International Research Journal of Finance and Economics
ISSN 1450-2887 Issue 35 (2010)

http://www.eurojournals.com/finance.htm

Which Output Gap Measure Matters for the Arab Gulf Cooperation Council Countries (AGCC): The Overall GDP Output Gap or the Non-Oil Sector Output Gap?

Mohamed A. Osman
Corresponding Author, Department of Economics and Statistics, University of Dubai
Assistant Professor, University of Dubai, Dubai, UAE, P.O. Box 14143
E-mail: mosman@ud.ac.ae
Tel: +971 04 2072 669; Fax: +971 04 224 2670

Rosmy Jean. Louis
Department of Economics and Finance
Assistant professor of economics at Vancouver Island University, Canada
Faculty of Management, Bldg 250 Room 464 Vancouver Island University
900 Fifth Street Nanaimo, B Canada V9R 5S5
E-mail: rosmy.jeanlouis@viu.ca
Tel: 250-753-3245; Local 2233; Fax 250 - 740 - 6551

Faruk Balli
Senior Lecturer, Department of Economics and Finance, Massey University
Private Bag 11 222, Massey University, Palmerston North, New Zealand
Assistant professor of economics and finance at the University of Dubai
E-mail: F.Balli@massey.ac.nz
Tel: 64 6 3505699 ext 2330; Fax: 64 6 3505651

Abstract

In this paper we estimate the output gaps of the AGCC countries using four different methods that are: the linear trend model, Hodrick-Prescott filter, Band-Pass filter and the unobserved components model. To perform meaningful comparisons, we differentiate between the overall and non-oil output gap and estimate their respective gaps. Several primary conclusions are manifestly noted from our analysis. First, all the different methods but the unobserved components model has produced almost similar results. Second, our results indicate that all the countries in the region have similar business cycles. Third, we find that there is no significant difference between the overall output gap measures and the non-oil output gaps for all the countries in the region. Fourth, the estimated output gaps did not have any explanatory power on domestic inflation for all the countries with the exception of Saudi Arabia and Oman.

Keywords: AGCC, Output gap, Inflation, Hodrick-Prescott filter, Frequency domain filter, Band-Pass filter, Unobserved Components model, Kalman filter, Phillips Curve.
JEL Classification Codes: C13, E5, E31, E32

1. Introduction

Recently, there has been an abundant literature that focuses on the estimation of output gaps both in the developed and less developed countries[1]. This underscores the importance of this variable in contemporary macroeconomic models designed to enhance our understanding of the dynamics of each country's economy. More importantly, the role of the output gap in monetary policy has been the subject of intensive discussion and research, since the successes of the inflation targeting regimes. It is considered to be an important indicator of the cyclical position of the economy and as well as the identification of changes in the pattern of business cycle evolution. Hence, knowledge of this variable together with other macroeconomic variables play a key role in explaining future economic forecasts essentially in the level of real GDP, price and wage inflation (Clarida et al, 1998 and Roberts, 1995).

Reflecting on this, we estimate and compare the output gaps for the Arab Golf Cooperatation Council (AGCC) Countries while distinguishing between the overall real GDP output gap and non-oil GDP output gap. Since these countries are forming a monetary union for the year 2010, this study is both appealing and opportune for several reasons. As indicated in the outset, first, the estimation of the output gap is necessary since it is an important indicator of domestic inflation. A major objective of the central banks of the AGCC countries is to achieve price stability and this has led the monetary policy authorities to utilize all available information in the economy to foresee the future course of price dynamics. In this respect, estimates of the different output gap measures obtained may thus become very useful since they are one of the many measures of resource utilization. Second, comparing and contrasting the different output gap measures (i.e. the overall GDP output gap and the non-oil GDP output gap) obtained from the different statistical models that are used for its estimation is essential in order to determine which measure of these output gap variables gives the best indication of the state of the macro economy of these countries. Consequently, we compare the information content of the different estimates of this variable in the determination of domestic inflation. By using the traditional Phillips Curve model in which inflation is determined by past inflation and the output gap, we focus on how useful the output gap variable is in determining domestic inflation of these countries. Third, the estimation of the output gap facilitates us to determine whether these countries share some common stylized facts about the dynamics of their economies. Since these countries share many characteristics such as language, religion, geographical location, structure of their economies etc, we can scrutinize if they have similar business cycles. Fourth, the output gap is a key input in different domains of economic analysis, such as the computation of the cyclically adjusted budget balances since government revenues and expenditures are affected by the cyclical position of the economy[2]. During boom periods, the budget balance improves as a consequence of higher tax revenues, high oil revenues and lower growth of government expenditures. Concurrently, during recessionary periods the opposite holds. Hence, having a reliable measure of the output gaps of these countries is essential in the determination of the cyclically adjusted budget balance of these countries.

Output gap is generally defined as the difference between actual and potential output. However, a major problem is that both potential output and the corresponding output gap are inherently unobservable and must be estimated using information from other observable macroeconomic variables. This has led to the development of many techniques that are extensively used in the literature to estimate these variables albeit that none of them is completely satisfactory[3]. These different methods

[1] The output gap is measured by decomposing the actual output (real GDP) into structural and conjunctural components using different methodological techniques. The structural component is usually described as the trend component or the "potential output", while the latter is termed as the "output gap" which is the irregular components of the actual output and it includes temporary elements that are shaped by business cycle and other very short-run fluctuations. See, Cerra and Saxena (2000).

[2] The cyclically adjusted budget balance is defined as the difference between the actual budget balance and its cyclical component, which is that component of the budget balance that remains after the effect of the economic cycle, is removed.

[3] Since these variables are unobservable and must be estimated, they are associated with uncertainties. The different techniques that are used to estimate them generally yield different results. Hence, there are many problems that are

can be compartmentalized into three categories depending on their usage of economic theory. These approaches are statistical methods, structural methods and mixed or multivariate methods. The first method is unequivocally mechanical in its estimations of these variables and does not rely on economic theory while the second method relies purely on economic theory in its estimation. The third method is a combination of the first two methods.

In this paper we use only the first method and this can be justified by three noteworthy reasons[4]. First, estimations of the structural and mix or the multivariate approaches typically rely on economic theory and this entails the fulfillment of stringent assumptions that are more appropriate for the industrialized economies. For instance, one of the main assumptions that these approaches require is that the structural relationships in these economies to remain stable during the sample period which is very difficult to satisfy in this study, since these economies have undergone profound structural transformations during our sample period. Second, data limitations make it difficult to estimate both the potential output and the corresponding output gap using both the structural and multivariate approaches. More importantly, data on employment and capital stock of these countries are needed to estimate these variables especially when using the production function approach which are not readily available. Third and finally, since there are uncertainties surrounding the estimations of these variables and there is no one definitive measure that is superior to all the others, it is necessary to provide these estimates in order to form an information set that can be applied with confidence in designing and formulating a sound monetary policies of these countries.

To foreshadow the results of the paper, our analysis indicate that the different approaches of estimating output gaps and the corresponding measures obtained have produced a broadly similar profile of the economies of these countries. Remarkably, the different measures of the non-oil output gaps give comparatively consistent indication of the magnitude of slack in these economies. Nonetheless, we could not find any statistical support that the output gap variable however measured is capable of explaining domestic inflation in the AGCC countries with the exception of Saudi Arabia and Oman.

The rest of the paper is structured as follows: section two provides a brief discussion of the data and the estimation methodologies, while section three presents the empirical results of the different output gap measures. Section four discusses and compares the information contents of the different output gap measures obtained from the different models while section five concludes the paper.

2. Data and Methodology

In this paper, we use annual data set that covers the period 1970 – 2006. The data series include the real GDP for all the AGCC countries in US dollars at constant 1990 prices and similarly for the non-oil GDP of these countries which is calculated as the total value added of all sectors but mining and quarrying. The series also includes the GDP deflator with 1990 as base year due to unavailability of consumer price index (CPI) for all the countries. All the data were taken from the United Nations Statistical Databases – National Accounts Main Aggregates.

For estimating the output gaps of these countries, we use only the statistical methods for the unassuming reasons indicated at the outset. Although there are many different statistical modus operandis for estimating output gaps that are available in the literature, we use only the four most popular ones which are the linear trend method, The Hodrick-Prescott Filter, the Frequency Domain Filter and The Unobservable Components Model. In the following sub-sections we describe these methods briefly and delineate both their advantages and disadvantages.

associated with their usage. For detailed discussion on this, see Orphanides, and Simon (2001) and Cayen and Simon (2004).

4 For similar arguments of estimating output gaps of Asian countries, see Gerlach and Yiu (2004).

2.1. The Linear Trend Method

The first and the oldest statistical technique that is empirically utilized to estimate both the potential output and the output gap are termed as the linear trend method. As the name indicates this method assumes that output is approximated as a simple deterministic function of time. This approach decomposes output into a trend component and a cyclical component[5]. The general criticisms of this technique are well documented in the literature (Gibbs 1995; Diebold and Senhadji 1996; de Brouwer 1998; Billmeier 2004). Notwithstanding the violations of time series properties, one of the main drawbacks of this technique is that it assumes that the potential output grows at a constant rate and this implies that all the movements in output about the time trend are interpreted as demand shocks since it does not allow any supply shocks to the system (Claus, 2000). This assumption is very problematic and difficult to justify theoretically since the growth of output depends on the growth of the factors of production and improvements in technology and there is no reason for these factors of production to be constant over time especially when the economies of these countries have undergone a considerable structural change over the years. In this regard, Graff (2004) also observes that the potential GDP is evolving along a path that shows a considerable amount of inertia.

