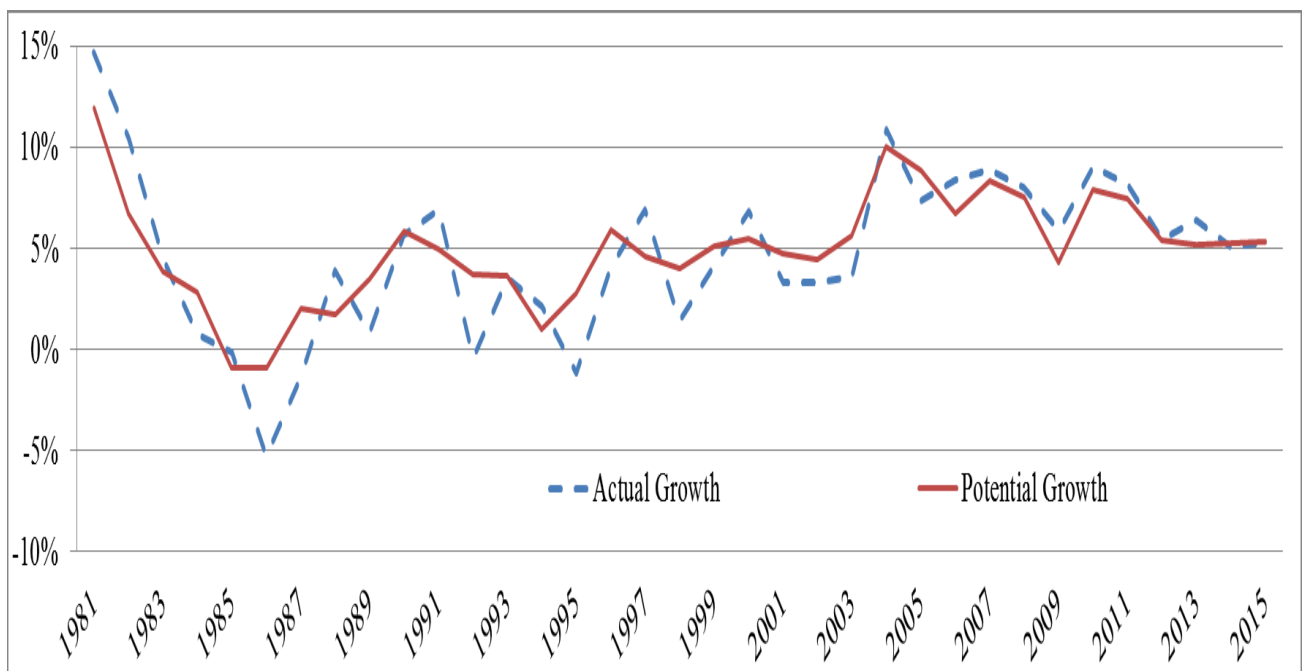
It is worth mentioning that the variations between the actual and potential real GDP growth rates has diminished in the past few years, in both the overall economy and the non-oil sector (Figures 1-2). As can be seen from the figures, the large drop in oil production during the mid-80s and again in the late 90s is clearly captured. The discrepancy between the actual and potential real GDP growth widens the most during boom and bust cycles, mainly due to the impact of sudden movements in oil prices on the level of government spending and the economy as a whole. Over the last few years, the Saudi economy has been performing above its potential. The Saudi government has been able to counterbalance adverse oil price shocks by implementing countercyclical spending policies, due to the strong economic fundamentals the Kingdom currently possesses (e.g., strong financial buffers, low debt levels, a moderate inflation environment, and a resilient banking system).

Figure 1: Real GDP Growth (Actual vs. Potential)



Source: Central Department of Statistics and Information and authors' estimations.

