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Robust Quarterization of GDP and Determination of Business Cycle Dates for IGC Partner Countries

Abdullah Tahir [1], Jameel Ahmed [2] & Waqas Ahmed [3]

Abstract

Business cycle dating, macroeconomic analysis and ex-ante policy prescription based on macroeconomic variables at annual data frequency is inadequate; as high frequency information on the state of the economy, otherwise inherent in quarterly data is averaged out at such low frequency. We use a robust method of disaggregating quarterly series from annual data, such that the aspect and information about the intervening business cycles is preserved. Extracting an orthogonal factor, which encompasses common variation (co-movements) of leading indicators of economic activity at quarterly data frequency, we use seemingly unrelated time series equation (SUTSE) model to disaggregate the annual GDP data into quarterly frequency. Utility of the quarterly GDP estimates is illustrated by (i) determining business cycle dates using a non-parametric Bry-Boschan (1971) algorithm and (ii) estimating the potential GDP and output gap for each of the 11 International Growth Center (IGC) partner countries.

JEL Classification: C32, E32, E58

Keywords: Temporal Disaggregation, Business Cycle Dates, Dynamic Linear Model

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Non-technical Summary

Analyzing short-term dynamics of the state of the economy based on annual macroeconomic data is fraught with caution. One probable solution is to arrive at reasonably credible approximations to quarterly frequency from annual data of macroeconomic variables. This entails the domain of disaggregation-interpolation and extrapolation of quarterly data using time series information of annual data dynamics and information on trend, cycle, seasonal and irregular components of closely moving/behaving relevant high frequency time series.

Since, Pakistan Bureau of Statistics does not disseminate national income accounts (NIA) data on quarterly frequency, as of 2018. Various studies have been conducted in order to obtain reasonable estimates of quarterly GDP for Pakistan. Notable among them are Bengaliwala (1995), Kemal & Arby (2004), Arby (2008) and Hanif et al. (2013). In general, these studies attempt to provide quarterly estimates on the components of expenditure-side of the NIA following a meticulous approach of aggregation of subcomponents of various sectors i.e. agriculture, industries and services as per their value addition in the overall economy. Though useful, this approach is tedious, time consuming and imposes deterministic (user assumed) sectoral shares for each quarter in computation of national income.

Interestingly, the sectoral shares of various sub-sectors, for instance, as appearing in Hanif et al. (2013) are assumed constant over the sample of the study i.e. 1999-2000 to 2009-2010. They illustrate that in order to obtain quarterly GDP estimates, the share of actual data is 44%, while the rest is obtained using (1) constant quarterly proportions (32% share in GDP of each year) and (2) mechanical proportions disaggregation method (24% share in GDP) developed by Lisman & Sandee (1964) (refer to Table J1 in Appendix J). They proposed a numerical technique for constructing synthetic quarterly data based on past trends in annual data, for details see Bloem et al. (2001). To reach out this end, Lisman & Sandee formulated a set of four equations, one for each quarter. Slope coefficients are kept fixed, such that to derive a smooth continuous quarterly time series from the annual data series.

Resultantly, these restrictions as imposed in Hanif et al. (2013) to obtain quarterly data arguably lead to imposing a definitive and predictable pattern in the quarterly estimates of GDP. In addition, important high frequency information on the macro economy is also smoothed-out, leading to dubious estimates and uncertain inference.

We attempt to circumvent these obstacles by employing a robust temporal disaggregation method to obtain quarterly GDP for Pakistan. As in Lucas (1977) and Stock & Watson (1993), our aim is to extract high frequency data information on seasonality, trend, cycle and irregular variations among key macroeconomic variables. We employ Principal Component Analysis (PCA) to extract independent variation in four key macroeconomic variables, at quarterly data frequency. Thereafter, we illustrate temporal disaggregation by regressing annual GDP on the extracted quarterly principal component. A key, intuitive constraint is assumed such that; quarterly GDP in each year adds up to the annual GDP value (see methodology section for details).

Our approach is flexible, intuitive and employs co-movement in macroeconomic variables as basis for quarterization of GDP. GDP growth estimates of Pakistan segregated based on Q1, Q2, Q3 and Q4 of each year in 1978 -2017 are illustrated in Appendix B, Figure B3. Our estimates illustrate robustness, as growth estimates are free from definitive patterns over the years, in contrast to Hanif et al. (2013).

In addition to estimates for Pakistan, motivated by the absence of such quarterly GDP data for other developing economies like Bangladesh, Ethiopia, Ghana, Liberia, Mozambique, Rwanda, Sierra Leone,

Uganda, Zambia and India, this research endeavors to extract quarterly estimates for output level as well as the business cycles dynamics for these countries. Our paper elaborates temporal disaggregation of annual GDP data to quarterly data frequency for these countries, which we believe preserve the business cycle aspects in the data. In addition, we also present business cycle dating and estimates of potential GDP and output gap.

The utility of methods presented in the paper is that these can be readily used for time disaggregation of other NIA data like private and government investment, aggregate consumption, unemployment etc.

1. Introduction

Tracking of business cycle turning points at high data dissemination frequency (e.g. quarterly GDP) is important for ex-ante policy implementation and ex-post analysis of the state of the economy. The magnitude, direction and dating of the turning points in economic activity contain valuable information for policy makers and economic researchers alike. Quarterly gross domestic product (GDP) data for numerous developing economies is not disseminated by the respective statistical agencies. In such instances, macroeconomic policy prescription remain uncertain, at best, and stymied at worst, as quarterly data on the state of the economy is crucial information, especially for prescribing adequate policy mix. To elaborate, uncertainty in the policy prescriptions and analyses occurs because policy makers have to resort to indicators of macroeconomic activity as proxy of the state of the economy. Such indicators include high frequency data on industrial production, information on manufacturing, production in agriculture sector, trend in consumer prices, etc. These indicators often contain limited information on the state of the economy and the business cycle and are also prone to drastic revisions.

It is well established in modern macroeconomics that the impact of monetary policy exists strictly in the short-run, meaning that the monetary policy has somewhat negligible impact on output and employment beyond one year. This necessitates availability, analysis and monitoring of indicators of aggregate economic activity at a reasonably higher frequency, viz., on quarterly data. However quarterly estimates of aggregate national income accounts (NIA), i.e., GDP, for most of the developing economies are unfortunately not available. The policy makers have, therefore, to rely on other proxies for economic activity, making it hard for them to know the state of business cycle in real time. This is particularly critical in developing countries given their unique economic features such as lower initial conditions of investments and savings, rigidities in domestic markets, corruption etc. Augmenting their information set with the knowledge of possible state of business cycle will thus help policy makers prepare proactive policy prescriptions.

Vital as this research question is, however, there exists an unusual dearth of available literature on developing economies. The major constraint is the unavailability of high frequency data on national income accounts (NIA) for developing economies. This study thus intends to fill this void for IGC[1] partner developing economies[2]; by presenting temporal disaggregates of total national income based on leading indicators of economic activity. Besides disaggregation of NIA indicators in a consistent and robust way, we also attempt to determine business cycle dates and their stylized facts for these developing economies.

The aim of this paper is, therefore, two fold; for a set of developing economies (i) estimation of quarterly national income accounts, in particular quarterly GDP, by exploiting the inter-linkages of various macroeconomic variables, which are available at a frequency higher than annual frequency, and (ii) determination, dating and stylized facts of turning points implied by these higher frequency estimates.

In the first phase of this study, we aim to circumvent the problem of lack of high frequency data. Using various (aggregate demand and supply side) macro-financial series at higher frequency, their inter-linkages with GDP will be exploited by implementing a novel approach, which captures common variation of these macro-financial indicators. The resulting series of high frequency data, extracted

[1] IGC directs a global network of world-leading researchers and in-country teams in Africa and South Asia and works closely with partner governments to generate high quality research and policy advice on key growth challenges. Based at London School of Economics (LSE) and in partnership with the University of Oxford, the IGC is funded by the UK Department for International Development (DFID).

[2] These IGC partner countries are: Bangladesh, Ethiopia, Liberia, India, Mozambique, Pakistan, Rwanda, Sierra Leone, Uganda and Zambia.

using information from various aggregate supply and demand side variables, will thus contain valuable time series information about business cycle movements. Parenthetically, we also verify the veracity and accuracy-of-fit of our quarterly estimates by disaggregating the annual GDP data of United States (US) and compare our estimates with its actual quarterly NIA data for US. With credible estimates of quarterly GDP at hand for the 11 countries, Business Cycle dating shall be illustrated by using a widely implemented non-parametric dating algorithm due to Bry & Boschan (1971). Alongside these turning points, the policy makers would also be interested in the depth and breadth of cycles. This will be achieved via the state-space framework to consistently estimate these unobserved states. Along the way, we shall estimate another crucial policy relevant variable - the output gap. We hope our research endeavor will provide the policy makers in these developing economies with a very useful data that will help them make better and informed policy decisions.

Having obtained the quarterly data on economic activity, we move on to segregate the periods of cyclical upturns and downturns using the classical non-parametric approach proposed by Bry & Boschan (1971). The approach segregates the recessionary and expansionary periods in a series using certain censoring rules. We prefer the non-parametric approach over other such approaches e.g., time series filters suggested by Hodrick & Prescott (1997), the band-pass filters of Baxter & King (1999) and Christiano & Fitzgerald (2003) because of their peculiar issues. For example, the end-point issue is one of the prominent criticism on HP filter. Recently, Hamilton (2017) has severely criticized its use on the ground that this filter introduces spurious dynamic relations unrelated to the data. Similarly, all the filters produce cycles that are either too short or too long. Anticipating results, we find that the average duration of recessions in the countries under consideration is 6 quarters, while expansions last for 19 quarters with the average complete cycle (peak-to-peak duration) spanning over 19 quarters. The quarterly average output loss is 2.21 percent when a typical economy goes from peak to trough while the quarterly gain is recorded at 1.58 percent when economic activity recovers from trough and achieves its peak.

The rest of the paper is organized as follows. The next section expounds on the methodology used for temporal disaggregation and the extraction of cyclical periods. We also do the relevant literature review on the go in Section 2. Section 3 discusses the data convention and presents the stylized facts for countries' expansions and recessions. We conclude in Section 4.

2. Methodology

According to the classical business cycle definition proposed by Burns & Mitchell (1946), the business cycle "*is composed of expansions which take place almost at the same time in many economic activities, followed by equally general recessions, contractions and recoveries which merge with the expansion phase of the following cycle; this sequence of changes is recurrent but not periodical*". A prominent feature of the business cycle is the presence of similarities in the dynamics of several representative series or, as Lucas (1977) put it, the *co-movements*[3]. Lucas (1977) elaborates that typically economic activities and specifically the business cycles are characterized by the presence of similarities in the macroeconomic variables. Macroeconomic dynamics are, therefore, characterized by aggregate variables exhibiting repeated fluctuations around trend.

The very nature of business cycle fluctuations implies that the "reference cycle" cannot be extracted from a single series, for instance the real measure of gross domestic product (GDP), but an analysis of a range of relevant indicators of economic activity is required. Stock & Watson (1993) developed an

[3] To explore on terms as *co-movements*, see (Proietti, 2005).

explicit probability model for the composite index of coincident economic indicators. They proposed a dynamic factor model with a common difference stationary factor that defines the composite index. The reference cycle is assumed to be the value of a single unobservable variable, "the state of the economy", that by assumption is the only source of the co-movements of four time series: industrial production, sales, employment, and real income. On the other hand, GDP is perhaps the most important coincident indicator, although it is available only quarterly and it is subject to greater revisions than the four coincident series in the original model. Mariano & Murosawa (2003), building on the Stock & Watson (1993) approach, extend their model with the inclusion of quarterly real GDP, developing a method for the treatment of mixed-frequency series. In this paper, we further build upon Mariano & Murosawa (2003) as motivated below.

In this vein, we consider four variables, namely, exports, industrial production index[4], consumer price index, and money supply for 11 countries. However, presence of muliticollinearity in multivariate regression settings is expected to lead to estimation of biased and inefficient coefficients; as the explanatory variables exhibit very high co-movements. To avoid this problem, therefore, we implement PCA in the first stage to extract the most significant independent co-movements within the explanatory variables for further analysis. In the second stage, a local linear trend (LLT), seemingly unrelated time series equation (SUTSE) model, proposed in Moauro & Savio (2005), is specified for temporal disaggregation of annual real GDP of each country into quarterly frequency by using the most significant first principal component extracted. In the third stage, business cycles dating algorithm is implemented owing to Bry & Boschan (1971). Finally, in order to further strengthen and expound the utility of quarterly GDP estimates, we estimate the potential output and output gap for each country. Each stage of estimation is described below in detail.

2.1 Principal Components Analysis (PCA)

As observed by Burns & Mitchell (1946), Lucas (1977) and Stock & Watson (1993), the business cycles are manifest in movements of various economic indicators. If treated in a multivariate regression, their co-movements often induce the issue of muliticollinearity. This is a non-negligible constraint on analytical methods and therefore needs to be addressed adequately. Intuitively, the co-movement or specific direction of the overall dynamics within key macroeconomic variables is due to the fact that variables or group of variables often move together. Arguably, the driving principle governing the state of the system is, more often, exhibited in more than one explanatory variables. Assume that principles governing the behavior of business cycles, as in our study, are subset of total number of explanatory variables i.e. fewer in number than the explanatory variables. This proposition indeed leads to an interesting simplification: replace this group of substantial number of explanatory variables (which exhibit strong co-movements), with one or two variables that contain statistically significant, orthogonal variations from among all explanatory variables.

PCA is a standard statistical tool used for multivariate data analysis (Einasto et al., 2011). It is a non-parametric method for extracting independent common variation from correlated variables. It reduces data dimension, removes redundant information and transforms data such that the greatest common variation amongst the variables is extracted in the 1st principal component (1st PC) and successive common variations are captured in 2nd PC, 3rd PC and so on. As principal components are linear combinations of the correlated variables, there can be as many PCs as the total number of variables.

[4] For countries except Pakistan, Bangladesh and India; data on Industrial Production Index is not readily available. Therefore, for such countries we use data on imports (million USD) as the fourth variable.

However, usually the 1st PC or the first few PCs are needed to illustrate the significant (about 90% or more) of the total variation within the data set.

Let X be $n \times p$ vector that contains the random variables such that $X = \left(X_{1t}, X_{2t}, \dots, X_{pt}\right)'$ for $i = 1, \dots, p$ and $t = 1,2, \dots, T$.

Let the variance covariance matrix be stated as:

$$\mathrm{E[X'X]} = \Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \sigma_{1p} \\ \sigma_{21} & \sigma_2^2 & \cdots & \sigma_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{p1} & \sigma_{p2} & \cdots & \sigma_p^2 \end{bmatrix}$$

Let the linear combinations:

$$\begin{aligned} Z_{1t} &= e_{11}X_{1t} + e_{12}X_{2t} + \cdots + e_{1p}X_{pt} \\ Z_{2t} &= e_{21}X_{1t} + e_{22}X_{2t} + \cdots + e_{2p}X_{pt} \\ &\vdots \\ Z_{pt} &= e_{p1}X_{1t} + e_{p2}X_{2t} + \cdots + e_{pp}X_{pt} \end{aligned}$$

Each of the above can be seen as regression equations for Z_{it} by using the regressors $X_{ii} = X_{1t}, \dots, X_{pt}$. In the above expression $e_{1k} = e_{11}, \dots, e_{1p}$can be interpreted as regression coefficients..