2.2. The Hodrick-Prescott Filter

These palpable shortcomings of the linear trend method have necessitated the need for alternative detrending methods. These methods include the development of several statistical filters that are widely used in the literature to estimate both the potential output and the corresponding output gap. The most popular filter among these is that of the Hodrick-Prescott method (H-P filter, here after). Similar to the linear trend, this method is not also based on economic theory or a structural relationship, but instead gives a useful approximation of the growth rate of the potential output. A desirable feature of the H-P filter is that it renders the output gap stationary over a wide range of smoothing values (Hodrick and Prescott 1997) and also it allows the trend to change overtime.

This approach identifies the long-term trend component of output by minimizing the following loss function.

$$L = \Sigma_s^t (y_t - y_t^T)^2 + \lambda \Sigma (\Delta y_{t+1}^T - \Delta y_t^T)^2$$

As a result, this function simultaneously minimizes a weighted average of the gap between actual and potential output and the rate of change of trend output. According to this method the weighting factor λ which is an exogenous detrending parameter is set arbitrarily where Hodrick and Prescott suggest that λ be 1600 for quarterly data and 100 for annual data. But the size of the weighting factor has been very contentious in the literature with some authors using different values for λ (See Billmeier 2004; Ross and Ubide 2001; and Slevin 2001). In particular the magnitude of the weighting factor has an impact on how the potential output responds to movements of the actual output since it controls the smoothness of the series by setting the ratio of the variance of the cyclical component and the variance of the actual series[6]. Needless to say that the magnitude of the output gap varies with the size of the smoothing factor, but more importantly, it also affects the relative scale and timing of the peaks and troughs in output.

In common with the other statistical methods and especially with the two-sided filters, the H-P filter is also plagued with the end-sample problems[7]. Many authors have highlighted this problem and noted that estimates of the output gap at the end of the sample may be subject to substantial revision as

---

[5] This method was very popular because it is easy to construct and interpret the results. The following equation is usually estimated.

$$Y^* = \alpha + \beta t \text{ where } Y^* = \text{the potential output}$$

[6] Higher values of λ leads to higher weight attached to the smoothness of the trend and vice versa. More precisely, as λ approaches infinity this resembles the linear trend method and as λ approaches zero the potential output will be equal to actual output.

[7] The difference between the two-side filters and one-side filter is that the two side-filter uses both past and future information while the one-side filters use only the past information

new data come to hand, the period which is of most interest to policy makers. To resolve this issue, a number of corrective measures have been suggested to reduce – at least partially – the end-sample problem. The most preferred solution in the literature is that of extending the dataset with forecasts. However, these corrective measures are also dependent on the accuracy of these forecasts. If these remedial procedures are not undertaken such as using output projections to augment the observations, this could lead to policy failures for users who are by and large interested in the most recent observations in order to make projections for the immediate future.

2.3. Frequency Domain Filters

Most macroeconomic time series variables such as the real GDP are generally non-stationary and often exhibit fluctuations that are inherently from different sources. These fluctuations reflect on the specific features of the data generating processes that occur with certain frequencies. According to this approach, these fluctuations can be decomposed into sums of different periodic components or frequencies which are usually assumed to be distinct and mutually independent. The periodic components or frequencies are described as the number of cycles per period. Hence, macroeconomic time series variables - such as the real GDP - are partitioned into three periodic components which are high-frequency, medium-frequency and low-frequency components. The high-frequency components of the data are described as the variations in the time series variables that are either seasonal or irregular, whereas the low-frequency components of the data are associated with the trend component of the time series variable. On the other hand, medium-frequency components of the data are described as the cyclical component or business cycles which are the main focus of this type of filtering. This kind of filter is often referred to as a Band-Pass filter and the most popular one in the literature is that of the Baxter and King (1999) filter.

Following Burns and Mitchell (1946), Baxter and King (1999) also observe that the business cycle consists of periodic components whose frequencies lie between 1.5 and 8 years per cycle. Cycles that are either too long or too short to be considered as a part of the business cycle are eliminated with the principal aim of isolating the medium-frequency components of the data so that the analysis is focused solely on it. Since, this filter can not handle non-stationary time series variables - such as the real GDP - in the frequency domain; it must be transformed into the time domain. In this regard, this filter relies on theory of spectral analysis of time series and this is achieved by performing a finite and moving average process of the real GDP. More importantly, the resulting filter is a centered moving average with symmetric weights.

The Baxter and King filter has some desirable features that have contributed appreciably to its extensive application in the literature. Firstly, it is imperative to note that this approach is more flexible than the H-P filter. It can handle easily data sampled from monthly or annually and also estimates the output gap directly, whereas the trend output is computed as the actual output minus the estimated output gap. Secondly, since the resulting filtered series is stationary and symmetric, it does not introduce phase shift. Thirdly and finally, this filter has the capability to track closely the NBER dating of business cycles. Similar to other band-pass filters, it is also subject to many limitations. Filtering in the time domain involves the loss of K observations at the beginning and at the end of the sample. This filter is also criticized on the basis that it produces spurious dynamics in the cyclical component.

2.4. The Unobservable Components Model

As suggested by Watson (1986) this methodology decomposes output into a permanent and a transitory component which correspond to the potential output and the output gap respectively. Hence, this decomposition of the output can be written as follows:

$$y_t \equiv y_t^p + z_t$$

It is assumed that the potential output follows a random walk with a drift.

$$y_t^p = \mu^p + y_{t-1}^p + \varepsilon_t^y$$

Where μ^p is a drift term and can be used as a measure of the rate of growth of the potential output and where $\varepsilon_t^y \approx (0, \sigma_y^2)$**.** This equation implies that the rate of growth of the potential output not only depends on temporary shocks captured by $\varepsilon_t^y \approx (0, \sigma_y^2)$ but also on the more persistent growth factor μ^p. As suggested by Clark (1989), we assume that the drift parameter follows a random walk and can be written as:

$$\mu^p = \mu_{t-1}^p + \varepsilon_t^\mu$$

Where $\varepsilon_t^\mu \approx N(0, \sigma_\mu^2)$[8] and implies a permanent shock to the rate of growth of potential output**.** Finally, we assume that the output gap follows an AR(2) process:

$$z_t = \phi_1 z_{t-1} + \phi_2 z_{t-2} + \varepsilon_t^z$$

Where $\varepsilon_t^z \approx (0, \sigma_z^2)$ and the roots of $(1-\varphi_1 L - \phi_2 L^2) = 0$ lie outside the unit circle**.**

In order to estimate the model, we must write it in a state space form[9]. The state space formulation consists of two equations, the measurement equation (or the observation equation) which describe the observed variables as a function of the unobserved variables and the transition equation (or the state equation) which describes the evolutionary processes of the unobserved state variables. Let ζ_t denote the vector of state variables and β be a matrix of coefficients;

$$\zeta_t = [y_t^p \quad z_t \quad z_{t-1} \quad \mu_t]$$

$$\beta = [1 \quad 1 \quad 0 \quad 0]$$

In vector notation, the measurement equation can be written as:

$$y_t = \beta\zeta_t$$

To complete the model, the transition equation which describes the evolutionary Processes of the state variables can also be written as:

$$\zeta_t = \Gamma\zeta_{t-1} + e_t$$

Where

$$\Gamma = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & \phi_1 & \phi_2 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

and $e_t = [e_t^y \quad e_t^z \quad 0 \quad e_t^\mu]$. Then estimates of the parameters of the model and the state variables can be obtained by maximizing the following likelihood function using the Kalman Filter. The likelihood function is defined as:

$$\log \Pi = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_1^T \log|F_t| - \frac{1}{2}\sum_1^T v_t^T F_t^{-1} v_t$$

where "T" is the sample size, "v" is the prediction error matrix and "F" is the mean square error matrix of the prediction errors.

---

8 Watson (1986) in his analysis of the U.S. data made the assumption that the rate of growth is constant over the sample period which implies that $\varepsilon_t^\mu = 0$. This assumption is very restrictive when applied to other economies as indicated by Gerlach and Smets (1997). Since our estimation exercises include periods where the economies of these three countries have undergone structural changes, we assume that the rate of growth varies over time.

9 The state space modeling generally deals with dynamic time series that involve unobserved state variables such as the trend output, output gap, time-varying parameters, etc and the basic tool used to estimate these variables is the Kalman Filter which is a recursive algorithm. For details, see Hamilton (1994).