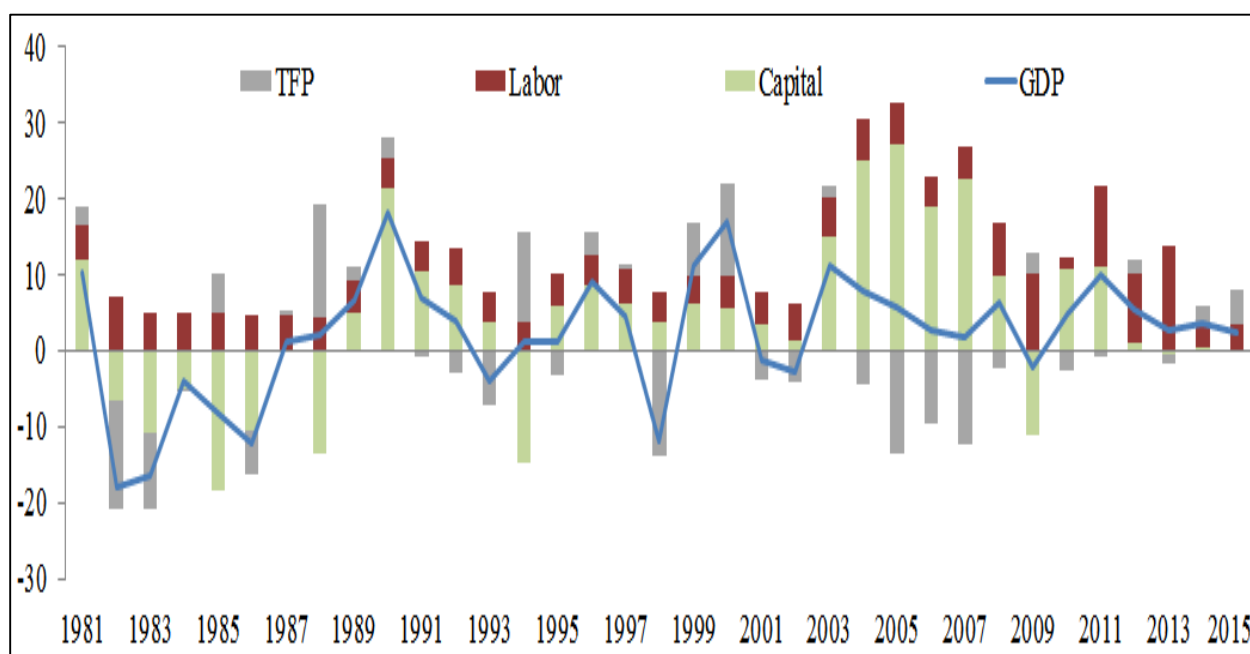
Figure 2: Real Non-oil GDP Growth (Actual vs. Potential)



Source: Central Department of Statistics and Information and authors' estimations.

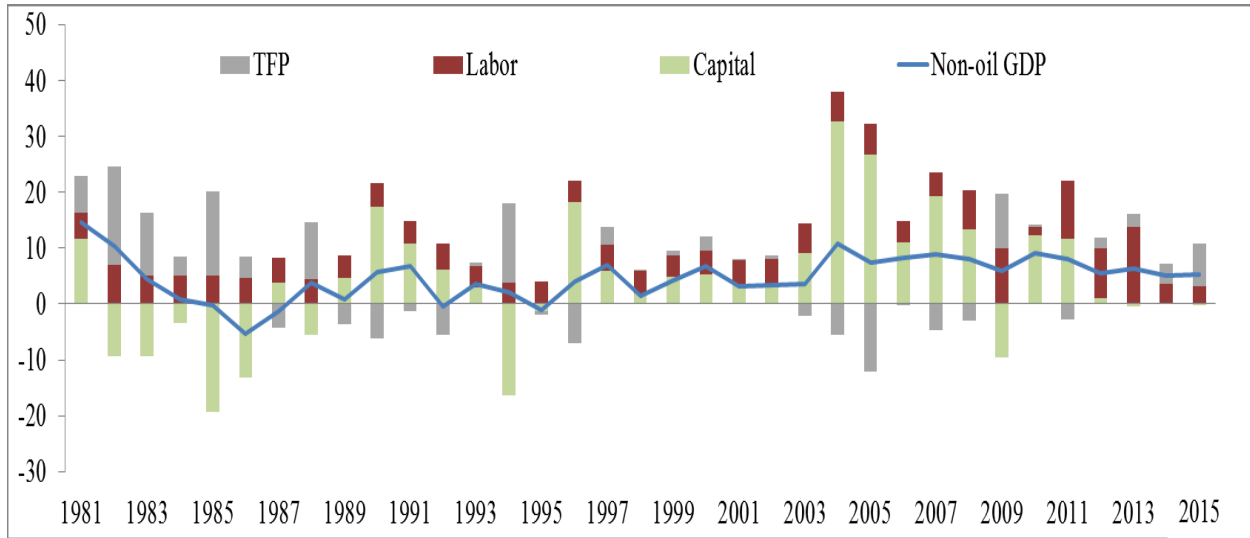
Looking at the decomposition of real GDP growth for both the overall economy and the non-oil sector, it is clearly evident that the massive level of capital spending was a key driver for growth (Figures 3-4). The contribution of labor component, on the other hand, has been broadly limited for most of the period. Large increase in employment is associated with public sector, where contribution to growth is quite limited compared to that of private sector. Nonetheless, the labor component, as well as the TFP, have been the driving factors for growth over the past four years—in addition to the attentive labor market reforms that took place recently. These reforms were mainly targeting at boosting employment and competitiveness of nationals in the private sector which is associated with higher productivity.

Figure 3: Real GDP Growth Decomposition



Source: authors' estimations.