It follows that $Z_i$is random; Therefore the variance $var(Z)$

$$\mathrm{var}(Z_i) = \sum_{k=1}^{p}\sum_{l=1}^{p} e_{ik}e_{il}\sigma_{kl}$$

$$\mathrm{var}(Z_i) = \mathrm{e_i'}\Sigma\mathrm{e_i}$$

Moreover the covariance between Z_i and Z_j can be stated as;

$$\mathrm{cov}\left(Z_i, Z_j\right) = \sum_{k=1}^{p}\sum_{l=1}^{p} e_{ik}e_{jl}\sigma_{kl}$$

$$\mathrm{cov}\left(Z_i, Z_j\right) = \mathrm{e_i'}\Sigma\mathrm{e_i}.$$

We select $\mathrm{e_i} = \left(e_{1p}, e_{2p}, \dots, e_{ip}\right)'$ that maximize the expression,

$$\mathrm{var}(Z_i) = \sum_{k=1}^{p}\sum_{l=1}^{p} e_{ik}e_{jl}\sigma_{kl},$$

subject to the condition that $e_i'e_i = \sum_{j=1}^{p} e_{ij}^2 = 1$ and $e_{i-1}'\Sigma e_i = 0$.

Each of the k^{th} PC extracted from k variables (X_i) is orthogonal to the other $(k-1)$ PCs and explains total variation successively. Data of four time series variables for each of the 11 countries under study is used to extract principle components. Let $X_i^{\mathbb{C}}$ be a vector containing quarterly data for country $\mathbb{C}$, where $\mathbb{C} = 1, \dots 11$. $X_i^{\mathbb{C}} = (X_1, \dots, X_4)'$ and X_i contain time series data on the macroeconomic variables.

2.2 Time Series Disaggregation using Seemingly Unrelated Time Series Equation (SUTSE) Model

Macroeconomic analysis on annual data, in general, and business cycle dating of an economy, specifically, is fraught with the obvious caveat of averaging out a lot of cyclical information that may otherwise occur in the quarterly NIA data. Several time series on macroeconomic data for numerous developing economies is only available on annual data frequency. Econometric analysis, for instance, in cases where some time series are disseminated only annually alongside higher frequency data series, is obviously difficult. Of the two obvious solutions to this problem, one solution is to analyze the research question on annual data. This however implies loss of 75% of data points (four quarterly data points compared to one annual observation). The other solution is to arrive at reasonably credible approximations to quarterly frequency from annual data. This entails the domain of disaggregation-interpolation and extrapolation of quarterly data using time series information of annual data dynamics and information on trend, cycle, seasonal and irregular components of closely moving/behaving relevant time series. This is a relatively well researched domain of econometrics. Friedman (1962) discusses that the problem of distribution (or disaggregation), interpolation and extrapolation is inter-lapping in domain.

Indeed, Boot et al. (1967), Chow (1971), Fernandez (1981), Litterman (1983), Wei & Stram (1990), Harvey & Chung (2000) and Moauro & Savio (2005) have treated disaggregation of lower frequency data to higher frequency estimates (like annual data disaggregation to quarterly, or monthly data) using time series information as missing-data statistical problem. Where, Boot et al. (1967) and Wei & Stram (1990), for instance, use the inherent time series information in the low frequency time series for temporal disaggregation to higher frequency within ARIMA and state-space model setup. Others like Chow-Lin (1971), Litterman (1983), Fernandez (1971), Harvey & Chung (2000), Moauro & Savio (2005) specify the temporal disaggregation problem in generalized least square (GLS) regression and dynamic linear models (DLM) [5] using co-moving time series based on macroeconomic theoretic linkages.

In this paper we use the methodology described in Moauro & Savio (2005) for temporal disaggregation of annual real GDP data of the 11 economies using the common factors, extracted as the respective first principal component (PC_1) from the four time series as described in the previous section.

Moauro & Savio (2005) specify a bi-variate, DLM and treat temporal disaggregation as a missing data problem. The two variables (annual real GDP and quarterly industrial production index) are modeled in a Local Linear Trend (LLT)[6] setting. Both DLMs are then estimated together in a similar setup as in seemingly unrelated regression (SUR) models, which, in state-space models domain, is termed as Seemingly Unrelated Time Series Equation (SUTSE) model (see Harvey & Chung (2000), Harvey, (2001) and Petris et al. (2009) for excellent commentary and detailed discussion on SUTSE models). A motivation for application of time series disaggregation or quarterization of real GDP by implementing SUTSE model is that this setup addresses structural breaks inherently by estimating the system using Kalman filter with time varying parameters (see Harvey & Chung, 2000). The latter is especially relevant as several economies in the study exhibit existence of structural breaks.

Let Y_t contain two variables such as quarterly real GDP ($Y_{1,t}$) and quarterly PCA_1 ($Y_{2,t}$), i.e., $Y_{i,t} = (Y_{1,t}, Y_{2,t})$. Assuming that the disaggregated series $Y_{1,t}$ is not observed but a temporally aggregated

[5] In this paper, we use state-space representation and DLM interchangeably in line with literature.
[6] More on Local Linear Trend DLM model is described in the following paras.

series, i.e. annual real GDP is observed at time; $\tau = 1,2,\dots,[n/s]$. The DLM in the temporal disaggregation set-up as in Moauro & Savio (2005), can be stated as below;

Consider a typical DLM of the form

$$y_{i,t} = F_i\theta_{i,t} + H_i v_{i,t} \qquad v_{i,t} \sim N(0, V_i)$$

$$\theta_{i,t} = G_i\theta_{i,t-1} + \omega_{i,t} \qquad \omega_{i,t} \sim N(0, W_i)$$

for $i = 1,2$. The above representation can be extended to model linear time trend inherent in real GDP series, the Local Linear Trend, along with the cumulator for time disaggregation in SUTSE framework. This turns out to be an extension of the above form and can be expressed as;

$$Y_{i,t} = \theta_{i,t} + v_{i,t} \qquad v_{i,t} \sim N(0, V_i)$$

$$\theta_{i,t} = G_i\theta_{i,t-1} + \beta_{i,t-1} + \omega_{i1,t} \qquad \omega_{i1,t} \sim N\left(0, \sigma_\mu^2\right)$$

$$\beta_{i,t} = \beta_{i,t-1} + \omega_{i2,t} \qquad \omega_{i2,t} \sim N\left(0, \sigma_\beta^2\right)$$

$$y_{i,t}^c = \xi_{i,t} y_{i,t-1}^c + y_t$$

$$\xi_{i,t} = \left[\xi_{1,t}, \xi_{2,t}\right]'$$

Where, $\theta_{t=}[\mu_t, \beta_t, y_t^c]'$, $G = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \\ 1 & 1 & C \end{bmatrix}$, $H = \begin{bmatrix} \sigma_{\omega_1} & 0 & 0 \\ 0 & \sigma_{\omega_2} & 0 \\ \sigma_{\omega_1} & \sigma_{\omega_2} & \sigma_v \end{bmatrix}$, $W = \begin{bmatrix} \sigma_\mu^2 & 0 \\ 0 & \sigma_\beta^2 \end{bmatrix}$, $F = [0 \quad 0 \quad 1]$,

The cummulator, $y_{i,t}^c$, is used for temporal disaggregation of annual GDP (see Harvey & Chung, 2000 and Harvey, 1989 section 6.3). Such an aggregator or cummulator setup is fairly standard and is used to impose a constraint that quarterly values for each year add to the annual numbers (see Chow & Lin (1971) and Litterman (1983) for a detailed exposition).

$$y_t^c = \xi_{i,t} y_{i,t-1}^c + y_t$$

$$\xi_t = \begin{cases} 0 \\ \\ 1 \end{cases}$$

$$\xi_t = 0, if; t = s(\tau - 1) + 1, \text{and}$$

$$\xi_t = 1, \text{otherwise}$$

To elaborate let us show the case of annual to quarterly data temporal disaggregation in this setup, here $s = 4$; therefore

$$\begin{array}{cccc} y_1^c = y_1, & y_2^c = y_1 + y_2, & y_3^c = y_1 + y_2 + y_3, & y_4^c = y_1 + y_2 + y_3 + y_4 \\ y_5^c = y_5, & y_6^c = y_5 + y_6, & y_7^c = y_5 + y_6 + y_7, & y_8^c = y_5 + y_6 + y_7 + y_8 \\ \vdots \quad , & \vdots \quad , & \vdots \quad , & \vdots \end{array}$$

As is intuitive from the expression above that, sample of every s^{th}value of y_t^c process is observed i.e. $y_{t,s}^c$, $\tau = 1, \dots, [n/s]$

Specifying DLMs as above correspond to the qualitative assumption that both series follow similar dynamics and that the components of state vectors have similar interpretations in the two state-space representations. Doing so implies that the form of level and slope in both cases is governed by independent random inputs, the DLMs can be combined to arrive at state-space representation for the multivariate observations. This is done by assuming that dynamics of the levels and slope components of both series is driven by correlated inputs. Indeed, correlation between annual real GDP and aggregate supply indicator like industrial production index is very high for the case of Pakistan, US and many other countries.

Therefore, the components of the system error corresponding to both levels and slopes of real GDP and PC1, respectively, are assumed to be correlated. Also, within the model setup we impose a reasonable assumption that the levels and slopes evolve in uncorrelated manner.

In the time domain, the Kalman filter is applied to the above representation for estimation of the LLT-SUTSE model. The system matrices, F, H, G and W depend on unknowm parameters, numerical optimization method can be used to maximize the log-likelihood function with respect to the unkown parameters. Consequently, forecasting, smoothing and further diagnostics can be carried out. Regarding the temporal disaggregation the backward recursions using smoothing algorithm lead to optimal estimates of the unknown components.

2.3. Dating of Business Cycles

Having obtained the quarterly data on economic activity, we move on to segregate the periods of cyclical upturns and downturns using the classical non-parametric approach proposed by Bry & Boschan (1971). The Bry & Boschan algorithm has been extensively applied in the business cycle literature (see for example, Stock & Watson (1993), Rand & Tarp (2002), Harding & Pagan (2002), Stock & Watson (2010), Claessens et al. (2012)).

The Bry & Boschan algorithm is in essence simplified implementation of classical methodology of extracting turning points from aggregate economic activity indicators suggested by Burns & Mitchell (1946). The approach segregates the recessionary and expansionary periods in a single reference series (y_t) using certain censoring rules. The location of turning points amounts to identifying local maxima or minima within a window of k quarters. More specifically, a turning point represents a peak at time t if;

$$y_{t-k}, \ldots, y_{t-1} < y_t > y_{t+1}, \ldots, y_{t+k}$$

Whereas, it represents a trough if;

$$y_{t-k}, \ldots, y_{t-1} > y_t < y_{t+1}, \ldots, y_{t+k}.$$

The periods from peak to trough are classified as *recessions* $(S_t = 1)$ while those from trough to peak are classified as *expansions* $(S_t = 0)$.

In terms of censoring criteria, based on reviewing the literature for developing economies (e.g., (Rand & Tarp, 2002)), we implement censoring criteria as follows. First, we set a window length of two quarters $(k = 2)$. Second, we assume that a complete business cycle cannot be lower than six quarters. Third, we impose phase durations of two quarters as well. Fourth, peaks and troughs have to alternate. Finally, we choose the highest of the peaks and the lowest of the troughs in case of multiple peaks or troughs and eliminate turning points within two quarters of beginning and end of the series.

Alongside the dates of business cycles, we also report some country specific stylized facts about output cycles. First, we report the average duration of both the expansions and recessions. This will give average time a country has experienced those periods. We also provide the average quarterly output loss (gain) during downturns (upturns). The average duration of complete business cycle, i.e., the time from peak-to-peak or trough-to-trough.

Incidentally, we prefer the non-parametric Bry & Boschan approach because over other such approaches e.g., time series filters suggested by Hodrick & Prescott (1997), the bank-pass filters of Baxter & King (1999) and Christiano & Fitzgerald (2003) because of their peculiar issues. For example, the end-point issue is one of the prominent criticism on HP filter. Recently, Hamilton (2017) has severely criticized its use on the ground that the filter introduces spurious dynamic relations unrelated to the data. Similarly, all the filters produce cycles that are either too short or too long. Other dating techniques include Hamilton (1989)'s Markov-switching framework, which has however also been found to emit false cyclical signals (see Harding & Pagan (2003)).

2.4. Estimation of Potential GDP and Output Gap

Monetary policy aims to minimize short-term fluctuations of aggregate output around its potential, in order to ensure price, monetary and financial sector stability. As stated before, unavailability of quarterly GDP estimates for the countries under study, stymie the task of policy makers aiming to prescribe policy actions especially with a short-term stabilization objective. In this context potential GDP i.e. maximum non-inflation inducing output and the deviation of actual gdp from this potential (i.e. Output Gap) are important variables.

The efficacy of the quarterly GDP obtained using afore-stated methods can be illustrated by estimation of output gap at quarterly frequency for the 11 countries studied in this paper. We use unobservable components (state-space) for this purpose. A bi-variable state-space model setup is specified; following, Kuttner (1998), the two time series used are quarterly GDP and consumer price inflation (CPI). The measurement equation for quarterly GDP contains two components, a trend and a cycle. The trend component is modeled to include an autoregressive term and deterministic term (i.e. random walk with drift), while the cyclical component of the quarterly GDP is modeled as AR(2) process. We also include a Phillips' curve that contains an adaptive component, linkage with the target inflation rate and also a trend output component.

$$Y_t = Y_t^1 + Y_t^2$$

$$Y_t^1 = \mu_{t-1} + Y_{t-1}^1 + \xi_t^1$$

$$\mu_t = (1-\beta)\bar{\mu} + \beta\mu_{t-1}$$

$$Y_t^2 = \tau_1 Y_{t-1}^2 + \tau_1 Y_{t-2}^2 + \xi_t^2, \text{ where, } \xi_t^2 \overset{\text{iid}}{\rightarrow} \mathrm{N}(0, \sigma_t^2)$$

$$\pi_t = \lambda_1\pi_{t-1} + \lambda_2\pi_t^* + \lambda_3 Y_{t-1}^2 + \xi_t^3 \text{ where, } \xi_t^3 \overset{iid}{\rightarrow} N(0, \sigma_t^2)$$

Where Y_t^1 and Y_t^2 represent, respectively, the trend and cycle component of output. π_t is CPI inflation while π_t^* is the target CPI inflation, assumed to be the steady state level of inflation.

3. Empircal Results

3.1 Data

Annual data for real GDP (local currency units), and quarterly data sets for consumer price inflation (CPI), industrial production index (IPI), imports (M), exports (X) and money supply (M2) of each of the 11 countries is extracted from Haver Analytics, International Financial Statistics (IFS), IMF Direction of Trade statistics, World Development Indicators, statistical offices/bureaus and data available on central bank websites. Please refer to Appendix A, Table A1, for availability of data range for each country. Moreover, the data and **R** codes utilizing routines from DLM package[7] are available from authors upon request.