3. Output Gap: Empirical Results

This section presents the empirical results obtained from the four different statistical methods used to measure the output gaps of the AGCC countries. A number of features are unhesitatingly perceptible from these results which are worth commenting on. One noteworthy attribute of the empirical results is that a reciprocated pattern materializes about the output gaps of these countries. First, though the different statistical methods are based on different theoretical assumptions and depict different fluctuations of the respective economies of these countries, our results reveal how comparable these estimates are. Second, the results suggest that there is a comprehensible sign of business cycles synchronization among these countries. This finding is outstandingly important for two main reasons: a) since the AGCC countries plan to adopt a common currency by 2010, and one of the required convergence criteria is that inflation be in line around 3 – 5%, it is reassuring to find signs of business cycle synchronization; b) it is a confirmation of the ties between these countries, be they political, economic, cultural and geographic. The AGCC countries are affected by the same shocks, understandably due to the dependency of their economies on the oil sector.

Figures 1-6 present further details on the state of the business cycles of the AGCC countries that are typical for oil dependent economies. For the estimated overall output gaps, it appears that all the AGCC countries had recessionary episodes in the early 1970s, mid 1980s and early 1990s. The first recessionary episode of these countries can be attributed to the OPEC oil embargo that was associated with the Yom Kippur war, while the second one was the result of the 1986 major oil price collapse that resulted from the dispute among the OPEC members. The last major recession of the region was that of the 1990 Gulf war which created a major instability and a climate of uncertainty that adversely affected the countries' whole economic performances. Principally, this war affected mainly Iraq and Kuwait economies which effectively removed about 9% of world oil production from the market and disrupted the supply of oil from the region and in addition caused considerable uncertainty in the crude oil market.

Likewise, the estimated non-oil output gaps of these countries have produced a similar profile for all these countries' economies. More characteristically, although, the different statistical methods used for the estimations have produced relatively different results, it is worth noting that a general pattern appears for all these countries. First, it appears that the performance of the non-oil sector follows that of the overall performance of the entire economy. Remarkably for the estimated non-oil output gaps, the AGCC countries had recessionary episodes in the early 1970s and from mid 1980s to early 2000s. Secondly, for all the countries in the region, the estimated non-oil output gaps have turned positive since 2000 onwards and this can be corroborated by the efforts of the macroeconomic policy authorities of these countries to diversify their economies and reduce the dependency of the oil as a major contributor of the economy. Furthermore, this could also be explained in part by the recent increases in the oil revenues stemming from the high world market price of oil and the repatriation of capital by these countries from the U.S. and elsewhere since September, 11 2000 to reinvest in the non-oil sector particularly in infrastructure.

It is truism that high oil prices have a positive impact on the economic performances of the AGCC countries since the oil sector accounts for 44 percent of the real GDP and 81 percent of the total exports. The booming of the oil sector over the years has undoubtedly contributed significantly to the non-oil sector since governments use oil revenues to foster economic growth. The non-oil sector is tributary to the oil sector as could be inferred from the match of the non-oil output gap and the overall output gap. The general implication is that if the business cycles of these countries are synchronized and have common shocks, then a coordination of macroeconomic policies can become desirable with the ultimate goal of achieving a common currency. More specifically, the different output gap measures obtained from the different models (i.e. the overall output gap and the non-oil output gap) describe the main macroeconomic fluctuations of these countries as they are commonly referred to. But, for an overall analysis, our results suggest that these countries' real output fluctuations are likely to be influenced by the effects of the world oil price fluctuations.

Turning now briefly to the country level results and for an overall picture of the differences between the different statistical methods, Figure 1 provides estimates of the overall output gaps and the non-oil output gaps for the UAE economy. The overall output gap measures obtained are approximately comparable demonstrating that this variable has turned negative at least on two major occasions: that of early 70s and mid 80s. Similarly, the non-oil output gaps obtained are also very analogous and indicated that the non-oil sector has turned both negative and positive on similar occasions for approximately all the different methods. Table 1 shows the correlation coefficients between the different statistical methods utilized in this study which demonstrates how strongly the results from these different methods are related to each other. As expected, the correlation coefficients between the overall output gaps obtained from the different statistical methods are generally high. Particularly, the output gap estimates obtained from the H-P filter and the B-K filter are exceedingly comparable as confirmed by their bilateral correlation coefficient of 0.90, while the output gaps from the linear method and the unobservable components model are least correlated (see Table1). The bilateral correlation coefficients among the different measuring methods of the output gaps range from 0.26-0.90 signifying that almost all these measures move closely together and are in harmony with the nation's economic business cycles. Similarly, the different statistical methods have produced similar non-oil output gap measures. As mentioned above, this variable has turned negative mainly on two occasions that of early 1970 and mid 1980s to early 2000 and then turned positive since then. The bilateral correlations between the different methods of the non-oil output gap are also generally high with the exception of the linear method and the unobservable components model.

Table 1: UAE's Correlation Matrix

Model	**Lgap**	**Lngap**	**HPgap**	**HPngap**	**BPgap**	**BPngap**	**Ucmgap**	**Ucmngap**
Lgap	1.00							
Lnongap	0.94	1.00						
HPgap	0.79	0.60	1.00					
HPngap	0.76	0.79	0.76	1.00				
BPgap	0.61	0.36	0.90	0.46	1.00			
BPngap	0.53	0.60	0.59	0.88	0.39	1.00		
Ucmgap	0.26	0.10	0.55	0.27	0.76	0.27	1.00	
Ucmngap	0.12	0.08	0.07	0.42	0.17	0.66	0.10	1.00