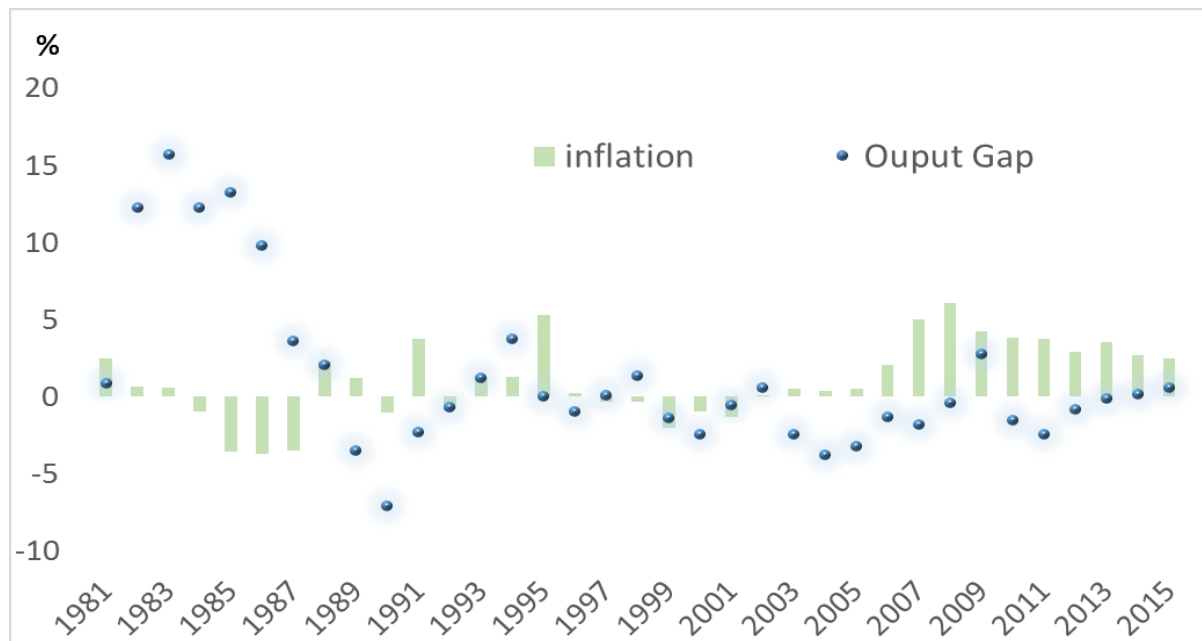
Figure 4: Real Non-oil GDP Growth Decomposition



Source: authors' estimations.

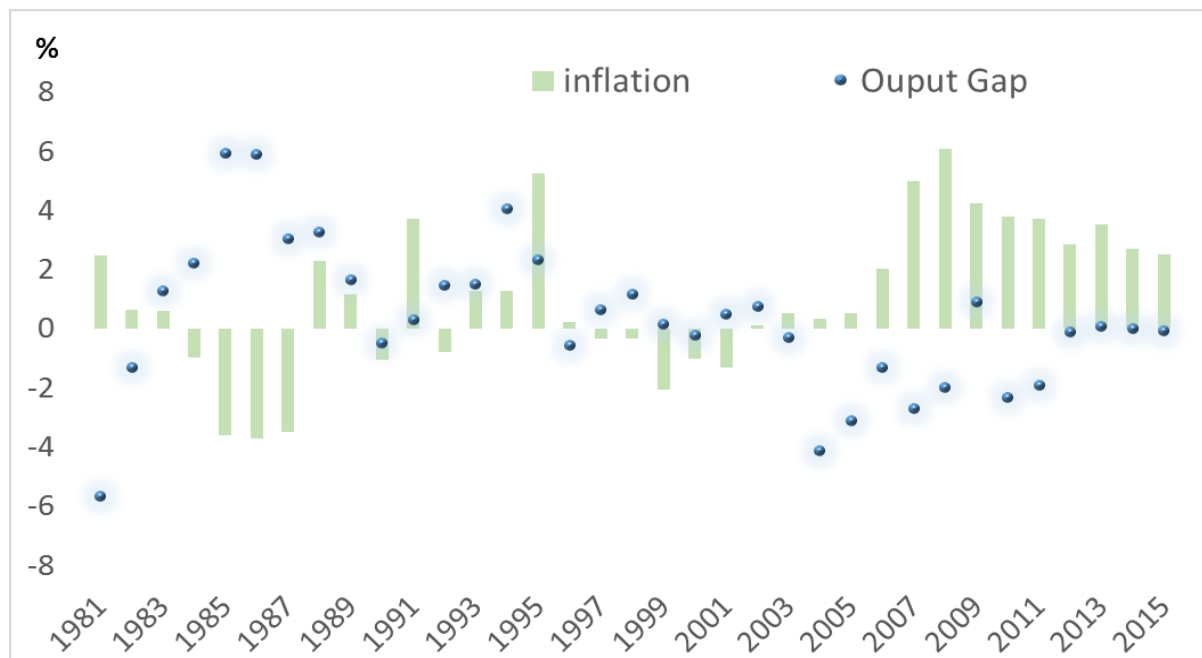
Finally, we compute the output gap (i.e., the difference between the actual output and its estimated potential) for the overall economy and the non-oil sector in Saudi Arabia over the period of 1980-2015. It appears that the pattern of the gap is susceptible to movements in oil prices, as they affect oil revenues (Figures 5-6). For instance, the drop in oil prices during the early 1980s and in 1998 led to negative output gaps. The output gaps have shrunk substantially over the past five years, for both the overall economy and the non-oil sector, in conjunction with stable inflation rates. This implies that the Saudi economy is performing at a level close to its potential. Inflation, on the other hand, was around 2-3 percent. If we assume that output gap was close to zero at that period, an inflation rate between 2-3 would fit ideally within the comfort zone for the Saudi economy.