3.2. Quarterization of Annual Output Data

3.2.1. Principal Components

As a first step, we used data on four quarterly macroeconomic variables to extract a common orthogonal factor, which is expected to include the business cycle dynamics. Indeed, the results indicate that for each country, the first PC contains the highest amount of variation, see Scree plot in Appendix A, Figure A2). More specifically, the variation in each country case explained in the PC_1 is within the range (87 percent to 98 percent see Appendix A, Figures A1, A2 & A3, for illustration of estimates of PCA for Pakistan) Therefore, based on the argument expounding the utility of principal components as useful in limiting the number of explanatory variables, we utilize PC_1 for each country in subsequent temporal disaggregation.

3.2.2. Temporal Disaggregation

Having extracted a common factor, we utilize it within the SUTSE framework to disaggregate the annual data on aggregate output, i.e., GDP. However, before doing this for the countries under consideration, as a first check of our method, we disaggregate the annual data on real GDP of the United States of America by using CPI. IPI, X and M2. We then compare the estimated quarterly GDP with the officially disseminated quarterly data on GDP. The usual metrics like Root Mean Squared Error and Mean Percentage Error are estimated to be 39.75 billion and 0.33%, respectively, illustrating the accuracy of fit. Appendix B, Figure B1 & B2 also display the time series in log-levels and log-differences of the actual and estimated series. This provides enough confidence to go on with temporal disaggregation using the SUTSE framework. The estimated quarterly GDP in constant US dollars (base year 2010) for all countries except Pakistan are reported in Appendix B, Tables B1-B11 while the data plot are depicted in Appendix B, Figures B3-B13. Please note that for Pakistan, we report figures in local currency (PKR).

3.3. Dating Business Cycles

We report business cycle dates (peaks and troughs) in Appendix C, Table C1 while Table C2 shows the stylized facts for each of the 10 countries.[8] Appendix C, Figures C1-C10 display the cyclical periods along with the quarterly GDP series. Some interesting facts emerge. For example, the highest average output loss has been experienced by African countries, with Liberia suffering a 6 percent quarterly contraction in economic activity. Rwanda and Ethiopia underwent second and third largest negative quarterly growth rates at 3.45 percent and 3.28 percent, respectively. Bangladesh with 0.44 percent and

[7] DLM package for **R**, by Giovanni Petris, (see https://cran.r-project.org/web/packages/dlm/dlm.pdf)
[8] Our algorithm failed to find any cyclical downturns or business cycles stages in the output data for Ghana. Therefore, as per our analysis, the country has not experienced any contractionary periods.

Pakistan with 0.57 percent quarterly GDP contraction turn out to be the lowest hit by recessions. As far expansions, Liberia stands out with 2.15 percent growth rate followed by Mozambique with 2.10 percent average quarterly uptick in output. Other countries on average experience 1.20-1.90 percent growth rates during upturns. As is common observation in the cyclical literature, we also find that the expansions last longer than contractions.

As regards the complete cycle, a typical country takes 19 quarters to attain its previous peak/trough in output. Pakistan seems to take the longest time of 30.5 quarters (around 8 years) in the sample to reach its previous cyclical phase. Minimum complete cycle of 12.5 quarters seems to have been experienced by Zambia. Please note that a longer cyclical period implies intervening difficulties faced by a country to reach its previous peak in economic activity.

3.4. Exposition of Quarterly GDP Estimates – Potential GDP and Output Gap

Using data on CPI inflation and disaggregated GDP series for each of the 11 countries, we estimate output gap and potential GDP within the state space model setup stated above, see Appendix D for illustrations.

For the case of Pakistan, results indicate that since 1997, output gap moved in a cyclical pattern, moving for the first trough during 1997:Q2 – 2004:Q1, this period is marked by constrained aggregate demand, the output gap plunged to about -5.3% of GDP in 2002:Q4, thereafter reverting to breakeven by 2004:Q1. Between 2004:Q2 – 2009-Q3 aggregate demand pressures increased continuously, peaking in 2007Q:4 at about 6.4% of GDP. Output gap within the period 2009:Q4 to 2016:Q4 has remained near break-even, implying that demand pressures remained manageable.

For India and Bangladesh output gap has oscillated within ±1 percent of GDP since 1990s, estimates for Ethiopia, Liberia, Mozambique and Rwanda project a similar trajectory, where output gap has moved within 1% of their respective GDP.

Similar to Pakistan, output gap estimates for Uganda portray distinct trough and peak in aggregate demand pressures emanating in a trough within 2000:Q2 -2006:Q3, followed by a spell of relatively greater demand pressures during 2006:Q4 to 2014:Q2.

4. Conclusion

Data on quarterly GDP for several developing economies is not available or disseminated for various reasons. Low frequency data generally yields inadequate macroeconomic analysis; hence, ex-ante policy prescriptions can be misleading. Policy makers have to resort to proxy indicators of the state of economy as the next-best alternative. However, that too involves considerable uncertainty, as the available high frequency leading indicator can be a poor representation of the state of aggregate economy. Moreover, a substantial loss of information occurs when estimation is conducted using only annual data.

Motivated by the concept of co-movements that occur in macroeconomic variables in line with business cycle dynamics, we use PCA to extract orthogonal variations of major high frequency macroeconomic indicators. Furthermore, using the estimated PCs, dynamic linear model in disaggregation framework is implemented to extract quarterly GDP estimates. Accuracy-of-fit of estimates is in line with results from Moauro & Savio, (2005) (see Tables 1-4). Furthermore, our temporal disaggregation of real GDP of USA is largely comparable with the original quarterly data series.

By means of Bry & Boschan (1971) algorithm, information is acquired on business cycle dynamics as per estimated quarterly data that yields interesting results for the sample countries. For example, the average business cycle in Pakistan spans over 30 quarters as per our estimates. This study contributes to existing literature, as data on quarterly GDP as well as analysis on higher frequency business cycles for the countries analyzed was previously not available. Furthermore, estimates provide vital information about stylized facts in these economies where short- as well as long-term shocks smooth out quickly particularly in the most recent decade. We also estimate two other important policy relevant variables, viz., the potential GDP and output gap, which provide important information especially for demand management policy like monetary policy.

References

Arby, M. (2008). *Some Issues in the National Income Accounts of Pakistan (Rebasing Quarterly and Provincial Accounts and Growth Accounting)*. Islamabad: Pakistan Institute of Development Economics (PIDE).

Baxter, M. & King, R. G., (1999). Measuring Business Cycles: Approximate Band-pass Filters for Economic Time Series. *Review of Economics and Statistics, 81* (4), 575-593.

Bengaliwala, K. (1995). *Temporal and Regional Decomposition of National Accounts of Pakistan*. PhD Dissertation, University of Karachi, Department of Economics.

Bloem, A. M., Dippelsman, R. J., & Nils, O. (2001). *Quarterly National Accounts Manual: Concepts, Data Sources, and Compilation*. International Monetary Fund (IMF).

Boot, J., Feibes, W., & Lisman, J. (1967). Further methods of derivation of quarterly figures from annual data. *Applied Statistics,16*(1), 65-75.

Bry, G. & Boschan, C., (1971). *Cyclical Analysis of time series: Procedures and Computer Programs*. New York: National Bureau of Economic Research (NBER).

Burns, A. F. & Mitchell, W. C., (1946). *Measuring Business Cycles*. New York: National Bureau of Economic Research (NBER).

Chow, G., & Lin, A. (1971). Best linear unbiased interpolation, distribution and extrapolation of time series by related series. *The Review of Economics and Statistics, 53*(4), 372-375.

Christiano, R. J. & Fitzgerald, T. J., (2003). The Band-Pass Filters. *International Economic Review, 44*(2), 435-465.

Claessens, S., Kose, A. M. & Terrones, M. E., (2012). How Do Business and Financial Cycles Interact. *Journal of International Economics, 87*(1), 178-190.

Einasto, M., Liivamagi, L. J., Saar, E. & Einas, J., (2011). SDSS DR7 superclusters - Principal component analysis. *Astronomy & Astrophysics, 535*(A&A), A36(1-12).

Fernadez, R. (1981). A methodological note on the estimationof time series. *The Review of Economics and Statistics, 63*(3), 471-476.

Friedman, M. (1962). The interpolation of time series by related series. *Journal of the American Statistical Association, 57*(300), 729-757.

Hamilton, J. D., (1989). A New Approach to the Economic Analysis of Non-stationary Time Series and the Business Cycle. *Econometrica, 57*(2), 357-384.

Hamilton, J. D., (2017). *Why You Should Never Use the Hodrick-Prescott Filter*. San Diego: University of California, Department of Economics.

Hanif, M. N., Javed, I., & M. Jahanzeb, M. (2013). *Quarterisation of National Income Accounts of Pakistan*. State Bank of Pakistan Working Paper Series, No. 54.

Harding, D. & Pagan, A., (2002). Dissecting the Cycle: A Methodological Investigation. *Journal of Monetary Economics, 49*(2), 365-381.

Harding, D. & Pagan, A., (2003). A comparison of two business cycle dating methods. *Journal of Economic Dynamics and Control, 27*(9), 1681-1690.

Harvey, A. C. & Chung, C., (2000). Estimating the underlying change in unemployment in the UK. *Journal of the Royal Statistical Society, 163*(3), 303–39.

Harvey, A. C., (2001). *Forecasting, structural time series models and the Kalman filter*. UK: Cambridge University Press.

Hodrick, R. J. & Prescott, E. C., (1997). Post War US Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking, 29*(1), 1-16.

Kemal, A., & Arby, M. (2004). *Quarterisation of Annual GDP of Pakistan*. Islamabad: Pakistan Institute of Development Economics (PIDE). Statistical Papers Series, No. 5.

Kuttner, K. (1994). Estimating Potential Output as a Latent Variable. *Journal of Business and Economic Statistics, 12*(3), 361-68.

Layton, A. P., (1996). Dating and predicting phase changes in the U.S. business cycle. *International Journal of Forecasting, 12*(3), 417-428.

Lisman, J., & Sandee, J. (1964). Derivation of Quarterly Figures from Annual Data. *Applied Statistics, 13*(2), 87-90.

Litterman, R. (1983). A random walk, markov model for the distribution of time series. *Journal of Business and Statistics, 1*(2), 169-173.

Lucas, R. E., (1977). Understanding Business Cycles. *Carnegie-Rochester Conference Series on Public Policy, 5*, 7-29.

Mariano, R., & Murasawa, Y. (2003). A new coincident index of business cycles based on monthly and quarterly series. *Journal of Applied Econometrics, 18*(4), 427-443.

Moauro, F. & Savio, G., (2005). Temporal disaggregation using multivariate structural time series models. *Econometrics Journal, 8*(2), 214–234.

Petris, G., Petrone, S. & Campagnoli, P., (2009). *Dynamic linear models with R*. New York: Springer-Verlag.

Proietti, T., (2005). *Temporal disaggregation by state space methods: dynamic regression methods revisited*. Eurostat Working Paper Series, Issue ISSN 1725-4825.

Rand, J. & Tarp, F., (2002). Business Cycles in Developing Countries: Are They Different?. *World Development, 30*(12), 2071-2088.

Stock, J. H. & Watson, M. W., (1993). A procedure for predicting recessions with leading indicators: econometric issues and recent experience. In *Business cycles, indicators and forecasting*, Chicago: Chicago University Press, 95-156.

Stock, J. H. & Watson, M. W., (2010). Indicators for Dating Business Cycles: Cross-History Selection and Comparisons. *American Economic Review, 100*(2), 16-19.

Wei, W. W., & Stram, D. O. (1990). Disaggregation of time series models. *Journal of the Royal Statistical Society, Series B (Methodological), 52*(3), 453-467.

Annexure A: Data and Sources

Table A1: Data Sources

Country	Data Span	Data Source
Bangladesh	1981:Q1 - 2016:Q4	Bank of Bangladesh, IFS (IMF), IMF Direction of Trade, WDI, World Bank (WB)
Ethiopia	1981:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)
Ghana	1981:Q1 – 2016:Q4	Bank of Ghana, IFS (IMF), IMF Direction of Trade, WDI (WB)
India	1963:Q1 - 2016:Q4	Reserve Bank of India, IFS (IMF), IMF Direction of Trade, WDI (WB)
Liberia	1981:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)
Mozambique	1981:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)
Pakistan	FY1977-78:Q1 - FY2016-17:Q4 (***Fiscal Year***)	State Bank of Pakistan, Pakistan Bureau of Statistics, IFS (IMF), IMF Direction of Trade, WDI (WB)
Rwanda	1981:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)
Sierra Leone	1987:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)
Uganda	1981:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)
Zambia	1981:Q1 - 2016:Q4	IFS (IMF), IMF Direction of Trade, WDI (WB)

Figure A1: Estimation of 1st Principal Component, using CPI inflation, Industrial Production Index, Exports and Money supply (M2) – data in figures below pertains to Pakistan

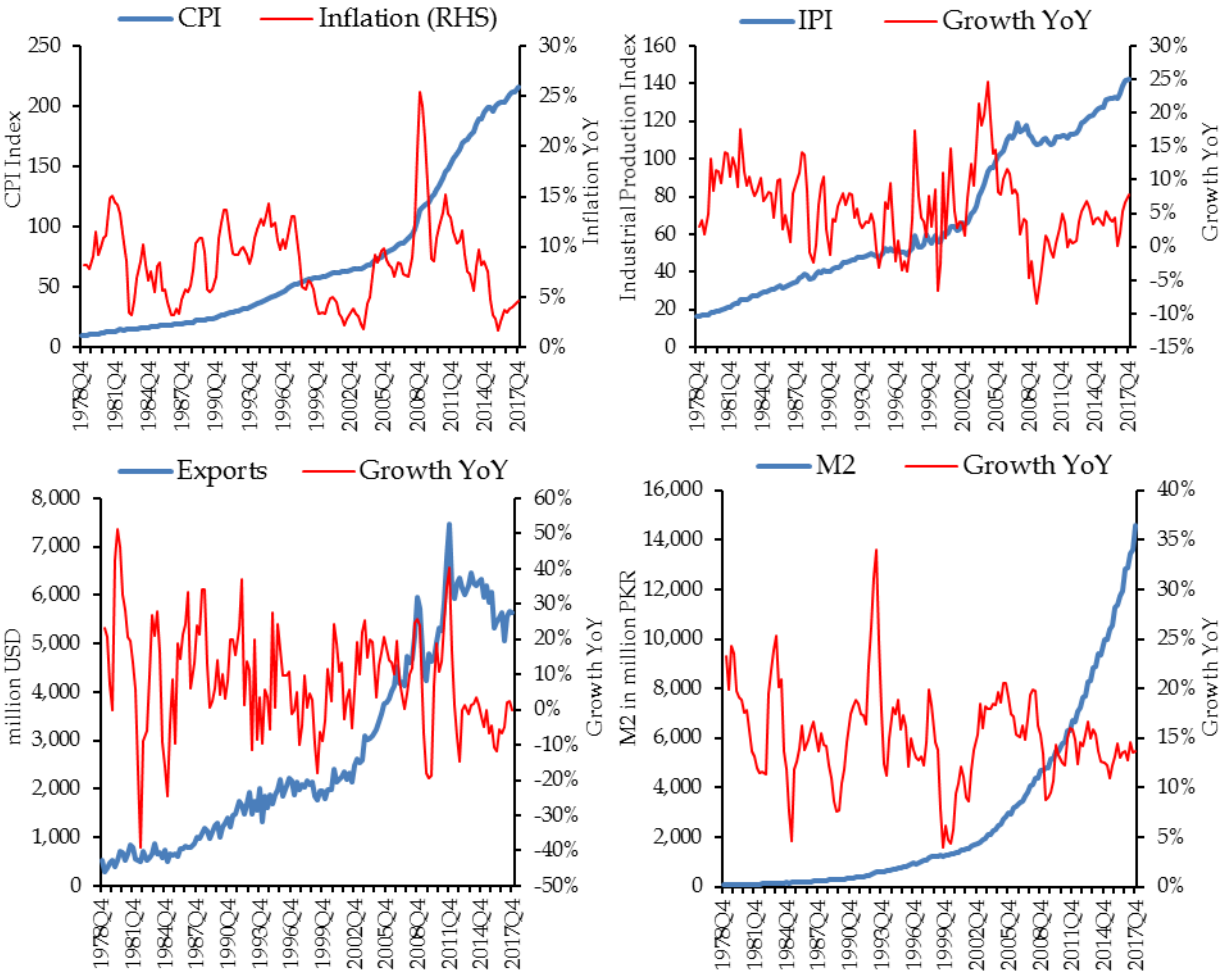


Figure A2: Scree Plot for the PCAs extracted from CPI, LSM index, M2 & Exports data