Figure 1: UAE – Comparisons of Output Gaps

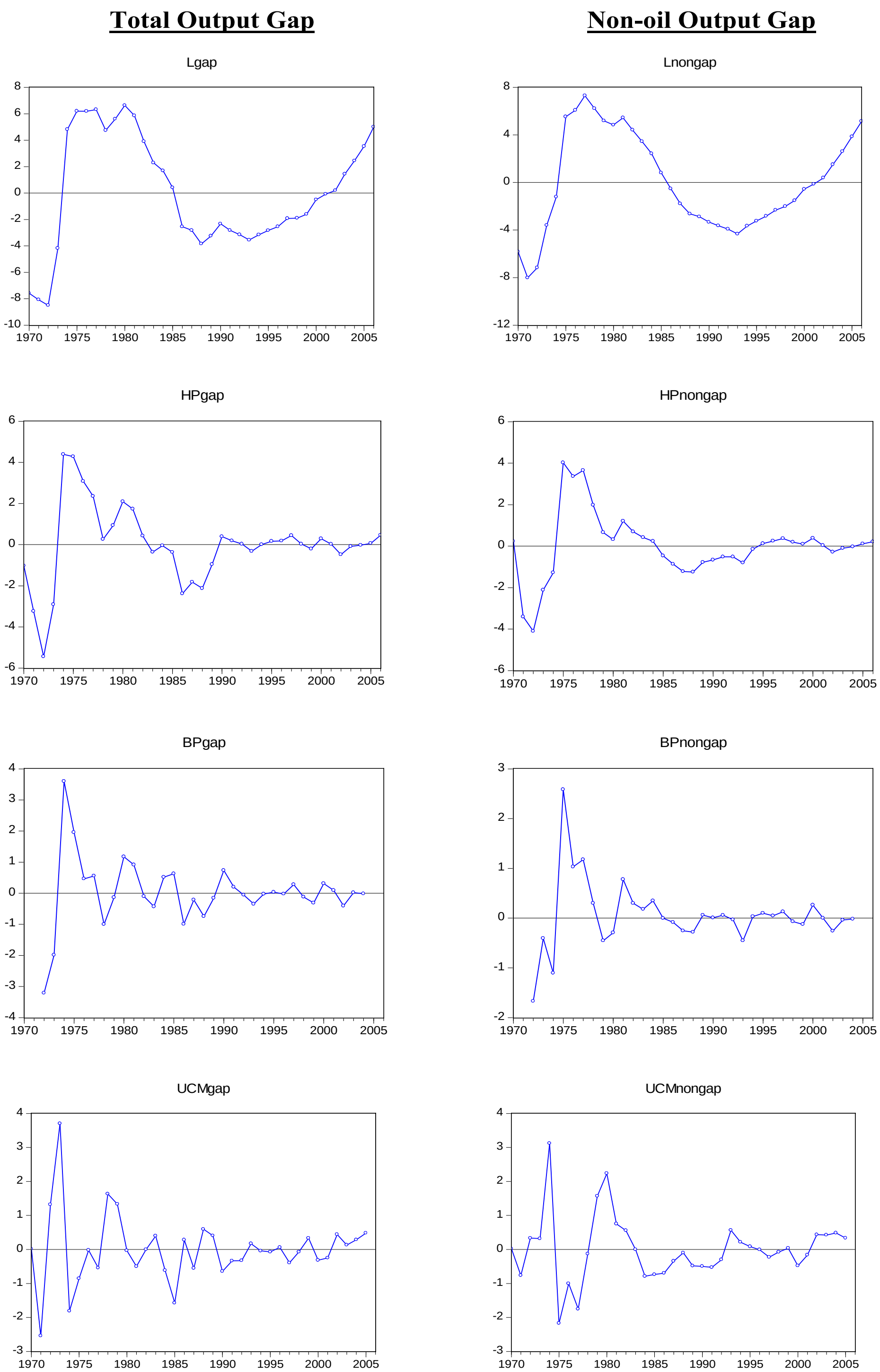


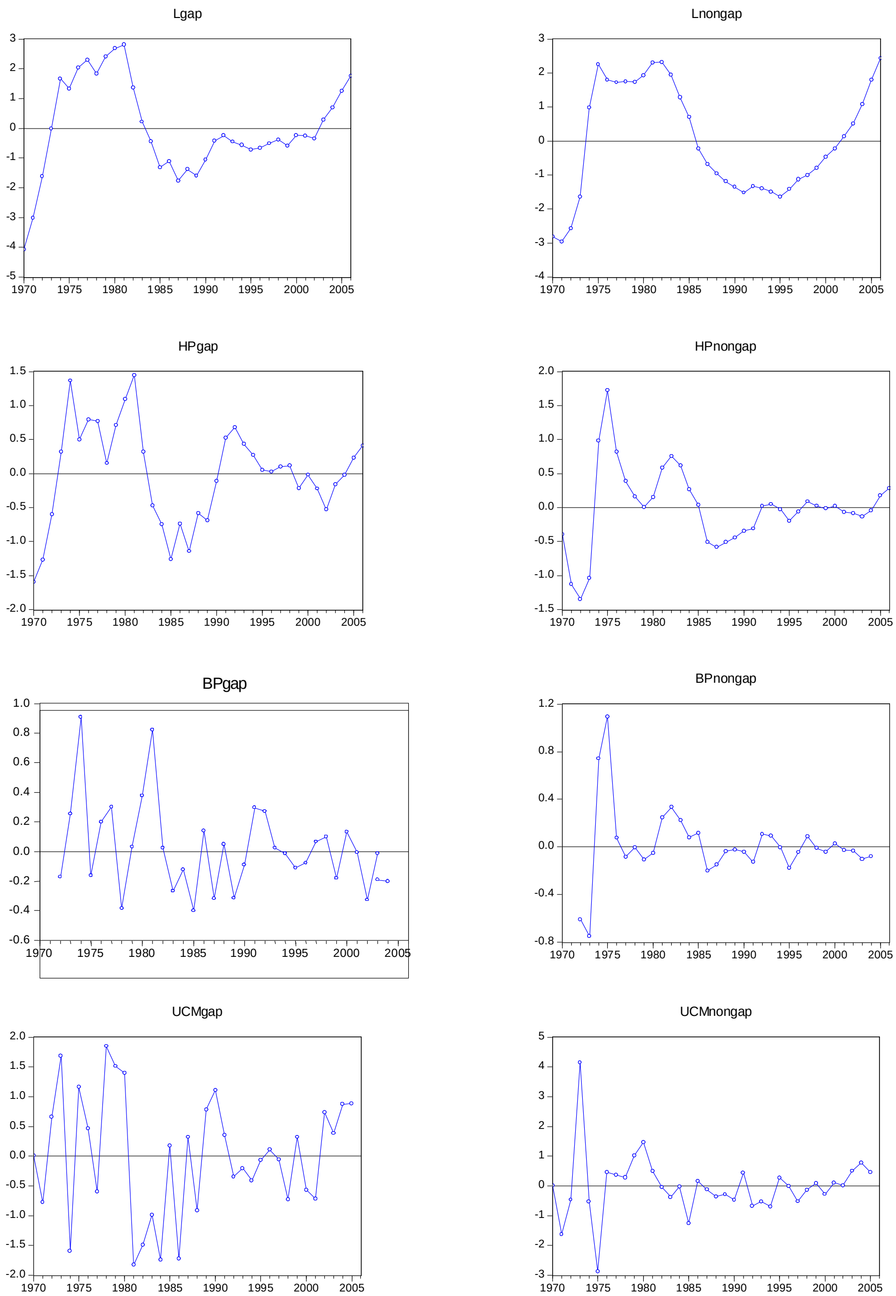
Figure 2 presents the results for Saudi Arabia. As can be gleaned from these charts, the estimates of the overall output gaps of the different approaches produced almost similar findings as indicated by their bilateral correlation coefficients which range from 0.06-0.79 (see Table 2). Mostly, the correlation coefficients between the different overall output gap measures are relatively strong with the exception of the unobserved components model which demonstrated to be the least correlated with the linear method. But in the main, all the different methods indicate that the Saudi economy was in recession for the most part during the mid 1980s to early1990s. This in part can be explained by worldwide recessions that followed the previous oil supply shocks of the 1979 – 80 and many of the industrial countries including the United States were in deep recessions and were also experiencing other macroeconomic disturbances such as the rising of inflation and the dismantling of price controls. However, after the 1990s to the 2000, the Saudi economy had rebounded and had more positive output gaps although this period also included the Asian financial crisis. Correspondingly, the different statistical methods have produced almost similar non-oil output gap measures that replicate the overall output gap measures as indicated by their corresponding bilateral correlations (see Table 2). The bilateral correlations between the different non-oil output gap measures range from 0.04 – 0.90 with the highest between the H–P gap and the B-P gap. The lowest correlation coefficients are between the linear model and the unobservable components model. This underscores the sensitivity of the estimates with the model used and this should be interpreted as point estimates. A desirable feature of the unobserved components model is that it renders this uncertainty of the output gap estimates with confidence bands.

Table 2: Saudi Arabia's Correlation Matrix

Model	Lgap	Lngap	HPgap	HPngap	BPgap	BPngap	Ucmgap	Ucmngap
Lgap	1.00							
Lnongap	0.79	1.00						
HPgap	0.79	0.33	1.00					
HPngap	0.63	0.74	0.49	1.00				
BPgap	0.53	0.17	0.79	0.25	1.00			
BPngap	0.36	0.54	0.32	0.90	0.18	1.00		
Ucmgap	0.06	0.10	0.01	0.24	0.39	0.29	1.00	
Ucmngap	0.23	0.04	0.20	0.44	0.27	0.68	0.26	1.00

Figure 2: Saudi Arabia – Comparisons of Output Gaps

Total Output Gap | **Non-oil Output Gap**

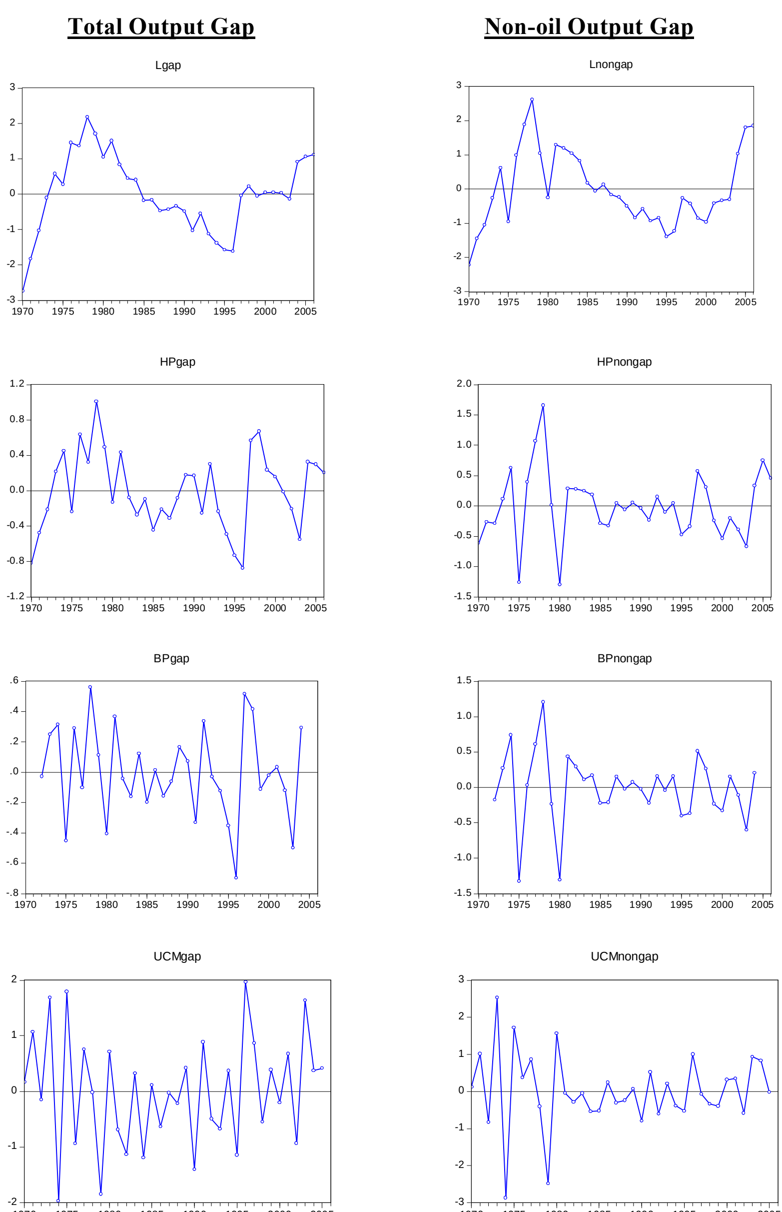


The results of Qatar are presented in figure 3. Similar to the above countries' findings, estimates of the Qatar's overall output gap measures indicate that it turned negative on early 1970s, mid 1980s to mid 1990s and early 2000s. The downturn of the output gap in the early 2000s can be accredited to the Asian financial crisis, while the other downturns are as mentioned in the above analysis. Table 3 shows the bilateral correlation coefficients of the output gaps obtained from the different methods. The bilateral correlation coefficients of the overall output gap measures obtained from the different statistical methods are lowest between the unobservable components model and the linear model with only 0.22 followed by the B-P filter with 0.47 (See Table 3). These results indicate that there are noteworthy differences across the various statistical methods used and consequently, Qatar has more variations in the overall output gap estimates than the other countries in the region. On the other hand, the results of the non-oil output gap measures obtained from the different models have also produced almost similar results indicating that this sector had only two major down turns which are mid 1970s and mid 1980s. Also, the bilateral correlation coefficients between the different methods are generally high suggesting that they contain almost the same information.