Figure 5: Inflation vs. Output Gap for the Overall Economy



Source: authors' estimations.

Figure 6: Inflation vs. Output Gap for the Non-oil Sector



Source: authors' estimations.

5. Conclusion

This paper presented estimates of the potential output and output gap for the Saudi economy using statistical and production function methodologies. The estimates vary based on selected approaches, which raise cautious about estimate uncertainty. Such estimate uncertainty are generally high in developing economies that experience volatile output growth. This call for further research on this area, especially for economies dependent on natural resource.

The estimates showed that output gap, for both total and non-oil, have been positive on average, but turns negative and shrinking in recent years. The increase in fiscal expenditure has been vital for aligning actual output with that of potential output. However, a slowing pace of government expenditure could result in widening output gap. With respect to labor, policies should be aimed at improving labor market efficiency by increasing labor skills and participation in productive sectors. The Saudi economy would certainly benefit from investment in promoting a diversified economy that is less dependent on natural resources.

The analysis indicated that growth in both potential GDP and total factor productivity have accelerated in the 2011-2015 period. This is in sharp contrast to growth in other countries, particularly in the developed world. Much of this slowdown is probably due to the after effects of the 2008-2009 financial crisis, but had little effect on the Saudi economy. This can be attributed to the development of a resilient financial sector in the Saudi economy.

Future potential GDP growth might be adversely impacted by changes in the two major factors of output. Capital investment could be adversely affected by the decline in oil prices, which will cut government spending on infrastructure. However, such a condition will only be short-term in nature. The drive for Saudization of the workforce could create a labor shortage, but only if there is a continued mismatch of the skill set of Saudis versus the needs of the non-oil sector. Such a possibility is not thought to be likely though, since the educational initiatives over the past decade are resulting in a much better trained and younger workforce. This will have a positive impact on longer-term growth and productivity, if wisely planned.

References

- Alkhareif, R.M.; Barnett, W.A. (2013) "Advances in Monetary Policy Design", Cambridge Scholars Publishing: Newcastle upon Tyne, UK.
- Cotis, J.-P., J. Elmeskov and A. Mourougane (2005): "Estimates of potential output: benefits and pitfalls from a policy perspective", in L. Reichlin (ed.), Euro area business cycle: stylised facts and measurement issues, CEPR.
- Era Dabla-Norris, Si Guo, Vikram Haksar, Minsuk Kim, Kalpana Kochhar, Kevin Wiseman, and Aleksandra Zdzienicka (2015): " The New Normal: A Sector-Level Perspective on Productivity Trends in Advanced Economies". IMF staff discussion note NO SDN/15/03.
- Hamilton, James D. 1994. Time Series Analysis. Princeton, New Jersey: Princeton University Press.
- Harvey, A.C. and Jaeger, A. (1993): "Detrending, Stylized Facts and the Business Cycle", Journal of Applied Econometrics, 8(3), 231- 247.
- Kuttner, K.N. (1994) "Estimating Potential Output as a Latent Variable," Journal of Business and Economic Statistics 12(3): 361–68.
- Loungani, Prakash, Assaf Razin and Chi-Wa Yuen (2001): "Capital Mobility and the OutputInflation Tradeoff," Journal of Development Economics 64, 255-74.
- Hasan, M and Alogoskoufis, M (2008): " Understanding the Inflationary Process in the GCC Region: The Case of Saudi Arabia and Kuwait", IMF
- Mitra P, Hosny A, Abajyan G and Fischer (2015): "Estimating Potential growth in the middle east and central Asia". IMF working paper.
- Romer, David (1993): "Openness and Inflation: Theory and Evidence," Quarterly Journal of Economics, CVII (4), November, pp. 869-904.