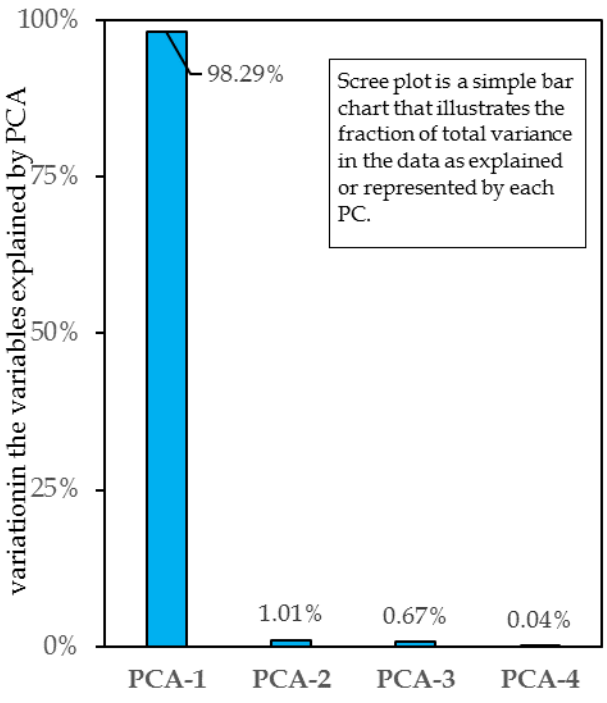
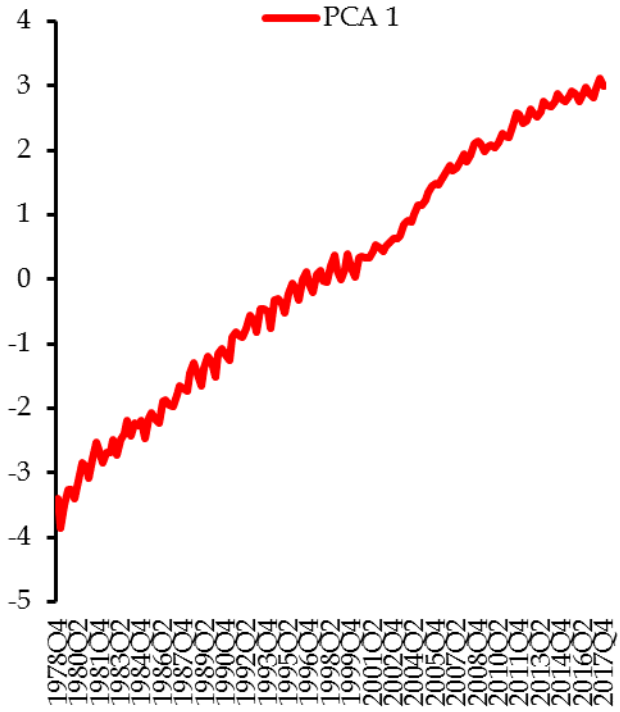


Figure A3: First Principal Component of 4 Variables



Annexure B: Estimates of Quarterly GDP

Figure B1: Comparison of actual real GDP of USA with interpolated real GDP obtained using leading indicators

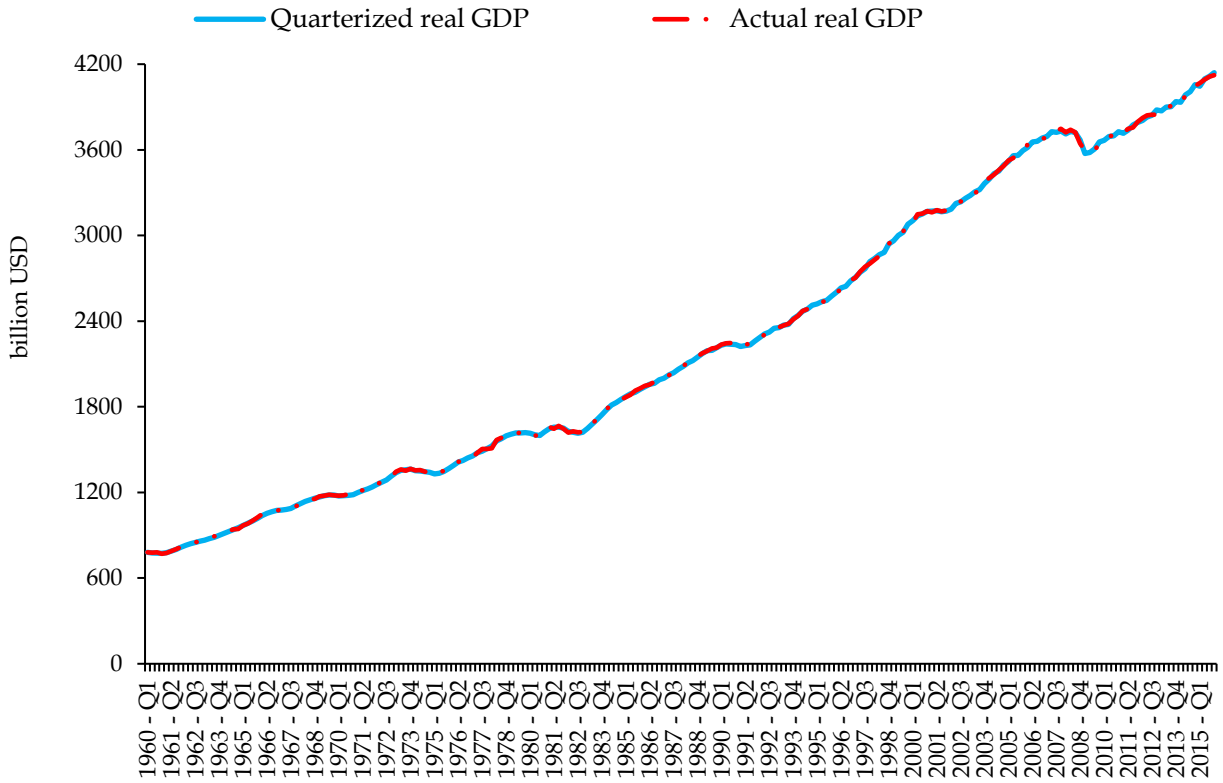


Figure B2: Comparison of Growth in actual real GDP of USA with interpolated real GDP obtained using leading indicators

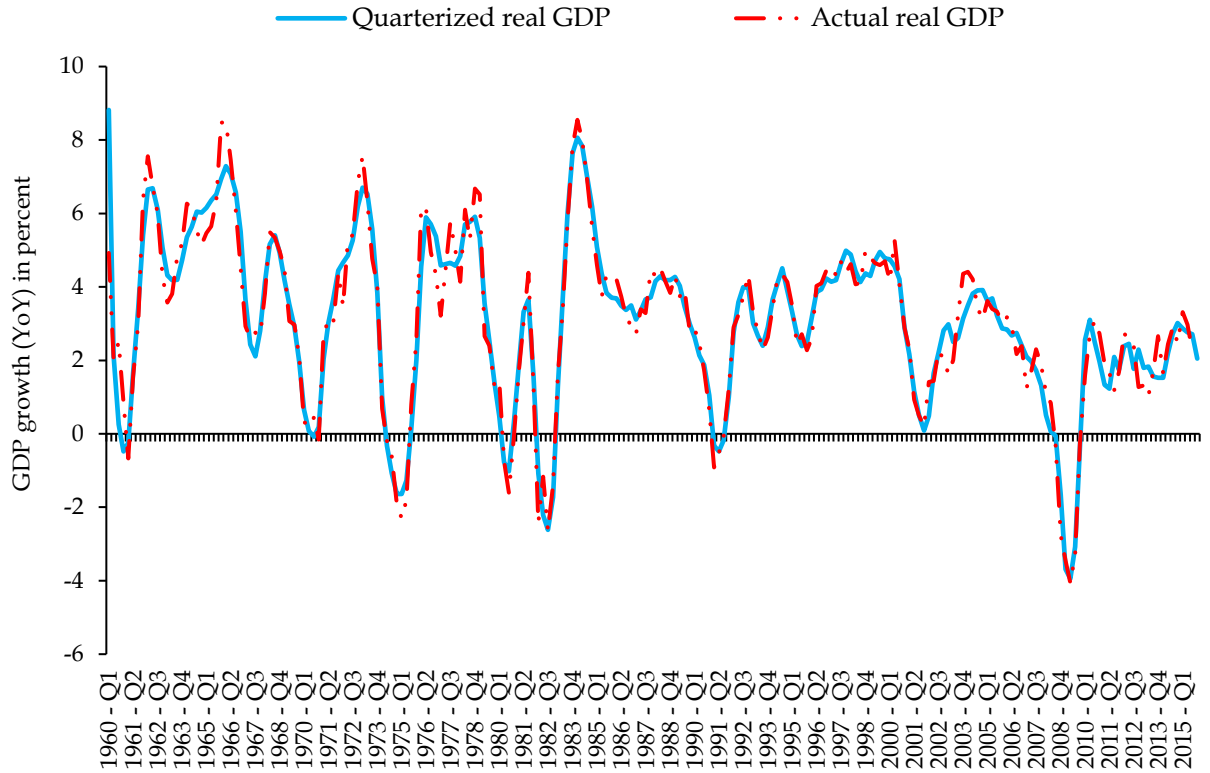


Figure B3: Real GDP Growth (YoY) of Pakistan - Quarterly Data

Each figure below plots growth rates in Q1, Q2, Q3 and Q4 of each fiscal year in 1978 -2017. Estimates illustrate robustness of our methodology in that, no definitive smoothness is imposed, because of which growth estimates are free from definitive and predictable patterns, as in comparison to Nadim H. et al (2013).