Table 3: Qatar’s Correlation Matrix

Model	Lgap	Lngap	HPgap	HPngap	BPgap	BPngap	Ucmgap	Ucmngap
Lgap	1.00							
Lnongap	0.85	1.00						
HPgap	0.72	0.57	1.00					
HPngap	0.44	0.72	0.65	1.00				
BPgap	0.47	0.48	0.87	0.71	1.00			
BPngap	0.30	0.59	0.58	0.95	0.74	1.00		
Ucmgap	0.22	0.26	0.30	0.27	0.42	0.31	1.00	
Ucmngap	0.07	0.17	0.22	0.32	0.32	0.37	0.79	1.00

Figure 3: Qatar – Comparisons of Output Gaps

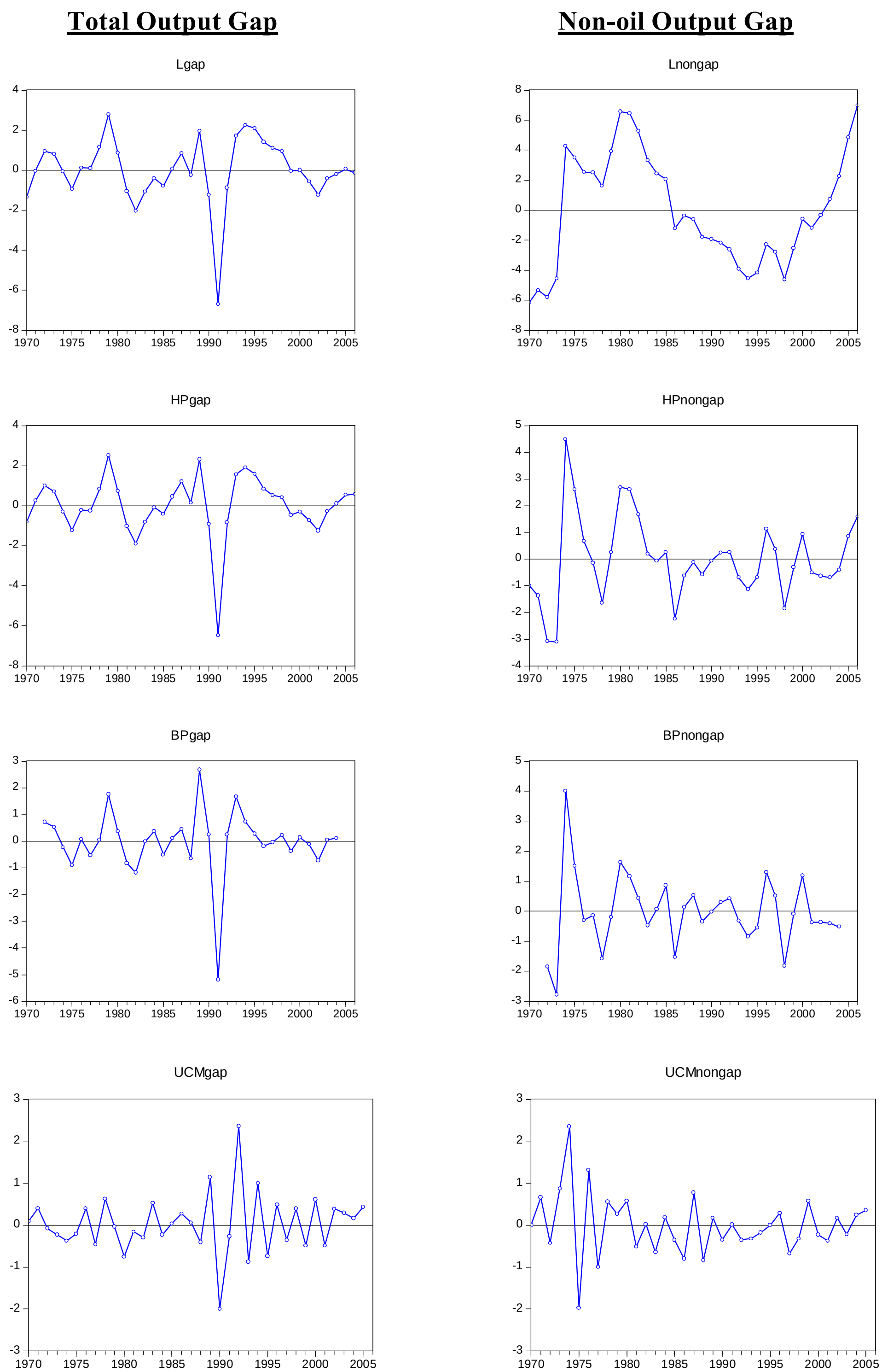


Regarding Kuwait, the results are presented in Figure 4. The different statistical methods used to estimate the output gap provide a rather consistent profile of the nation's business cycles. For the most part, estimates of the overall output gap measures obtained from the different models insinuate that it turned sharply negative on only one occasion which was the early 1990s. This major downturn of the overall output gap measure in the early 1990s can be attributed to the Gulf war of the 1990s. All the different methods capture superbly this significant downturn, where the actual output fell below its potential by more than 6 percent. This had a colossal impact on the nation's economic performance by disrupting the oil supply which was the main source of revenue for the nation. Before the invasion of the country, the economy was performing well with a positive output gap of 2 percentage point above the potential output. After the invasion of the country, the economy turned from positive 2 to negative 6 highlighting the degree or the magnitude of the economic disruption the country has suffered. All our estimates indicate that this downturn was short-lived and after 1992 the economy returned to its pre-war normal levels. More precisely, from 1992 to 1998 the overall output gap was above its potential according to all the different statistical methods used. Table 4 shows the bilateral correlation coefficients of the output gaps obtained from the different methods. Especially, the bilateral correlation coefficients of the overall output gap measures show that the unobservable components model has the lowest correlations with the other models (See Table 4). The strongest correlation is between the linear method and the H-P gap followed by the correlation between the H-P gap and the B-P gap. In sum, the results indicate that there are significant similarities across these methods with the exception of the unobservable components model as accentuated by the bilateral correlation coefficients. Similarly, the different methods have produced similar results of the non-oil output gaps with the exception of the unobservable components model as indicated by the close correlation coefficients between the methods. The bilateral correlation coefficients range from 0.11 to 0.94 showing the unobservable components model and the linear method are the least correlated while the other two methods also do not fare much better. But, the correlation coefficients between the other three methods are generally high indicating that they contain the same information of the economy. Our results indicate that this variable has been negative for the most part since 1985 implying that there is a significant opportunity for improvement in this sector.

Table 4: Kuwait's Correlation Matrix

Model	Lgap	Lngap	HPgap	HPngap	BPgap	BPngap	Ucmgap	Ucmngap
Lgap	1.00							
Lnongap	0.21	1.00						
HPgap	0.98	0.18	1.00					
HPngap	0.24	0.70	0.28	1.00				
BPgap	0.87	0.14	0.92	0.25	1.00			
BPngap	0.21	0.54	0.24	0.94	0.23	1.00		
Ucmgap	0.11	0.10	0.12	0.14	0.15	0.13	1.00	
Ucmngap	0.14	0.11	0.12	0.16	0.11	0.17	0.02	1.00

Figure 4: Kuwait – Comparisons of Output Gaps

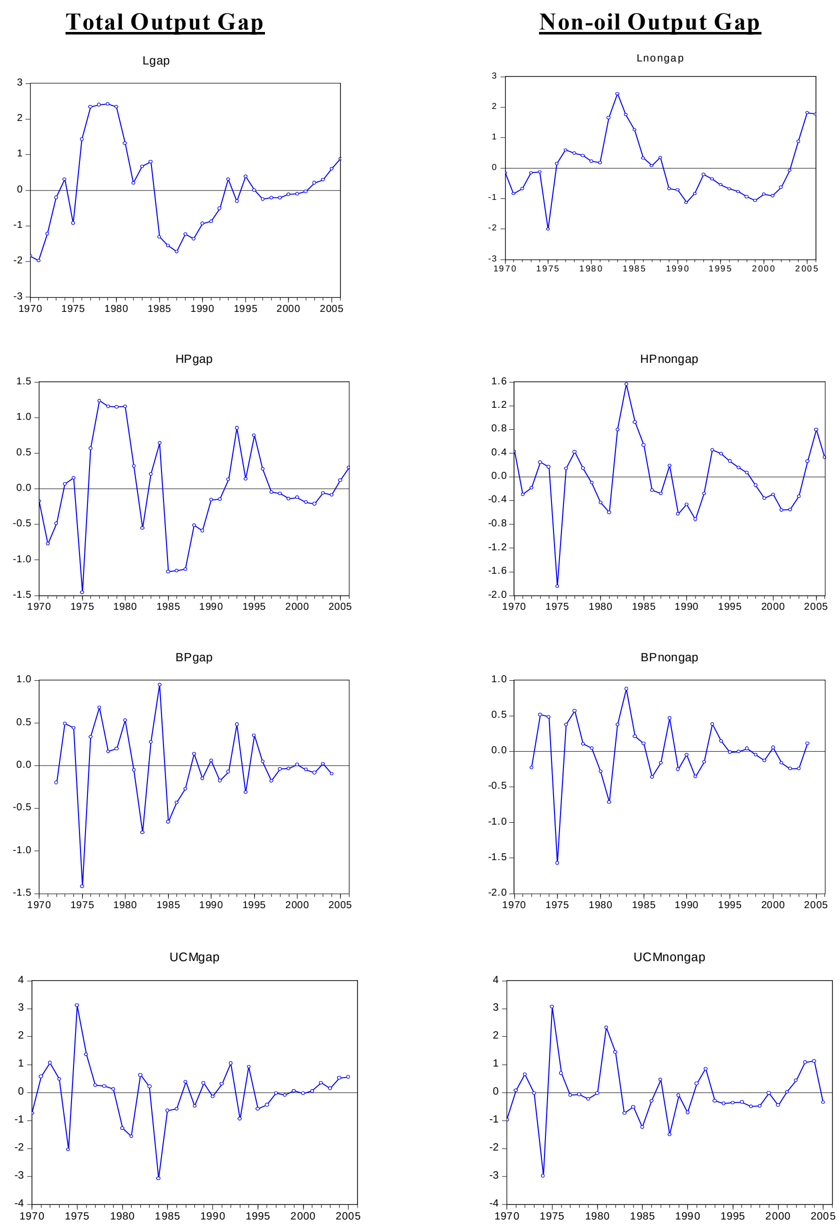


The results for Bahrain are plotted in figure 5. Again, the estimates from the different methods of extracting the output gap produced similar results and this is highlighted by the results from Table 5 which reports the bilateral correlation coefficients of the different statistical methods utilized in this study and indicates that these correlation coefficients are generally high with the exception of the unobservable components model. The results intimate that the overall output gap measure has turned sharply negative only on two occasions in the early 1970s and mid 1980s. After the 1990 Gulf war, the economy recovered from these recessions and was more stable during the 2000 onwards although it did not show significant improvements. Similarly, the non-oil output gap showed comparable patterns with the overall output gap (see Figure 5 and Table 5).

Table 5: Bahrain's Correlation Matrix

Model	Lgap	Lngap	HPgap	HPngap	BPgap	BPngap	Ucmgap	Ucmngap
Lgap	1.00							
Lnongap	0.34	1.00						
HPgap	0.87	0.21	1.00					
HPngap	0.26	0.80	0.35	1.00				
BPgap	0.55	0.30	0.78	0.47	1.00			
BPngap	0.26	0.61	0.42	0.87	0.61	1.00		
Ucmgap	0.22	0.39	0.35	0.39	0.61	0.32	1.00	
Ucmngap	0.04	0.19	0.19	0.47	0.48	0.64	0.55	1.00

Figure 5: Bahrain – Comparisons of Output Gaps

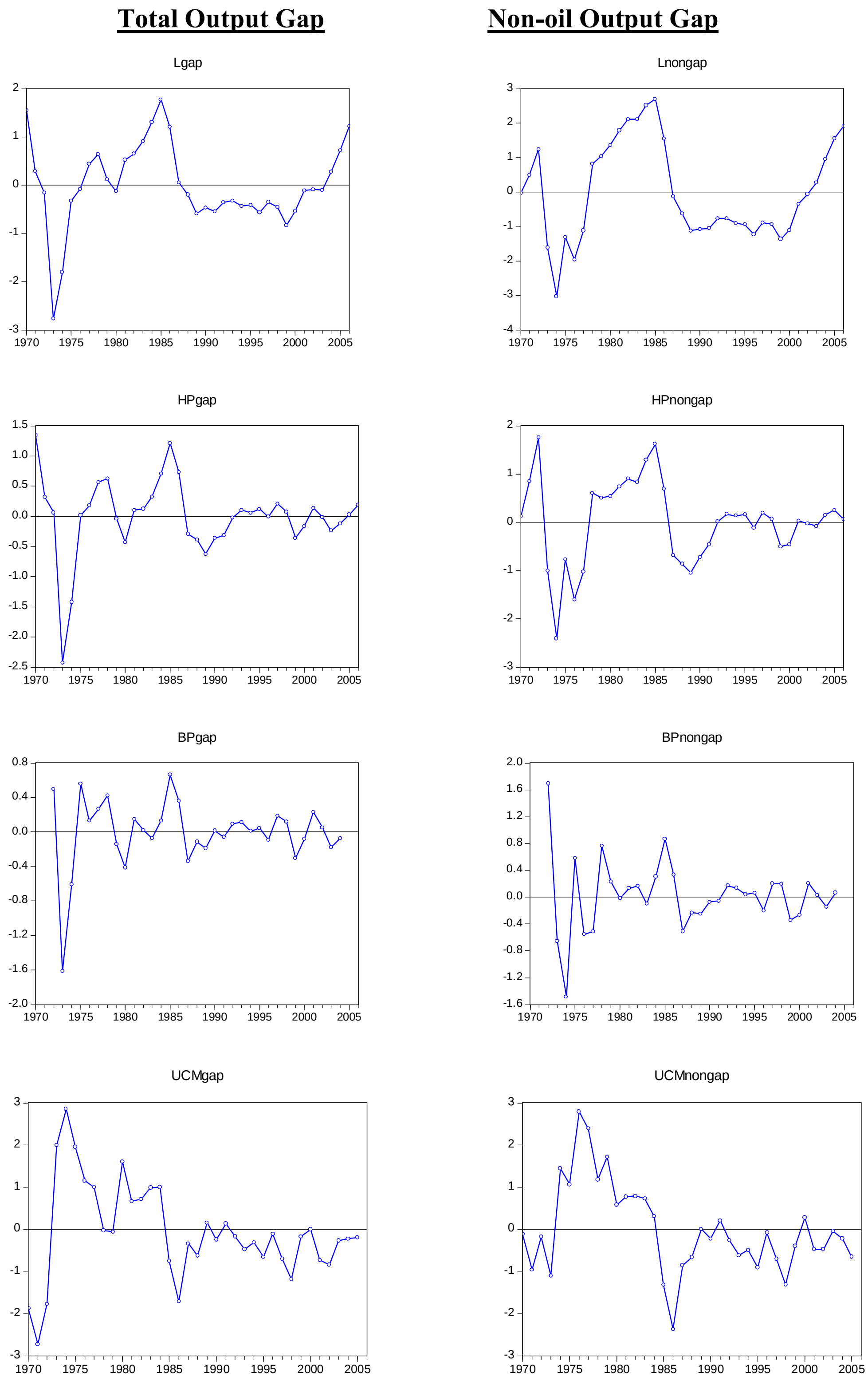


The results from Oman are plotted in figures 6. As can be gleaned from these figures, the output gaps from the different models are exceedingly comparable as revealed by their bilateral correlation coefficients (see Table 6). Most intuitively, for the overall output gap measures; it is prominent to know how similar the estimates from the linear method and the H-P filter are followed by that of between the H-P filter and the B-P filter, while the bilateral correlation between the linear model and the unobserved components model is the lowest with 0.35. Likewise, the non-oil output gap measures obtained from the different methods have produced similar results with that of the overall output gap measures (see Figure 6 and Table 6).

Table 6: Oman's Correlation Matrix

Model	Lgap	Lngap	HPgap	HPngap	BPgap	BPngap	Ucmgap	Ucmngap
Lgap	1.00							
Lnongap	0.80	1.00						
HPgap	0.90	0.55	1.00					
HPngap	0.66	0.87	0.61	1.00				
BPgap	0.73	0.36	0.89	0.47	1.00			
BPngap	0.52	0.59	0.59	0.81	0.68	1.00		
Ucmgap	0.33	0.23	0.46	0.47	0.47	0.56	1.00	
Ucmngap	0.03	0.12	0.02	0.30	0.05	0.24	0.62	1.00

Figure 6: Oman – Comparisons of Output Gaps



4. Output Gap and Inflation: Econometric Analysis

Both theoretically and empirically the output gap is an important variable used in contemporary macroeconomic models of inflations. Theoretically, the link between output gap and inflation is embedded in the general definition of the output gap which is the difference between actual output and potential output. More broadly speaking, it can also be understood as the deviations of the current output from its equilibrium level. A positive output gap signals an excess aggregate demand and this tends to put an upward pressure on prices, while negative output gaps is referred to as spare capacity and puts a sustained downward pressure on prices. Empirically many macroeconomic models use the output gap variable as an important indicator of domestic inflationary pressures and the cyclical positions of the economy.