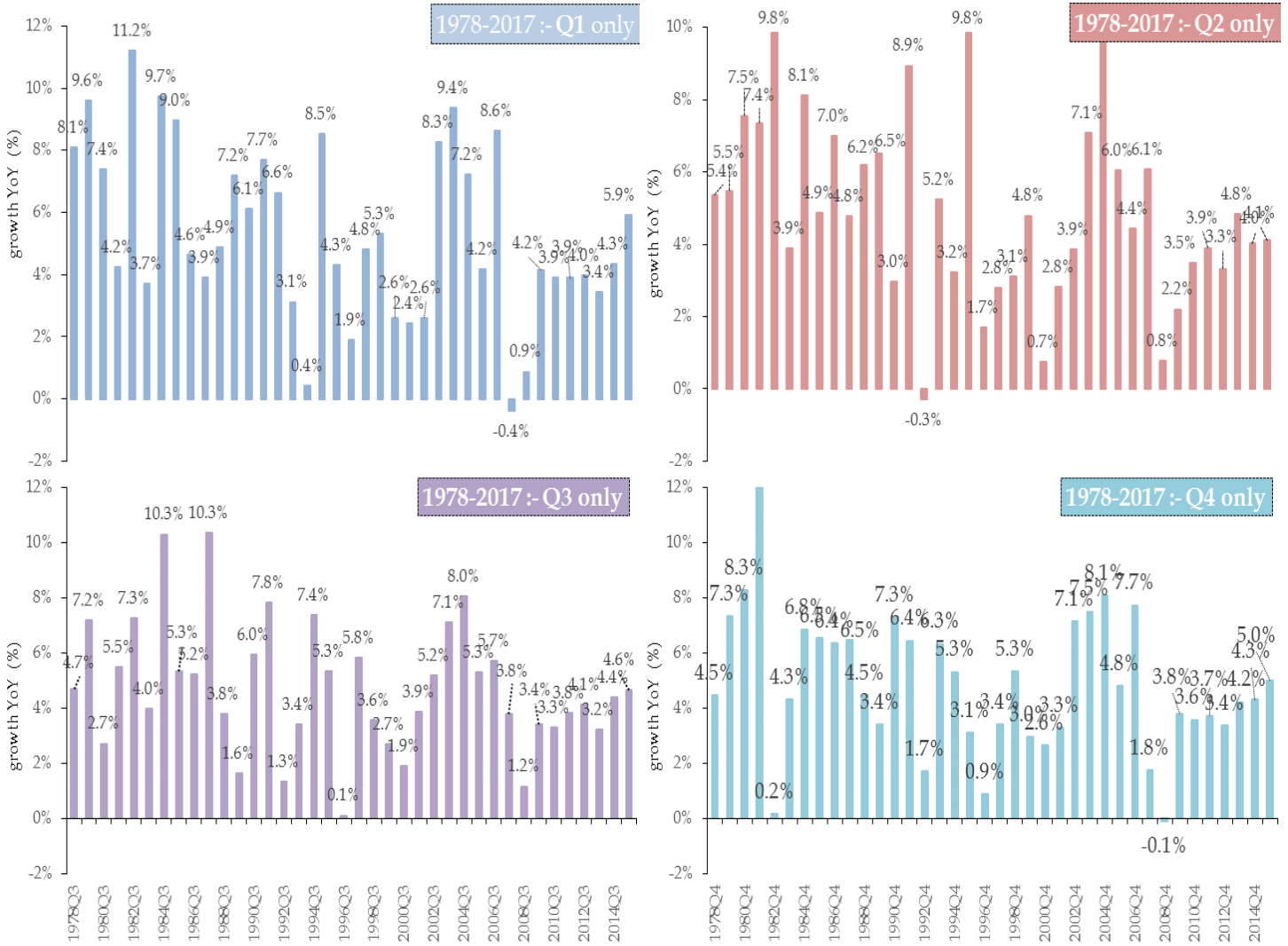


Table B1: Quarterly Real GDP Estimates for India (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1963:Q1	39157.3	--	1976:Q3	58605.9	0.5%	1990:Q1	118646.2	7.6%	2003:Q3	236423.7	8.1%
1963:Q2	36972.8	--	1976:Q4	60956.4	2.7%	1990:Q2	115318.2	6.7%	2003:Q4	241621.2	8.3%
1963:Q3	38318.7	--	1977:Q1	63948.0	7.7%	1990:Q3	115595.9	5.3%	2004:Q1	249468.1	8.0%
1963:Q4	40297.1	--	1977:Q2	61973.6	6.8%	1990:Q4	116972.9	2.7%	2004:Q2	250278.0	7.3%
1964:Q1	40655.5	3.8%	1977:Q3	62784.3	7.1%	1991:Q1	122313.0	3.1%	2004:Q3	255377.2	8.0%
1964:Q2	39489.6	6.8%	1977:Q4	65397.3	7.3%	1991:Q2	114439.3	-0.8%	2004:Q4	261671.2	8.3%
1964:Q3	42528.6	11.0%	1978:Q1	67347.1	5.3%	1991:Q3	115899.8	0.3%	2005:Q1	271753.2	8.9%
1964:Q4	43605.4	8.2%	1978:Q2	67278.5	8.6%	1991:Q4	118811.5	1.6%	2005:Q2	274785.9	9.8%
1965:Q1	42276.2	4.0%	1978:Q3	66410.9	5.8%	1992:Q1	126554.6	3.5%	2005:Q3	279327.4	9.4%
1965:Q2	39429.8	-0.2%	1978:Q4	67582.4	3.3%	1992:Q2	121794.8	6.4%	2005:Q4	285335.6	9.0%
1965:Q3	39993.9	-6.0%	1979:Q1	65521.2	-2.7%	1992:Q3	123263.5	6.4%	2006:Q1	296102.0	9.0%
1965:Q4	40196.3	-7.8%	1979:Q2	61998.5	-7.8%	1992:Q4	125698.3	5.8%	2006:Q2	299497.9	9.0%
1966:Q1	38616.9	-8.7%	1979:Q3	62433.6	-6.0%	1993:Q1	129172.4	2.1%	2006:Q3	305553.3	9.4%
1966:Q2	39482.4	0.1%	1979:Q4	64594.9	-4.4%	1993:Q2	127226.1	4.5%	2006:Q4	312990.3	9.7%
1966:Q3	40904.7	2.3%	1980:Q1	67530.6	3.1%	1993:Q3	130380.3	5.8%	2007:Q1	328223.1	10.8%
1966:Q4	42802.8	6.5%	1980:Q2	64966.5	4.8%	1993:Q4	134158.6	6.7%	2007:Q2	330733.4	10.4%
1967:Q1	43025.4	11.4%	1980:Q3	67586.2	8.3%	1994:Q1	137899.0	6.8%	2007:Q3	335491.4	9.8%
1967:Q2	43003.6	8.9%	1980:Q4	71610.9	10.9%	1994:Q2	136628.5	7.4%	2007:Q4	338698.2	8.2%
1967:Q3	43927.3	7.4%	1981:Q1	73111.6	8.3%	1994:Q3	138497.7	6.2%	2008:Q1	344015.7	4.8%
1967:Q4	44513.4	4.0%	1981:Q2	69995.1	7.7%	1994:Q4	142600.9	6.3%	2008:Q2	343388.2	3.8%
1968:Q1	45925.1	6.7%	1981:Q3	71372.5	5.6%	1995:Q1	147141.6	6.7%	2008:Q3	347279.5	3.5%
1968:Q2	43596.0	1.4%	1981:Q4	73533.5	2.7%	1995:Q2	147236.7	7.8%	2008:Q4	350334.7	3.4%
1968:Q3	44963.3	2.4%	1982:Q1	75052.0	2.7%	1995:Q3	150138.0	8.4%	2009:Q1	364677.8	6.0%
1968:Q4	45896.2	3.1%	1982:Q2	72210.4	3.2%	1995:Q4	153195.7	7.4%	2009:Q2	369215.3	7.5%
1969:Q1	47379.9	3.2%	1982:Q3	73325.7	2.7%	1996:Q1	160427.6	9.0%	2009:Q3	379135.5	9.2%
1969:Q2	47675.5	9.4%	1982:Q4	77435.2	5.3%	1996:Q2	159407.8	8.3%	2009:Q4	389436.2	11.2%
1969:Q3	47736.5	6.2%	1983:Q1	79667.4	6.1%	1996:Q3	160336.0	6.8%	2010:Q1	406543.8	11.5%
1969:Q4	49385.0	7.6%	1983:Q2	77818.0	7.8%	1996:Q4	162665.0	6.2%	2010:Q2	409955.8	11.0%
1970:Q1	50516.5	6.6%	1983:Q3	79015.6	7.8%	1997:Q1	166646.1	3.9%	2010:Q3	416237.1	9.8%
1970:Q2	50923.1	6.8%	1983:Q4	83244.9	7.5%	1997:Q2	167647.2	5.2%	2010:Q4	423880.3	8.8%
1970:Q3	50201.8	5.2%	1984:Q1	85154.9	6.9%	1997:Q3	165961.4	3.5%	2011:Q1	437429.5	7.6%
1970:Q4	50446.6	2.1%	1984:Q2	81212.1	4.4%	1997:Q4	168615.4	3.7%	2011:Q2	438561.7	7.0%
1971:Q1	51408.2	1.8%	1984:Q3	81605.2	3.3%	1998:Q1	174970.8	5.0%	2011:Q3	442435.3	6.3%
1971:Q2	50170.0	-1.5%	1984:Q4	83990.4	0.9%	1998:Q2	174749.0	4.2%	2011:Q4	448162.9	5.7%
1971:Q3	51124.5	1.8%	1985:Q1	86356.7	1.4%	1998:Q3	177377.4	6.9%	2012:Q1	459925.0	5.1%
1971:Q4	52705.4	4.5%	1985:Q2	85743.2	5.6%	1998:Q4	183138.5	8.6%	2012:Q2	462479.5	5.5%
1972:Q1	52165.3	1.5%	1985:Q3	86036.9	5.4%	1999:Q1	191435.5	9.4%	2012:Q3	466879.7	5.5%
1972:Q2	50047.5	-0.2%	1985:Q4	91267.9	8.7%	1999:Q2	191351.0	9.5%	2012:Q4	473697.1	5.7%
1972:Q3	50157.8	-1.9%	1986:Q1	92000.1	6.5%	1999:Q3	193088.0	8.9%	2013:Q1	488225.6	6.2%
1972:Q4	51901.0	-1.5%	1986:Q2	89770.3	4.7%	1999:Q4	197187.1	7.7%	2013:Q2	490372.6	6.0%
1973:Q1	51099.3	-2.0%	1986:Q3	90035.5	4.6%	2000:Q1	201194.3	5.1%	2013:Q3	497698.3	6.6%
1973:Q2	51309.8	2.5%	1986:Q4	94288.6	3.3%	2000:Q2	198717.4	3.8%	2013:Q4	505656.7	6.7%
1973:Q3	53764.5	7.2%	1987:Q1	96098.0	4.5%	2000:Q3	199368.3	3.3%	2014:Q1	523624.8	7.3%

Table B1: Quarterly Real GDP Estimates for India (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1973:Q4	54829.8	5.6%	1987:Q2	92338.8	2.9%	2000:Q4	203474.7	3.2%	2014:Q2	528362.5	7.7%
1974:Q1	52110.8	2.0%	1987:Q3	94386.7	4.8%	2001:Q1	208244.6	3.5%	2014:Q3	535232.3	7.5%
1974:Q2	51667.1	0.7%	1987:Q4	97787.8	3.7%	2001:Q2	209402.9	5.4%	2014:Q4	543483.6	7.5%
1974:Q3	53854.7	0.2%	1988:Q1	102126.9	6.3%	2001:Q3	210453.5	5.6%	2015:Q1	564466.5	7.8%
1974:Q4	55871.9	1.9%	1988:Q2	103037.9	11.6%	2001:Q4	213378.3	4.9%	2015:Q2	569924.3	7.9%
1975:Q1	58792.6	12.8%	1988:Q3	103548.8	9.7%	2002:Q1	216365.4	3.9%	2015:Q3	578738.0	8.1%
1975:Q2	56632.6	9.6%	1988:Q4	108542.2	11.0%	2002:Q2	215333.8	2.8%	2015:Q4	588244.9	8.2%
1975:Q3	58289.0	8.2%	1989:Q1	110267.0	8.0%	2002:Q3	218749.6	3.9%	2016:Q1	610103.4	8.1%
1975:Q4	59325.7	6.2%	1989:Q2	108071.9	4.9%	2002:Q4	223040.2	4.5%	2016:Q2	614698.4	7.9%
1976:Q1	59351.3	1.0%	1989:Q3	109820.0	6.1%	2003:Q1	230897.2	6.7%	2016:Q3	619607.9	7.1%
1976:Q2	58002.1	2.4%	1989:Q4	113912.4	4.9%	2003:Q2	233206.5	8.3%	2016:Q4	620523.4	5.5%

Table B2: Quarterly Real GDP Estimates for Pakistan (million PKR, base-2005-2006) – Data Spans over Fiscal Year 1978Q1-2017Q4

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1978:Q1	384.3	--	1988:Q1	764.1	3.9%	1998:Q1	1250.5	1.9%	2008:Q1	2138.5	8.6%
1978:Q2	447.0	--	1988:Q2	831.9	4.8%	1998:Q2	1313.0	2.8%	2008:Q2	2119.9	6.1%
1978:Q3	485.9	--	1988:Q3	888.6	10.3%	1998:Q3	1344.9	5.8%	2008:Q3	2127.9	3.8%
1978:Q4	472.8	--	1988:Q4	870.0	6.5%	1998:Q4	1315.1	3.4%	2008:Q4	2162.8	1.8%
1979:Q1	415.3	8.1%	1989:Q1	801.5	4.9%	1999:Q1	1310.4	4.8%	2009:Q1	2130.4	-0.4%
1979:Q2	471.0	5.4%	1989:Q2	883.5	6.2%	1999:Q2	1353.6	3.1%	2009:Q2	2136.2	0.8%
1979:Q3	508.7	4.7%	1989:Q3	922.2	3.8%	1999:Q3	1392.7	3.6%	2009:Q3	2152.7	1.2%
1979:Q4	493.9	4.5%	1989:Q4	908.8	4.5%	1999:Q4	1385.3	5.3%	2009:Q4	2160.7	-0.1%
1980:Q1	455.2	9.6%	1990:Q1	859.1	7.2%	2000:Q1	1379.9	5.3%	2010:Q1	2149.0	0.9%
1980:Q2	496.8	5.5%	1990:Q2	941.0	6.5%	2000:Q2	1418.5	4.8%	2010:Q2	2183.2	2.2%
1980:Q3	545.2	7.2%	1990:Q3	937.4	1.6%	2000:Q3	1430.0	2.7%	2010:Q3	2226.4	3.4%
1980:Q4	530.1	7.3%	1990:Q4	939.8	3.4%	2000:Q4	1426.2	3.0%	2010:Q4	2242.8	3.8%
1981:Q1	488.9	7.4%	1991:Q1	911.5	6.1%	2001:Q1	1415.8	2.6%	2011:Q1	2238.3	4.2%
1981:Q2	534.2	7.5%	1991:Q2	968.8	3.0%	2001:Q2	1429.1	0.7%	2011:Q2	2259.4	3.5%
1981:Q3	560.0	2.7%	1991:Q3	993.2	6.0%	2001:Q3	1457.0	1.9%	2011:Q3	2299.5	3.3%
1981:Q4	573.9	8.3%	1991:Q4	1008.4	7.3%	2001:Q4	1463.9	2.6%	2011:Q4	2323.1	3.6%
1982:Q1	509.6	4.2%	1992:Q1	981.7	7.7%	2002:Q1	1450.3	2.4%	2012:Q1	2325.9	3.9%
1982:Q2	573.5	7.4%	1992:Q2	1055.4	8.9%	2002:Q2	1469.3	2.8%	2012:Q2	2347.3	3.9%
1982:Q3	590.8	5.5%	1992:Q3	1070.9	7.8%	2002:Q3	1513.3	3.9%	2012:Q3	2387.3	3.8%
1982:Q4	646.3	12.6%	1992:Q4	1073.4	6.4%	2002:Q4	1512.3	3.3%	2012:Q4	2409.7	3.7%
1983:Q1	566.7	11.2%	1993:Q1	1046.8	6.6%	2003:Q1	1488.2	2.6%	2013:Q1	2416.7	3.9%
1983:Q2	630.0	9.8%	1993:Q2	1052.5	-0.3%	2003:Q2	1525.9	3.9%	2013:Q2	2425.2	3.3%
1983:Q3	633.7	7.3%	1993:Q3	1085.3	1.3%	2003:Q3	1591.9	5.2%	2013:Q3	2486.2	4.1%
1983:Q4	647.3	0.2%	1993:Q4	1091.9	1.7%	2003:Q4	1620.2	7.1%	2013:Q4	2491.1	3.4%
1984:Q1	587.7	3.7%	1994:Q1	1079.5	3.1%	2004:Q1	1611.3	8.3%	2014:Q1	2512.9	4.0%
1984:Q2	654.5	3.9%	1994:Q2	1107.7	5.2%	2004:Q2	1633.8	7.1%	2014:Q2	2542.5	4.8%
1984:Q3	658.8	4.0%	1994:Q3	1122.4	3.4%	2004:Q3	1705.1	7.1%	2014:Q3	2566.0	3.2%
1984:Q4	675.1	4.3%	1994:Q4	1161.0	6.3%	2004:Q4	1741.8	7.5%	2014:Q4	2595.6	4.2%
1985:Q1	645.0	9.7%	1995:Q1	1084.0	0.4%	2005:Q1	1762.3	9.4%	2015:Q1	2599.1	3.4%
1985:Q2	707.6	8.1%	1995:Q2	1143.4	3.2%	2005:Q2	1804.5	10.4%	2015:Q2	2644.8	4.0%
1985:Q3	726.6	10.3%	1995:Q3	1205.2	7.4%	2005:Q3	1842.1	8.0%	2015:Q3	2678.4	4.4%
1985:Q4	721.3	6.8%	1995:Q4	1222.7	5.3%	2005:Q4	1882.5	8.1%	2015:Q4	2707.4	4.3%
1986:Q1	702.7	9.0%	1996:Q1	1176.4	8.5%	2006:Q1	1889.7	7.2%	2016:Q1	2711.5	4.3%
1986:Q2	742.1	4.9%	1996:Q2	1256.0	9.8%	2006:Q2	1913.5	6.0%	2016:Q2	2753.3	4.1%
1986:Q3	765.4	5.3%	1996:Q3	1269.5	5.3%	2006:Q3	1939.6	5.3%	2016:Q3	2802.7	4.6%
1986:Q4	768.4	6.5%	1996:Q4	1260.6	3.1%	2006:Q4	1972.9	4.8%	2016:Q4	2843.1	5.0%
1987:Q1	735.3	4.6%	1997:Q1	1227.1	4.3%	2007:Q1	1968.8	4.2%	2017:Q1	2872.0	5.9%
1987:Q2	794.0	7.0%	1997:Q2	1277.4	1.7%	2007:Q2	1998.4	4.4%	2017:Q2	2914.7	5.9%
1987:Q3	805.3	5.2%	1997:Q3	1270.9	0.1%	2007:Q3	2050.3	5.7%	2017:Q3	2949.1	5.2%
1987:Q4	817.2	6.4%	1997:Q4	1271.8	0.9%	2007:Q4	2125.5	7.7%	2017:Q4	2961.1	4.2%

Table B3: Quarterly Real GDP Estimates for Bangladesh (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	7773.3	--	1990:Q1	10295.9	-0.8%	1999:Q1	15507.7	6.1%	2008:Q1	25550.7	6.8%
1981:Q2	7763.4	--	1990:Q2	10776.4	10.7%	1999:Q2	15838.5	6.0%	2008:Q2	25999.1	6.2%
1981:Q3	7410.9	--	1990:Q3	10500.5	8.8%	1999:Q3	16155.9	4.0%	2008:Q3	26173.9	5.5%
1981:Q4	7750.1	--	1990:Q4	10847.9	4.3%	1999:Q4	16142.4	2.8%	2008:Q4	26226.9	5.6%
1982:Q1	8047.6	3.5%	1991:Q1	11090.3	7.7%	2000:Q1	16269.4	4.9%	2009:Q1	26899.6	5.3%
1982:Q2	7898.8	1.7%	1991:Q2	10989.3	2.0%	2000:Q2	16931.8	6.9%	2009:Q2	27175.1	4.5%
1982:Q3	7229.8	-2.4%	1991:Q3	10779.1	2.7%	2000:Q3	16913.2	4.7%	2009:Q3	27728.6	5.9%
1982:Q4	8176.7	5.5%	1991:Q4	11040.4	1.8%	2000:Q4	16899.0	4.7%	2009:Q4	27391.6	4.4%
1983:Q1	8427.1	4.7%	1992:Q1	11578.6	4.4%	2001:Q1	16809.7	3.3%	2010:Q1	28428.0	5.7%
1983:Q2	7873.4	-0.3%	1992:Q2	11318.6	3.0%	2001:Q2	17691.1	4.5%	2010:Q2	28537.0	5.0%
1983:Q3	8028.2	11.0%	1992:Q3	11350.2	5.3%	2001:Q3	17988.6	6.4%	2010:Q3	28961.7	4.4%
1983:Q4	8241.1	0.8%	1992:Q4	12041.0	9.1%	2001:Q4	17926.5	6.1%	2010:Q4	29352.4	7.2%
1984:Q1	8621.0	2.3%	1993:Q1	11936.8	3.1%	2002:Q1	17935.9	6.7%	2011:Q1	29852.0	5.0%
1984:Q2	8820.8	12.0%	1993:Q2	12012.9	6.1%	2002:Q2	18422.8	4.1%	2011:Q2	30448.9	6.7%
1984:Q3	7969.6	-0.7%	1993:Q3	12180.6	7.3%	2002:Q3	18522.2	3.0%	2011:Q3	30912.7	6.7%
1984:Q4	8722.8	5.8%	1993:Q4	12339.1	2.5%	2002:Q4	18234.2	1.7%	2011:Q4	31517.6	7.4%
1985:Q1	9281.3	7.7%	1994:Q1	12247.1	2.6%	2003:Q1	18944.9	5.6%	2012:Q1	32018.2	7.3%
1985:Q2	8793.7	-0.3%	1994:Q2	12782.2	6.4%	2003:Q2	19006.8	3.2%	2012:Q2	32745.5	7.5%
1985:Q3	8079.8	1.4%	1994:Q3	12565.4	3.2%	2003:Q3	19405.2	4.8%	2012:Q3	32886.7	6.4%
1985:Q4	9120.2	4.6%	1994:Q4	12760.1	3.4%	2003:Q4	19223.5	5.4%	2012:Q4	33084.6	5.0%
1986:Q1	9342.0	0.7%	1995:Q1	12777.2	4.3%	2004:Q1	19781.4	4.4%	2013:Q1	34149.3	6.7%
1986:Q2	9322.9	6.0%	1995:Q2	13042.8	2.0%	2004:Q2	19948.0	5.0%	2013:Q2	34497.9	5.4%
1986:Q3	8881.6	9.9%	1995:Q3	13227.0	5.3%	2004:Q3	20568.1	6.0%	2013:Q3	34865.7	6.0%
1986:Q4	9200.6	0.9%	1995:Q4	13886.7	8.8%	2004:Q4	20295.4	5.6%	2013:Q4	35084.0	6.0%
1987:Q1	9335.2	-0.1%	1996:Q1	13633.9	6.7%	2005:Q1	20736.5	4.8%	2014:Q1	36021.9	5.5%
1987:Q2	9227.5	-1.0%	1996:Q2	13863.9	6.3%	2005:Q2	21379.1	7.2%	2014:Q2	36490.1	5.8%
1987:Q3	9583.6	7.9%	1996:Q3	13914.4	5.2%	2005:Q3	21879.4	6.4%	2014:Q3	37120.1	6.5%
1987:Q4	9987.1	8.5%	1996:Q4	13915.6	0.2%	2005:Q4	21865.4	7.7%	2014:Q4	37365.1	6.5%
1988:Q1	9726.2	4.2%	1997:Q1	13985.5	2.6%	2006:Q1	22446.4	8.2%	2015:Q1	38351.8	6.5%
1988:Q2	9864.8	6.9%	1997:Q2	14365.8	3.6%	2006:Q2	22808.7	6.7%	2015:Q2	38936.1	6.7%
1988:Q3	9342.1	-2.5%	1997:Q3	14740.6	5.9%	2006:Q3	23156.1	5.8%	2015:Q3	39538.3	6.5%
1988:Q4	10121.7	1.3%	1997:Q4	14720.0	5.8%	2006:Q4	23177.6	6.0%	2015:Q4	39803.2	6.5%
1989:Q1	10376.2	6.7%	1998:Q1	14619.4	4.5%	2007:Q1	23925.3	6.6%	2016:Q1	41245.3	7.5%
1989:Q2	9731.1	-1.4%	1998:Q2	14938.9	4.0%	2007:Q2	24477.8	7.3%	2016:Q2	41919.0	7.7%
1989:Q3	9651.5	3.3%	1998:Q3	15537.5	5.4%	2007:Q3	24810.5	7.1%	2016:Q3	42359.3	7.1%
1989:Q4	10403.7	2.8%	1998:Q4	15709.0	6.7%	2007:Q4	24840.1	7.2%	2016:Q4	42247.8	6.1%

Table B4: Quarterly Real GDP Estimates for Ethiopia (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	2039.1	--	1990:Q1	2405.7	4.1%	1999:Q1	2936.0	-0.3%	2008:Q1	5860.1	10.1%
1981:Q2	2177.0	--	1990:Q2	2480.5	-1.8%	1999:Q2	3064.1	3.1%	2008:Q2	6121.6	11.3%
1981:Q3	2004.6	--	1990:Q3	2538.1	6.3%	1999:Q3	3199.1	10.6%	2008:Q3	6203.9	11.2%
1981:Q4	2006.9	--	1990:Q4	2540.2	2.6%	1999:Q4	3127.2	7.3%	2008:Q4	6258.6	10.5%
1982:Q1	1972.6	-3.3%	1991:Q1	2460.0	2.3%	2000:Q1	3157.9	7.6%	2009:Q1	6409.3	9.4%
1982:Q2	2151.7	-1.2%	1991:Q2	2456.3	-1.0%	2000:Q2	3262.8	6.5%	2009:Q2	6589.0	7.6%
1982:Q3	2106.9	5.1%	1991:Q3	2183.6	-14.0%	2000:Q3	3313.9	3.6%	2009:Q3	6740.9	8.7%
1982:Q4	2071.8	3.2%	1991:Q4	2153.3	-15.2%	2000:Q4	3340.4	6.8%	2009:Q4	6856.7	9.6%
1983:Q1	2199.5	11.5%	1992:Q1	1967.5	-20.0%	2001:Q1	3485.2	10.4%	2010:Q1	7169.9	11.9%
1983:Q2	2330.9	8.3%	1992:Q2	2141.4	-12.8%	2001:Q2	3543.0	8.6%	2010:Q2	7398.2	12.3%
1983:Q3	2271.2	7.8%	1992:Q3	2177.4	-0.3%	2001:Q3	3555.4	7.3%	2010:Q3	7605.2	12.8%
1983:Q4	2185.1	5.5%	1992:Q4	2164.4	0.5%	2001:Q4	3576.8	7.1%	2010:Q4	7760.6	13.2%
1984:Q1	2252.6	2.4%	1993:Q1	2239.3	13.8%	2002:Q1	3541.5	1.6%	2011:Q1	8010.4	11.7%
1984:Q2	2527.2	8.4%	1993:Q2	2436.7	13.8%	2002:Q2	3599.7	1.6%	2011:Q2	8289.3	12.0%
1984:Q3	2140.5	-5.8%	1993:Q3	2472.0	13.5%	2002:Q3	3665.8	3.1%	2011:Q3	8476.3	11.5%
1984:Q4	1810.5	-17.1%	1993:Q4	2413.5	11.5%	2002:Q4	3567.7	-0.3%	2011:Q4	8504.0	9.6%
1985:Q1	1857.8	-17.5%	1994:Q1	2273.8	1.5%	2003:Q1	3433.4	-3.1%	2012:Q1	8697.3	8.6%
1985:Q2	2024.4	-19.9%	1994:Q2	2502.0	2.7%	2003:Q2	3497.9	-2.8%	2012:Q2	8995.1	8.5%
1985:Q3	1981.6	-7.4%	1994:Q3	2510.2	1.5%	2003:Q3	3520.9	-4.0%	2012:Q3	9098.7	7.3%
1985:Q4	1894.0	4.6%	1994:Q4	2580.5	6.9%	2003:Q4	3612.0	1.2%	2012:Q4	9366.8	10.1%
1986:Q1	2168.5	16.7%	1995:Q1	2436.8	7.2%	2004:Q1	3789.5	10.4%	2013:Q1	9681.7	11.3%
1986:Q2	2256.2	11.5%	1995:Q2	2693.5	7.7%	2004:Q2	4008.8	14.6%	2013:Q2	9936.3	10.5%
1986:Q3	2255.6	13.8%	1995:Q3	2672.4	6.5%	2004:Q3	4059.0	15.3%	2013:Q3	10107.7	11.1%
1986:Q4	1827.0	-3.5%	1995:Q4	2668.3	3.4%	2004:Q4	4115.6	13.9%	2013:Q4	10258.4	9.5%
1987:Q1	2364.0	9.0%	1996:Q1	2821.2	15.8%	2005:Q1	4215.6	11.2%	2014:Q1	10673.9	10.2%
1987:Q2	2427.7	7.6%	1996:Q2	3006.2	11.6%	2005:Q2	4522.7	12.8%	2014:Q2	10931.8	10.0%
1987:Q3	2401.3	6.5%	1996:Q3	2956.0	10.6%	2005:Q3	4534.2	11.7%	2014:Q3	11111.5	9.9%
1987:Q4	2493.4	36.5%	1996:Q4	2988.8	12.0%	2005:Q4	4588.3	11.5%	2014:Q4	11368.3	10.8%
1988:Q1	2397.9	1.4%	1997:Q1	2971.1	5.3%	2006:Q1	4766.8	13.1%	2015:Q1	11779.6	10.4%
1988:Q2	2424.1	-0.1%	1997:Q2	3082.9	2.6%	2006:Q2	4915.5	8.7%	2015:Q2	12152.2	11.2%
1988:Q3	2460.8	2.5%	1997:Q3	3066.1	3.7%	2006:Q3	5020.0	10.7%	2015:Q3	12294.6	10.6%
1988:Q4	2452.4	-1.6%	1997:Q4	3021.0	1.1%	2006:Q4	5093.6	11.0%	2015:Q4	12440.7	9.4%
1989:Q1	2310.2	-3.7%	1998:Q1	2945.0	-0.9%	2007:Q1	5320.7	11.6%	2016:Q1	12822.5	8.9%
1989:Q2	2526.3	4.2%	1998:Q2	2971.0	-3.6%	2007:Q2	5498.8	11.9%	2016:Q2	13012.0	7.1%
1989:Q3	2387.3	-3.0%	1998:Q3	2891.9	-5.7%	2007:Q3	5578.5	11.1%	2016:Q3	13232.4	7.6%
1989:Q4	2476.2	1.0%	1998:Q4	2913.3	-3.6%	2007:Q4	5665.9	11.2%	2016:Q4	13280.3	6.7%