To assess empirically, the information content of the different output gap measures obtained from the different statistical models in determining the domestic inflation of the AGCC countries, we use the standard Phillips Curve since many central banks use this model as their maintained theory of inflation. The standard Phillips Curve is generally specified in the literature as follows:

$$\pi_t = \delta_0 + \sum_{i=1}^{n} \delta_i \pi_{t=1} + \sum_{i=i+1}^{n} \delta_i \text{Gap}_t + \varepsilon \quad (1)$$ [10]

Equation 1 relates current inflation to past inflation (because it proxies expectations of future inflation) and to current and past output gaps. According to this specification, inflation develops gradually over time in response to aggregate demand factors as approximated by the different measures of the output gap variable while the residuals of the regression equation capture aggregate supply shocks. In this equation, inflation is represented by $\pi = (\log P_t - \log P_{t-1})$, where P_t = the GDP deflator at 1990 prices. Since economic theory does not provide much guidance with regard to the time lag between movements in inflation and output gap, we use the Akaike Information Criterion to determine the optimum lag length. In this exercise, we are interested in the sign and significance of the output gap coefficient in order to determine how well it explains the domestic inflations of these countries[11]. Idiosyncratically, we expect the sign of the output gap measure to be positive implying that aggregate demand induced fluctuations in output to be associated with higher inflation overtime.

The results of Equation 1 are shown in Tables 1A – 5A. Before discussing the results of the individual countries, it is worth commenting on some of the general features of these results. First, one of the prominent distinctiveness of the results is that the overall output gap variable had the expected positive sign in all the different models for all the countries with the exception of Qatar and Oman. For Qatar the overall output gap had the expected sign for half of the models while the other half had the wrong negative sign. But, for Oman, this variable had the wrong negative sign for all the different models with the exception of the unobserved components model. Second, an important feature of the results is that the overall output gap is not statistically significant for all the different models for all the countries with the exception of Saudi Arabia and Oman[12]. For Saudi Arabia, not only this variable had the expected positive sign but it was also statistically significant for all the different models but the unobserved components model at the 5% level. For Oman, on the other hand, the coefficient of the overall output gap variable not only had the wrong negative sign for all the models with the exception of the unobserved components model, but was also statistically significant at the 5% for all the different models. Third, similar results were observed in the performance of the non-oil output gap variable for all the countries.

---

[10] Many studies that estimate output gaps use this Phillips Curve specification to test the information content of this variable. For instance, see Gerlach and Peng (2006), de Brouwer (1998) and Clouse (2000). The variables that are mostly in this type of inflation models are: i) lags of inflation which captures such factors such as inflation inertia, expectations, institutional factors such as wage and price contracts and the presence of adjustment and transactions costs, ii) demand factors or indicators of excess demand captured by the output gap.

[11] It should be noted that full structural models of inflation also include variables that capture the behavior in product and labor markets explicitly in their role in contributing the future movements of inflation in these countries. Furthermore, it worth noting that changes in the output gap variable not only it has a direct effect on domestic inflation but indirectly also, through labor costs.

[12] The lack of significance of this variable can be justified for few reasons. First, it appears that this variable may not be the main driver of domestic inflation in these countries as measured by the GDP deflator. Second, since these countries are relatively open economies and are heavily dependent on international trade, inflation may be imported. Third, it might be the case that relevant variables are omitted which are peculiar to these countries.

For the individual countries, the results were generally mixed. For UAE, the overall output gap was significant at the 5% only for the linear model while it was insignificant for all the other models indicating that this variable has no explanatory power for the movements of domestic inflation. Almost similar results were noted in the non-oil output gap except that it was significant at the 5% level for both the linear model and the unobserved components model.

Table 1A: UAE's Estimates of alternative Phillips Curve

Model	Linear		H-P		B-K		UCM	
Coeff.	All	N-oil	All	N-oil	All	N-oil	All	N-oil
δ_0	0.03 (2.79)*	0.03 (2.55)*	0.03 (2.45)*	0.03 (2.36)*	0.03 (2.76)*	0.03 (2.82)*	0.04 (3.59)*	0.03 (3.31)*
δ_1	0.40 (2.67)*	0.40 (2.70)*	0.46 (2.94)*	0.44 (2.81)*	0.27 (1.86)**	0.26 (1.88)**	0.15 (0.96)	0.30 (2.09)*
δ_2	-0.51 (3.06)*	-0.35 (2.45)*	-0.38 (2.46)*	-0.33 (2.15)*	-0.35 (2.66)*	-0.36 (2.75)*	-0.49 (3.36)*	-0.49 (3.25)**
δ_3	0.13 (2.02)*	0.05 (2.04)*	0.06 (0.973)	0.05 (0.641)	0.01 (0.155)	0.06 (0.432)	0.02 (1.62)	0.02 (1.96)*
δ_4	-0.07 (1.20)						0.02 (1.99)*	0.00 (0.15)
R^2	0.38	0.33	0.26	0.25	0.23	0.23	0.34	0.31
D.W.	1.88	1.81	1.72	1.70	1.99	1.91	1.54	1.80

Notes: Absolute value of t-statistics is in parentheses.
*, ** denotes the level of significance which are 5% and 10% respectively.

For Saudi Arabia as indicated above the overall output gap not only had the expected positive sign but also was statistically significant at the 5% level for all the models with the exception of the unobserved components model. In addition, the lagged overall output gap variable was not only also significant at the 5% level for all the models but also increased considerably the R^2 improving the goodness of fit with the exception of the linear model. This implies that the overall output gap variable contributes significantly to the dynamics of the domestic inflation of Saudi Arabia as reflected by the t-statistic. For the non-oil output gap variable similar results were obtained and it is significant for all the models with the exception of the linear model. Therefore, the general pattern of the non-oil output gap variable suggests that it has similar effects on domestic inflation with that of the overall output gap variable.

Table 2A: Saudi Arabia's Estimates of alternative Phillips Curve

Model	Linear		H-P		B-K		UCM	
Coeff.	All	N-oil	All	N-oil	All	N-oil	All	N-oil
δ_0	0.06 (1.81)**	0.05 (1.64)	0.05 (1.82)**	0.06 (2.47)*	0.05 (1.76)**	0.02 (0.95)	0.05 (1.81)**	0.05 (2.08)*
δ_1	0.05 (0.26)	0.23 (1.25)	0.00 (0.04)	-0.06 (0.35)	0.08 (0.50)	0.06 (0.38)	0.13 (0.82)	0.21 (1.48)
δ_2			0.00 (0.03)			0.58 (3.85)*	0.06 (0.39)	
δ_3	0.55 (2.20)*	0.09 (0.42)	2.57 (4.19)*	2.79 (3.59)*	3.19 (3.11)*	2.15 (2.02)*	0.01 (0.60)	0.05 (1.94)**
δ_4			-1.35 (2.19)*	-2.79 (4.47)*		-5.31 (5.69)*	0.09 (3.34)*	0.10 (4.08)*
R^2	0.19	0.07	0.43	0.43	0.29	0.58	0.35	0.45
D.W.	1.76	2.01	2.18	1.61	1.92	1.87	2.17	1.91

Notes: Absolute value of t-statistics is in parentheses.
*, ** denotes the level of significance which are 5% and 10% respectively.

For Qatar, Bahrain and Kuwait, the overall output gap is not statistically significant for all the models indicating that it has no explanatory power for the domestic inflationary dynamics of these countries. Similar results were also obtained for the non-oil output gap variable.

Table 3A: Qatar's Estimates of alternative Phillips Curve

Model	Linear		H-P		B-K		UCM	
Coeff.	All	N-oil	All	N-oil	All	N-oil	All	N-oil
δ_0	0.04 (1.69)**	0.04 (1.65)**	0.04 (1.65)**	0.04 (1.69)**	0.03 (1.39)	0.04 (1.51)	0.04 (1.67)**	0.04 (1.61)
δ_1	0.36 (2.10)*	0.42 (2.54)*	0.40 (2.34)*	0.42 (2.68)*	0.44 (2.67)*	0.41 (2.65)*	0.39 (2.33)*	0.40 (2.35)*
δ_2								
δ_3	0.14 (0.54)	-0.14 (0.54)	0.03 (0.05)	-0.50 (1.22)	-1.06 (1.30)	-0.97 (2.08)*	0.01 (0.51)	0.00 (0.00)
δ_4								
R^2	0.17	0.17	0.17	0.23	0.20	0.27	0.17	0.16
D.W.	1.92	1.92	1.93	1.88	1.88	1.89	1.90	1.89

Notes: Absolute value of t-statistics is in parentheses.
*, ** denotes the level of significance which are 5% and 10% respectively.