Table B5: Quarterly Real GDP Estimates for Ghana (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	2382.2	--	1990:Q1	2955.8	2.7%	1999:Q1	4357.0	4.6%	2008:Q1	6887.3	8.2%
1981:Q2	2365.1	--	1990:Q2	2986.0	2.5%	1999:Q2	4404.3	4.6%	2008:Q2	7060.8	9.7%
1981:Q3	2340.1	--	1990:Q3	3025.6	3.3%	1999:Q3	4447.2	4.2%	2008:Q3	7197.5	9.9%
1981:Q4	2306.7	--	1990:Q4	3080.2	4.8%	1999:Q4	4492.5	4.2%	2008:Q4	7295.3	8.8%
1982:Q1	2263.0	-5.0%	1991:Q1	3111.6	5.3%	2000:Q1	4528.4	3.9%	2009:Q1	7352.8	6.8%
1982:Q2	2218.0	-6.2%	1991:Q2	3162.8	5.9%	2000:Q2	4565.8	3.7%	2009:Q2	7413.2	5.0%
1982:Q3	2159.7	-7.7%	1991:Q3	3196.2	5.6%	2000:Q3	4607.0	3.6%	2009:Q3	7480.9	3.9%
1982:Q4	2103.1	-8.8%	1991:Q4	3213.3	4.3%	2000:Q4	4654.6	3.6%	2009:Q4	7572.2	3.8%
1983:Q1	2067.5	-8.6%	1992:Q1	3262.3	4.8%	2001:Q1	4700.8	3.8%	2010:Q1	7709.5	4.9%
1983:Q2	2066.8	-6.8%	1992:Q2	3277.3	3.6%	2001:Q2	4748.7	4.0%	2010:Q2	7893.2	6.5%
1983:Q3	2078.1	-3.8%	1992:Q3	3297.0	3.2%	2001:Q3	4796.6	4.1%	2010:Q3	8139.2	8.8%
1983:Q4	2132.4	1.4%	1992:Q4	3339.4	3.9%	2001:Q4	4844.0	4.1%	2010:Q4	8432.8	11.4%
1984:Q1	2180.4	5.5%	1993:Q1	3388.5	3.9%	2002:Q1	4900.5	4.2%	2011:Q1	8756.5	13.6%
1984:Q2	2253.4	9.0%	1993:Q2	3437.6	4.9%	2002:Q2	4957.7	4.4%	2011:Q2	9062.5	14.8%
1984:Q3	2304.3	10.9%	1993:Q3	3480.0	5.6%	2002:Q3	5016.4	4.6%	2011:Q3	9326.0	14.6%
1984:Q4	2328.2	9.2%	1993:Q4	3508.9	5.1%	2002:Q4	5074.6	4.8%	2011:Q4	9549.0	13.2%
1985:Q1	2350.6	7.8%	1994:Q1	3528.5	4.1%	2003:Q1	5143.1	5.0%	2012:Q1	9742.8	11.3%
1985:Q2	2373.8	5.3%	1994:Q2	3551.5	3.3%	2003:Q2	5211.9	5.1%	2012:Q2	9925.6	9.5%
1985:Q3	2389.9	3.7%	1994:Q3	3576.5	2.8%	2003:Q3	5278.9	5.2%	2012:Q3	10117.4	8.5%
1985:Q4	2413.6	3.7%	1994:Q4	3614.4	3.0%	2003:Q4	5352.6	5.5%	2012:Q4	10318.0	8.1%
1986:Q1	2455.4	4.5%	1995:Q1	3650.0	3.4%	2004:Q1	5433.3	5.6%	2013:Q1	10520.9	8.0%
1986:Q2	2492.0	5.0%	1995:Q2	3693.7	4.0%	2004:Q2	5505.0	5.6%	2013:Q2	10703.2	7.8%
1986:Q3	2523.5	5.6%	1995:Q3	3735.7	4.5%	2004:Q3	5575.6	5.6%	2013:Q3	10848.9	7.2%
1986:Q4	2552.5	5.8%	1995:Q4	3778.3	4.5%	2004:Q4	5648.0	5.5%	2013:Q4	10963.5	6.3%
1987:Q1	2579.9	5.1%	1996:Q1	3829.0	4.9%	2005:Q1	5724.2	5.4%	2014:Q1	11053.4	5.1%
1987:Q2	2612.2	4.8%	1996:Q2	3863.2	4.6%	2005:Q2	5811.2	5.6%	2014:Q2	11137.3	4.1%
1987:Q3	2639.5	4.6%	1996:Q3	3904.9	4.5%	2005:Q3	5911.9	6.0%	2014:Q3	11228.9	3.5%
1987:Q4	2672.3	4.7%	1996:Q4	3944.5	4.4%	2005:Q4	6022.1	6.6%	2014:Q4	11332.3	3.4%
1988:Q1	2707.0	4.9%	1997:Q1	3984.1	4.1%	2006:Q1	6136.2	7.2%	2015:Q1	11442.8	3.5%
1988:Q2	2754.1	5.4%	1997:Q2	4025.9	4.2%	2006:Q2	6223.1	7.1%	2015:Q2	11565.6	3.8%
1988:Q3	2793.2	5.8%	1997:Q3	4069.3	4.2%	2006:Q3	6285.7	6.3%	2015:Q3	11684.6	4.1%
1988:Q4	2840.8	6.3%	1997:Q4	4114.4	4.3%	2006:Q4	6326.3	5.1%	2015:Q4	11796.5	4.1%
1989:Q1	2878.3	6.3%	1998:Q1	4164.8	4.5%	2007:Q1	6365.1	3.7%	2016:Q1	11901.5	4.0%
1989:Q2	2914.1	5.8%	1998:Q2	4212.4	4.6%	2007:Q2	6437.3	3.4%	2016:Q2	11998.8	3.7%
1989:Q3	2928.5	4.8%	1998:Q3	4266.4	4.8%	2007:Q3	6549.0	4.2%	2016:Q3	12077.0	3.4%
1989:Q4	2938.6	3.4%	1998:Q4	4311.3	4.8%	2007:Q4	6705.4	6.0%	2016:Q4	12139.3	2.9%

Table B6: Quarterly Real GDP Estimates for Liberia (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	680.4	--	1990:Q1	250.2	-51.1%	1999:Q1	204.1	33.8%	2008:Q1	280.1	7.3%
1981:Q2	676.1	--	1990:Q2	209.3	-54.8%	1999:Q2	214.8	18.7%	2008:Q2	278.1	9.0%
1981:Q3	671.9	--	1990:Q3	208.5	-49.6%	1999:Q3	214.5	12.2%	2008:Q3	297.1	2.9%
1981:Q4	671.8	--	1990:Q4	190.9	-47.8%	1999:Q4	246.9	24.4%	2008:Q4	301.8	9.8%
1982:Q1	663.8	-2.4%	1991:Q1	200.1	-20.0%	2000:Q1	276.9	35.7%	2009:Q1	311.4	11.2%
1982:Q2	658.1	-2.7%	1991:Q2	192.4	-8.1%	2000:Q2	275.9	28.4%	2009:Q2	303.2	9.0%
1982:Q3	658.1	-2.1%	1991:Q3	177.6	-14.8%	2000:Q3	282.6	31.7%	2009:Q3	310.4	4.5%
1982:Q4	654.6	-2.6%	1991:Q4	166.7	-12.7%	2000:Q4	296.8	20.2%	2009:Q4	293.3	-2.8%
1983:Q1	649.3	-2.2%	1992:Q1	139.3	-30.4%	2001:Q1	286.9	3.6%	2010:Q1	319.2	2.5%
1983:Q2	641.9	-2.5%	1992:Q2	128.0	-33.5%	2001:Q2	288.2	4.5%	2010:Q2	322.4	6.3%
1983:Q3	645.8	-1.9%	1992:Q3	117.9	-33.6%	2001:Q3	281.4	-0.4%	2010:Q3	323.6	4.2%
1983:Q4	647.5	-1.1%	1992:Q4	93.0	-44.2%	2001:Q4	308.7	4.0%	2010:Q4	327.5	11.7%
1984:Q1	632.0	-2.7%	1993:Q1	78.7	-43.5%	2002:Q1	313.1	9.1%	2011:Q1	341.9	7.1%
1984:Q2	632.8	-1.4%	1993:Q2	100.7	-21.4%	2002:Q2	321.9	11.7%	2011:Q2	338.9	5.1%
1984:Q3	629.9	-2.5%	1993:Q3	82.6	-29.9%	2002:Q3	276.1	-1.9%	2011:Q3	348.9	7.8%
1984:Q4	635.3	-1.9%	1993:Q4	58.5	-37.1%	2002:Q4	297.9	-3.5%	2011:Q4	369.0	12.7%
1985:Q1	629.0	-0.5%	1994:Q1	62.4	-20.8%	2003:Q1	251.4	-19.7%	2012:Q1	368.3	7.7%
1985:Q2	629.1	-0.6%	1994:Q2	68.5	-31.9%	2003:Q2	215.4	-33.1%	2012:Q2	361.3	6.6%
1985:Q3	625.0	-0.8%	1994:Q3	60.4	-26.9%	2003:Q3	178.6	-35.3%	2012:Q3	383.9	10.0%
1985:Q4	625.6	-1.5%	1994:Q4	59.5	1.7%	2003:Q4	199.1	-33.2%	2012:Q4	397.0	7.6%
1986:Q1	623.1	-0.9%	1995:Q1	69.8	11.8%	2004:Q1	201.2	-20.0%	2013:Q1	407.7	10.7%
1986:Q2	615.5	-2.2%	1995:Q2	65.0	-5.2%	2004:Q2	225.1	4.5%	2013:Q2	404.9	12.1%
1986:Q3	612.1	-2.1%	1995:Q3	55.8	-7.6%	2004:Q3	226.1	26.6%	2013:Q3	408.3	6.4%
1986:Q4	615.8	-1.6%	1995:Q4	49.6	-16.7%	2004:Q4	214.4	7.7%	2013:Q4	421.0	6.0%
1987:Q1	597.8	-4.1%	1996:Q1	50.7	-27.3%	2005:Q1	238.2	18.4%	2014:Q1	410.8	0.8%
1987:Q2	615.0	-0.1%	1996:Q2	63.8	-1.8%	2005:Q2	204.8	-9.0%	2014:Q2	409.0	1.0%
1987:Q3	617.3	0.9%	1996:Q3	72.7	30.4%	2005:Q3	233.3	3.2%	2014:Q3	410.6	0.5%
1987:Q4	611.8	-0.7%	1996:Q4	81.9	65.2%	2005:Q4	236.2	10.2%	2014:Q4	423.2	0.5%
1988:Q1	621.1	3.9%	1997:Q1	114.3	125.3%	2006:Q1	256.8	7.8%	2015:Q1	413.9	0.8%
1988:Q2	615.0	0.0%	1997:Q2	118.1	85.1%	2006:Q2	226.9	10.8%	2015:Q2	407.5	-0.4%
1988:Q3	596.5	-3.4%	1997:Q3	160.5	120.6%	2006:Q3	231.4	-0.8%	2015:Q3	412.1	0.4%
1988:Q4	559.5	-8.5%	1997:Q4	162.5	98.3%	2006:Q4	270.8	14.6%	2015:Q4	419.9	-0.8%
1989:Q1	511.3	-17.7%	1998:Q1	152.5	33.4%	2007:Q1	261.1	1.7%	2016:Q1	403.7	-2.5%
1989:Q2	463.2	-24.7%	1998:Q2	181.0	53.2%	2007:Q2	255.1	12.5%	2016:Q2	401.1	-1.6%
1989:Q3	413.5	-30.7%	1998:Q3	191.2	19.2%	2007:Q3	288.7	24.8%	2016:Q3	408.2	-1.0%
1989:Q4	366.1	-34.6%	1998:Q4	198.4	22.1%	2007:Q4	274.9	1.5%	2016:Q4	414.0	-1.4%

Table B7: Quarterly Real GDP Estimates for Mozambique (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	444.3	--	1990:Q1	581.6	5.6%	1999:Q1	1117.9	9.9%	2008:Q1	2183.1	7.0%
1981:Q2	447.9	--	1990:Q2	596.7	5.2%	1999:Q2	1138.5	9.0%	2008:Q2	2208.3	6.5%
1981:Q3	592.7	--	1990:Q3	595.9	3.8%	1999:Q3	1153.1	7.6%	2008:Q3	2258.3	7.2%
1981:Q4	592.5	--	1990:Q4	592.8	3.0%	1999:Q4	1149.1	4.9%	2008:Q4	2299.6	6.8%
1982:Q1	593.5	33.6%	1991:Q1	591.5	1.7%	2000:Q1	1138.1	1.8%	2009:Q1	2325.5	6.5%
1982:Q2	558.5	24.7%	1991:Q2	596.0	-0.1%	2000:Q2	1143.3	0.4%	2009:Q2	2351.7	6.5%
1982:Q3	545.8	-7.9%	1991:Q3	600.0	0.7%	2000:Q3	1161.5	0.7%	2009:Q3	2398.1	6.2%
1982:Q4	542.1	-8.5%	1991:Q4	606.7	2.3%	2000:Q4	1192.2	3.7%	2009:Q4	2442.4	6.2%
1983:Q1	539.7	-9.1%	1992:Q1	606.1	2.5%	2001:Q1	1241.0	9.0%	2010:Q1	2478.3	6.6%
1983:Q2	490.8	-12.1%	1992:Q2	586.2	-1.6%	2001:Q2	1292.3	13.0%	2010:Q2	2520.7	7.2%
1983:Q3	464.2	-15.0%	1992:Q3	580.5	-3.2%	2001:Q3	1330.1	14.5%	2010:Q3	2559.7	6.7%
1983:Q4	444.3	-18.0%	1992:Q4	576.9	-4.9%	2001:Q4	1361.2	14.2%	2010:Q4	2595.5	6.3%
1984:Q1	440.0	-18.5%	1993:Q1	572.9	-5.5%	2002:Q1	1391.8	12.1%	2011:Q1	2644.8	6.7%
1984:Q2	416.6	-15.1%	1993:Q2	593.7	1.3%	2002:Q2	1410.8	9.2%	2011:Q2	2693.1	6.8%
1984:Q3	408.0	-12.1%	1993:Q3	606.1	4.4%	2002:Q3	1431.9	7.7%	2011:Q3	2744.2	7.2%
1984:Q4	406.0	-8.6%	1993:Q4	615.1	6.6%	2002:Q4	1449.7	6.5%	2011:Q4	2795.0	7.7%
1985:Q1	409.7	-6.9%	1994:Q1	621.9	8.6%	2003:Q1	1474.7	6.0%	2012:Q1	2842.3	7.5%
1985:Q2	411.3	-1.3%	1994:Q2	645.5	8.7%	2003:Q2	1496.0	6.0%	2012:Q2	2887.6	7.2%
1985:Q3	414.8	1.7%	1994:Q3	658.7	8.7%	2003:Q3	1522.7	6.3%	2012:Q3	2938.6	7.1%
1985:Q4	423.4	4.3%	1994:Q4	668.4	8.7%	2003:Q4	1560.2	7.6%	2012:Q4	2991.4	7.0%
1986:Q1	427.2	4.3%	1995:Q1	671.1	7.9%	2004:Q1	1591.7	7.9%	2013:Q1	3041.3	7.0%
1986:Q2	423.7	3.0%	1995:Q2	674.5	4.5%	2004:Q2	1610.0	7.6%	2013:Q2	3096.8	7.2%
1986:Q3	425.4	2.5%	1995:Q3	680.4	3.3%	2004:Q3	1636.5	7.5%	2013:Q3	3145.7	7.0%
1986:Q4	427.1	0.9%	1995:Q4	686.7	2.7%	2004:Q4	1688.4	8.2%	2013:Q4	3208.8	7.3%
1987:Q1	427.0	0.0%	1996:Q1	687.6	2.5%	2005:Q1	1715.8	7.8%	2014:Q1	3261.0	7.2%
1987:Q2	458.6	8.2%	1996:Q2	769.0	14.0%	2005:Q2	1743.4	8.3%	2014:Q2	3316.0	7.1%
1987:Q3	479.6	12.8%	1996:Q3	822.6	20.9%	2005:Q3	1797.3	9.8%	2014:Q3	3388.3	7.7%
1987:Q4	495.6	16.1%	1996:Q4	859.9	25.2%	2005:Q4	1839.1	8.9%	2014:Q4	3456.0	7.7%
1988:Q1	503.7	18.0%	1997:Q1	914.3	33.0%	2006:Q1	1883.4	9.8%	2015:Q1	3509.4	7.6%
1988:Q2	522.6	14.0%	1997:Q2	928.3	20.7%	2006:Q2	1931.7	10.8%	2015:Q2	3551.6	7.1%
1988:Q3	535.8	11.7%	1997:Q3	950.9	15.6%	2006:Q3	1967.5	9.5%	2015:Q3	3585.4	5.8%
1988:Q4	547.3	10.4%	1997:Q4	986.0	14.7%	2006:Q4	2012.1	9.4%	2015:Q4	3616.0	4.6%
1989:Q1	550.5	9.3%	1998:Q1	1016.8	11.2%	2007:Q1	2040.4	8.3%	2016:Q1	3653.2	4.1%
1989:Q2	567.2	8.5%	1998:Q2	1044.1	12.5%	2007:Q2	2072.5	7.3%	2016:Q2	3677.3	3.5%
1989:Q3	574.0	7.1%	1998:Q3	1071.3	12.7%	2007:Q3	2107.5	7.1%	2016:Q3	3694.7	3.0%
1989:Q4	575.4	5.1%	1998:Q4	1095.7	11.1%	2007:Q4	2153.1	7.0%	2016:Q4	3707.9	2.5%