Table 4A: Bahrain's Estimates of alternative Phillips Curve

Model	Linear		H-P		B-K		UCM	
Coeff.	All	N-oil	All	N-oil	All	N-oil	All	N-oil
δ_0	0.04 (2.23)*	0.03 (1.96)*	0.03 (2.02)*	0.03 (1.96)*	0.03 (1.76)**	0.03 (1.77)**	0.03 (1.89)**	0.034 (1.90)**
δ_1	0.33 (1.98)*	0.44 (2.71)*	0.42 (2.63)*	0.44 (2.73)*	0.44 (2.67)*	0.43 (2.62)*	0.43 (2.65)*	0.43 (2.57)*
δ_2								
δ_3	0.22 (1.59)	0.02 (0.15)	0.21 (0.96)	-0.07 (0.27)	0.17 (0.48)	0.04 (0.11)	0.00 (0.04)	0.00 (0.18)
δ_4								
R^2	0.25	0.19	0.21	0.19	0.19	0.19	0.19	0.19
D.W.	2.10	2.08	2.18	2.10	2.17	2.09	2.08	2.08

Notes: Absolute value of t-statistics is in parentheses.
*, ** denotes the level of significance which are 5% and 10% respectively.

Table 5A: Kuwait's Estimates of alternative Phillips Curve

Model	Linear		H-P		B-K		UCM	
Coeff.	All	N-oil	All	N-oil	All	N-oil	All	N-oil
δ_0	0.06 (1.66)**	0.07 (1.88)**	0.06 (1.66)**	0.03 (1.01)	0.06 (1.66)**	0.03 (2.17)*	0.07 (1.70)**	0.08 (2.2)*
δ_1	0.21 (1.24)	0.08 (0.46)	0.21 (1.24)	0.62 (4.35)*	0.20 (1.12)	0.62 (8.13)*	0.18 (1.04)	-0.02 (0.12)
δ_2								
δ_3	0.15 (0.67)	0.19 (1.83)**	0.13 (0.57)			0.65 (5.91)*	-0.90 (0.89)	
δ_4				-1.08 (5.67)*	0.40 (1.29)	-1.70 (14.06)*		0.10 (1.56)
R^2	0.05	0.13	0.05	0.52	0.08	0.92	0.06	0.11
D.W.	2.01	1.65	2.01	1.99	2.01	1.79	1.99	1.98

Notes: Absolute value of t-statistics is in parentheses.
*, ** denotes the level of significance which are 5% and 10% respectively.

On the other hand for Oman, not only the overall output gap had the wrong negative sign but was statistically significant at the 5% level for all the models. In interpreting this results it is important to note that a possible explanation for the negative sign of the overall output gap variable might be that since Oman is not oil rich as the other AGCC countries and does not depend heavily on oil for the overall performances of its economy, it appears that the fluctuations in output reflect supply shocks rather than the usual demand shocks. Hence, in this case the sign of this variable could be negative implying that temporary rises in output above its potential due to a favorable supply shocks is associated with lower inflation. Also, similar results were observed for the non-oil output gap variable.

Table 6A: Oman's Estimates of alternative Phillips Curve

Model	**Linear**		**H-P**		**B-K**		**UCM**	
Coeff.	**All**	**N-oil**	**All**	**N-oil**	**All**	**N-oil**	**All**	**N-oil**
δ_0	0.04 (1.41)	0.04 (1.38)	0.05 (2.10)*	0.04 (1.28)	0.05 (2.17)*	0.03 (1.14)	0.06 (1.94)**	0.04 (1.29)
δ_1	0.17 (1.19)	0.41 (2.52)*	-0.12 (0.72)	0.38 (2.52)*	-0.03 (0.24)	0.45 (2.93)*	-0.08 (0.52)	0.27 (1.73)**
δ_2		-0.15 (1.00)		-0.222 (1.58)		-0.212 (1.70)**	-0.293 (2.06)*	
δ_3	-1.31 (3.59)*	-1.38 (3.56)*	-1.79 (3.73)*	-2.06 (4.76)*	-3.57 (6.32)*	-3.40 (5.49)*	0.17 (4.86)*	0.11 (2.79)*
δ_4		1.19 (2.91)*	-1.48 (2.28)*	1.37 (3.17)*	-3.06 (4.31)*	1.02 (1.66)**		-0.11 (2.87)*
R^2	0.34	0.36	0.58	0.49	0.72	0.60	0.49	0.30
D.W.	1.97	1.94	1.62	2.00	1.73	2.18	1.80	1.70

Notes: Absolute value of t-statistics is in parentheses.
*, ** denotes the level of significance which are 5% and 10% respectively.

5. Conclusion

This paper documents estimates of output gaps for all the AGCC countries using four different statistical methods. We also disaggregate these output gap measures into overall output gap and non-oil output gap in order to determine the information contents of these variables. Several results of our study are worth emphasizing. First, for the results of the individual countries, our findings indicate that all the methods used have produced similar assessments of the variables (i.e. the overall output gap measures and the non-oil output gap measures) and share common stylized facts. More precisely, the different statistical methods used give rise to equivalent output gap measures by producing same turning points although there are some marginal differences at the level and magnitude of these variables. This implies that it is perceptive to assess the relative size of the output gap at a particular point in time by comparing the current estimate of the output gap variable to its recent history and particularly to past peaks and troughs. Secondly, another desirable feature of our results is that not only the estimates of the output gap variables obtained from the different methodologies are broadly consistent, but also the high bilateral correlations between them indicate that the different measures move closely together. This insinuates that they contain much the same information about inflation and other macroeconomic variables that policy makers are interested in. Thirdly, our estimations of these variables corroborate the historical boom-bust cycles of their economies and demonstrate that business cycles of these countries display sharp turning points rather than exhibiting smooth patterns that are typical for the advanced economies. Consequently, this implies that external factors were the major source of such drastic economic fluctuations in these countries during our sample period. This also reflects how predisposed these countries are to external shocks such as wars, terrorism and fluctuations of the oil prices that adversely affect their economies.

We also examined whether the estimated output gap variables contain information on future inflation of these countries using a standard Phillips Curve. Our analysis indicate that with the exception of Saudi Arabia and Oman the overall output gap variable does not have an explanatory power of inflation in these countries and in turn are not a useful indicators of domestic inflation. Similar results were also obtained for the non-oil output gap variable in explaining inflation in these countries.

References

[1] Baxter, M and R. King, 1999, "Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series," *Review of Economics and Statistics*, 81, 575-93.

[2] Billmeier, A., 2004, "Measuring a Roller Coaster: Evidence on the Finish Output Gap," IMF Working Paper04/57 (Washington, DC; International Monetary Fund).

[3] Cayen, Jean-Philippe and Simon van Norden, (2004)," The Unreliability of Canadian Output Gap Estimates," *Deutsche Bundesbank Discussion Paper*, N0 29/2004

[4] Cerra, Valerie and Sweta C. Saxena, (2000), "Alternative Methods of Estimating Potential Output and the Output Gap: An Application to Sweden", *International Monetary Fund Working Paper*, wp/00/59.

[5] Clarida, R., Gali, J., Gertler, M. 1998, "Monetary Policy Rules in Practice: Some International Evidence," *European Economic Review,* 42, 1033-1067

[6] Clark, P.K., 1989, "Trend Reversion in Real Output and Unemployment," *Journal of Econometrics,* 40, pp. 15-32.

[7] Claus, I. (2000), "Is the Output Gap a Useful Indicator of Inflation," Reserve Bank of New Zealand, Discussion Paper Series No 2000/05.

[8] De Brouwer, G. 1998, "Estimating Output Gaps", Reserve Bank of Australia Research Discussion Paper No, 9809.

[9] Diebold, F.X. and A.S. Senhadji (1996), "The Uncertain Unit Root on GNP: Comment", *American Economic Review,* 86(5), pp. 1291-8.

[10] Gerlach, S. and F. Smets (1997), "Output Gaps and Inflation", *Bank for International Settlements mimeo.*

[11] Gerlach, S. and M. s. Yiu (2004), Estimating Output Gaps in Asia: A Cross-Country Study" *Journal of the Japanese and International Economies*, 18, pp. 115 – 136.

[12] Gerlach, S. and W. Peng (2006), "Output Gaps and Inflation in Mainland China", *Bank for International Settlements Working Papers*, N0 194.

[13] Gibbs, D. 1995, "Potential Output: Concepts and Measurements", Labour Market Bulletin of New Zealand Department of Labour 1, pp. 72-115.

[14] Hodrick, R.J. and E.C. Prescott, 1997, "Post-War U.S. Business Cycles: An Empirical Investigation," *Journal of Money, Credit, and Banking,* 29, 1-16.

[15] Orphanides, Athanasios and Simon van Norden, (2001), "The Unreliability of Output Gap Estimates in Real Time", CIRANO and CIREQ *working paper*.

[16] Roberts, J. M., (1995), "New Keynesian Economics and the Phillips Curve", *Journal of Money, Credit, and Banking* 27, 975-984.

[17] Watson, M.W. (1986), "Univariate Detrending Methods with Stochastic Trends", *Journal of Monetary Economics,* 18(1), pp. 49-75.