Table B8: Quarterly Real GDP Estimates for Rwanda (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	583.5	--	1990:Q1	655.4	-1.5%	1999:Q1	587.7	-0.9%	2008:Q1	1202.2	6.8%
1981:Q2	562.4	--	1990:Q2	648.8	-3.9%	1999:Q2	571.4	1.7%	2008:Q2	1233.1	11.2%
1981:Q3	559.4	--	1990:Q3	653.3	0.3%	1999:Q3	612.9	9.1%	2008:Q3	1298.3	13.4%
1981:Q4	541.8	--	1990:Q4	648.5	-4.4%	1999:Q4	650.8	7.3%	2008:Q4	1329.7	13.1%
1982:Q1	556.2	-4.7%	1991:Q1	636.6	-2.9%	2000:Q1	652.5	11.0%	2009:Q1	1289.4	7.3%
1982:Q2	579.3	3.0%	1991:Q2	636.5	-1.9%	2000:Q2	637.6	11.6%	2009:Q2	1315.6	6.7%
1982:Q3	549.0	-1.9%	1991:Q3	622.0	-4.8%	2000:Q3	662.5	8.1%	2009:Q3	1380.4	6.3%
1982:Q4	603.3	11.3%	1991:Q4	645.3	-0.5%	2000:Q4	672.6	3.3%	2009:Q4	1396.2	5.0%
1983:Q1	585.4	5.2%	1992:Q1	642.2	0.9%	2001:Q1	688.0	5.4%	2010:Q1	1384.9	7.4%
1983:Q2	621.4	7.3%	1992:Q2	738.2	16.0%	2001:Q2	706.6	10.8%	2010:Q2	1426.6	8.4%
1983:Q3	599.2	9.1%	1992:Q3	643.3	3.4%	2001:Q3	720.2	8.7%	2010:Q3	1476.9	7.0%
1983:Q4	618.7	2.6%	1992:Q4	666.0	3.2%	2001:Q4	733.7	9.1%	2010:Q4	1485.5	6.4%
1984:Q1	571.7	-2.3%	1993:Q1	672.0	4.6%	2002:Q1	778.4	13.1%	2011:Q1	1496.9	8.1%
1984:Q2	565.8	-8.9%	1993:Q2	648.2	-12.2%	2002:Q2	795.6	12.6%	2011:Q2	1522.0	6.7%
1984:Q3	586.1	-2.2%	1993:Q3	610.2	-5.1%	2002:Q3	823.7	14.4%	2011:Q3	1585.7	7.4%
1984:Q4	598.3	-3.3%	1993:Q4	541.3	-18.7%	2002:Q4	826.5	12.7%	2011:Q4	1619.0	9.0%
1985:Q1	578.6	1.2%	1994:Q1	435.8	-35.1%	2003:Q1	846.1	8.7%	2012:Q1	1642.5	9.7%
1985:Q2	601.4	6.3%	1994:Q2	276.6	-57.3%	2003:Q2	812.0	2.0%	2012:Q2	1675.9	10.1%
1985:Q3	600.8	2.5%	1994:Q3	260.1	-57.4%	2003:Q3	826.0	0.3%	2012:Q3	1708.5	7.7%
1985:Q4	643.2	7.5%	1994:Q4	257.1	-52.5%	2003:Q4	811.4	-1.8%	2012:Q4	1746.8	7.9%
1986:Q1	635.3	9.8%	1995:Q1	330.5	-24.2%	2004:Q1	856.5	1.2%	2013:Q1	1722.8	4.9%
1986:Q2	635.7	5.7%	1995:Q2	394.3	42.5%	2004:Q2	857.6	5.6%	2013:Q2	1757.9	4.9%
1986:Q3	613.1	2.0%	1995:Q3	457.4	75.8%	2004:Q3	888.3	7.6%	2013:Q3	1799.6	5.3%
1986:Q4	672.7	4.6%	1995:Q4	480.7	86.9%	2004:Q4	937.3	15.5%	2013:Q4	1811.9	3.7%
1987:Q1	641.5	1.0%	1996:Q1	464.0	40.4%	2005:Q1	937.3	9.4%	2014:Q1	1828.1	6.1%
1987:Q2	629.3	-1.0%	1996:Q2	463.1	17.5%	2005:Q2	930.6	8.5%	2014:Q2	1874.0	6.6%
1987:Q3	621.7	1.4%	1996:Q3	451.5	-1.3%	2005:Q3	981.6	10.5%	2014:Q3	1943.2	8.0%
1987:Q4	663.5	-1.4%	1996:Q4	496.1	3.2%	2005:Q4	1022.7	9.1%	2014:Q4	1987.2	9.7%
1988:Q1	659.0	2.7%	1997:Q1	481.5	3.8%	2006:Q1	1044.2	11.4%	2015:Q1	2004.4	9.6%
1988:Q2	655.4	4.1%	1997:Q2	510.6	10.2%	2006:Q2	1024.6	10.1%	2015:Q2	2047.9	9.3%
1988:Q3	658.1	5.8%	1997:Q3	548.7	21.5%	2006:Q3	1067.4	8.7%	2015:Q3	2118.4	9.0%
1988:Q4	698.6	5.3%	1997:Q4	593.7	19.7%	2006:Q4	1093.4	6.9%	2015:Q4	2139.1	7.6%
1989:Q1	665.4	1.0%	1998:Q1	593.2	23.2%	2007:Q1	1126.1	7.8%	2016:Q1	2169.6	8.2%
1989:Q2	674.9	3.0%	1998:Q2	562.0	10.1%	2007:Q2	1109.0	8.2%	2016:Q2	2185.3	6.7%
1989:Q3	651.5	-1.0%	1998:Q3	561.7	2.4%	2007:Q3	1144.7	7.2%	2016:Q3	2228.6	5.2%
1989:Q4	678.3	-2.9%	1998:Q4	606.5	2.1%	2007:Q4	1175.2	7.5%	2016:Q4	2219.3	3.7%

Table B9: Quarterly Real GDP Estimates for Uganda (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	961.7		1990:Q1	1275.8	5.5%	1999:Q1	2383.6	11.4%	2008:Q1	4305.0	6.9%
1981:Q2	1042.5		1990:Q2	1266.6	5.1%	1999:Q2	2404.3	10.6%	2008:Q2	4418.1	8.2%
1981:Q3	944.3		1990:Q3	1317.5	6.6%	1999:Q3	2393.1	6.3%	2008:Q3	4540.9	9.9%
1981:Q4	1058.3		1990:Q4	1408.9	8.6%	1999:Q4	2426.1	4.3%	2008:Q4	4628.3	9.8%
1982:Q1	973.5	1.2%	1991:Q1	1404.8	10.1%	2000:Q1	2479.2	4.0%	2009:Q1	4630.5	7.6%
1982:Q2	980.1	-6.0%	1991:Q2	1400.2	10.5%	2000:Q2	2513.3	4.5%	2009:Q2	4759.9	7.7%
1982:Q3	992.1	5.1%	1991:Q3	1338.9	1.6%	2000:Q3	2449.7	2.4%	2009:Q3	4833.6	6.4%
1982:Q4	1095.0	3.5%	1991:Q4	1417.5	0.6%	2000:Q4	2466.7	1.7%	2009:Q4	4885.3	5.6%
1983:Q1	1042.4	7.1%	1992:Q1	1380.8	-1.7%	2001:Q1	2543.2	2.6%	2010:Q1	4929.0	6.4%
1983:Q2	1027.2	4.8%	1992:Q2	1441.0	2.9%	2001:Q2	2573.1	2.4%	2010:Q2	5013.4	5.3%
1983:Q3	1090.2	9.9%	1992:Q3	1427.3	6.6%	2001:Q3	2631.5	7.4%	2010:Q3	5065.8	4.8%
1983:Q4	1113.1	1.7%	1992:Q4	1502.4	6.0%	2001:Q4	2674.7	8.4%	2010:Q4	5178.3	6.0%
1984:Q1	1069.4	2.6%	1993:Q1	1554.7	12.6%	2002:Q1	2769.5	8.9%	2011:Q1	5357.3	8.7%
1984:Q2	1069.3	4.1%	1993:Q2	1593.3	10.6%	2002:Q2	2828.6	9.9%	2011:Q2	5509.5	9.9%
1984:Q3	1063.9	-2.4%	1993:Q3	1545.0	8.2%	2002:Q3	2845.0	8.1%	2011:Q3	5597.5	10.5%
1984:Q4	1055.6	-5.2%	1993:Q4	1537.4	2.3%	2002:Q4	2889.5	8.0%	2011:Q4	5618.1	8.5%
1985:Q1	1044.6	-2.3%	1994:Q1	1614.3	3.8%	2003:Q1	2974.0	7.4%	2012:Q1	5668.5	5.8%
1985:Q2	1053.8	-1.4%	1994:Q2	1587.0	-0.4%	2003:Q2	2987.8	5.6%	2012:Q2	5743.1	4.2%
1985:Q3	1007.6	-5.3%	1994:Q3	1693.1	9.6%	2003:Q3	3045.3	7.0%	2012:Q3	5750.9	2.7%
1985:Q4	1011.2	-4.2%	1994:Q4	1734.9	12.8%	2003:Q4	3059.3	5.9%	2012:Q4	5767.2	2.7%
1986:Q1	993.4	-4.9%	1995:Q1	1768.4	9.5%	2004:Q1	3170.5	6.6%	2013:Q1	5816.6	2.6%
1986:Q2	985.0	-6.5%	1995:Q2	1833.2	15.5%	2004:Q2	3197.2	7.0%	2013:Q2	5914.1	3.0%
1986:Q3	1072.5	6.4%	1995:Q3	1875.5	10.8%	2004:Q3	3248.8	6.7%	2013:Q3	5987.4	4.1%
1986:Q4	1082.4	7.0%	1995:Q4	1916.1	10.4%	2004:Q4	3271.1	6.9%	2013:Q4	6034.0	4.6%
1987:Q1	1065.6	7.3%	1996:Q1	1978.5	11.9%	2005:Q1	3314.6	4.5%	2014:Q1	6091.4	4.7%
1987:Q2	1054.6	7.1%	1996:Q2	2043.7	11.5%	2005:Q2	3402.2	6.4%	2014:Q2	6243.0	5.6%
1987:Q3	1039.3	-3.1%	1996:Q3	1995.8	6.4%	2005:Q3	3455.0	6.3%	2014:Q3	6283.1	4.9%
1987:Q4	1137.6	5.1%	1996:Q4	2046.0	6.8%	2005:Q4	3531.9	8.0%	2014:Q4	6347.6	5.2%
1988:Q1	1099.9	3.2%	1997:Q1	2147.4	8.5%	2006:Q1	3645.6	10.0%	2015:Q1	6421.4	5.4%
1988:Q2	1154.4	9.5%	1997:Q2	2133.0	4.4%	2006:Q2	3747.1	10.1%	2015:Q2	6552.3	5.0%
1988:Q3	1204.3	15.9%	1997:Q3	2072.7	3.9%	2006:Q3	3857.1	11.6%	2015:Q3	6603.0	5.1%
1988:Q4	1193.8	4.9%	1997:Q4	2122.1	3.7%	2006:Q4	3931.9	11.3%	2015:Q4	6683.6	5.3%
1989:Q1	1209.7	10.0%	1998:Q1	2139.2	-0.4%	2007:Q1	4026.2	10.4%	2016:Q1	6790.7	5.8%
1989:Q2	1205.6	4.4%	1998:Q2	2173.7	1.9%	2007:Q2	4084.9	9.0%	2016:Q2	6902.5	5.3%
1989:Q3	1236.3	2.7%	1998:Q3	2252.2	8.7%	2007:Q3	4130.8	7.1%	2016:Q3	6899.0	4.5%
1989:Q4	1296.8	8.6%	1998:Q4	2325.9	9.6%	2007:Q4	4217.0	7.3%	2016:Q4	6890.9	3.1%

Table B10: Quarterly Real GDP Estimates for Zambia (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1981:Q1	2044.3	--	1990:Q1	2035.6	-1.0%	1999:Q1	2336.4	4.0%	2008:Q1	4072.7	8.2%
1981:Q2	2005.8	--	1990:Q2	2106.4	-0.8%	1999:Q2	2359.2	5.7%	2008:Q2	4200.5	8.7%
1981:Q3	2004.5	--	1990:Q3	2118.7	0.4%	1999:Q3	2389.5	3.8%	2008:Q3	4279.1	7.6%
1981:Q4	1975.2	--	1990:Q4	2127.5	-0.5%	1999:Q4	2426.2	5.1%	2008:Q4	4270.1	6.7%
1982:Q1	2000.2	-2.2%	1991:Q1	2124.7	4.4%	2000:Q1	2407.7	3.1%	2009:Q1	4366.1	7.2%
1982:Q2	1978.2	-1.4%	1991:Q2	2114.1	0.4%	2000:Q2	2460.1	4.3%	2009:Q2	4522.9	7.7%
1982:Q3	1923.1	-4.1%	1991:Q3	2091.7	-1.3%	2000:Q3	2468.1	3.3%	2009:Q3	4679.7	9.4%
1982:Q4	1902.4	-3.7%	1991:Q4	2054.7	-3.4%	2000:Q4	2546.1	4.9%	2009:Q4	4804.7	12.5%
1983:Q1	1915.6	-4.2%	1992:Q1	1951.5	-8.1%	2001:Q1	2534.6	5.3%	2010:Q1	4953.4	13.5%
1983:Q2	1890.0	-4.5%	1992:Q2	2039.6	-3.5%	2001:Q2	2602.8	5.8%	2010:Q2	5037.9	11.4%
1983:Q3	1939.6	0.9%	1992:Q3	2111.8	1.0%	2001:Q3	2636.5	6.8%	2010:Q3	5104.7	9.1%
1983:Q4	1905.2	0.1%	1992:Q4	2137.1	4.0%	2001:Q4	2633.5	3.4%	2010:Q4	5169.7	7.6%
1984:Q1	1871.8	-2.3%	1993:Q1	2177.5	11.6%	2002:Q1	2657.2	4.8%	2011:Q1	5233.7	5.7%
1984:Q2	1876.2	-0.7%	1993:Q2	2230.4	9.4%	2002:Q2	2717.4	4.4%	2011:Q2	5305.8	5.3%
1984:Q3	1919.9	-1.0%	1993:Q3	2212.4	4.8%	2002:Q3	2751.6	4.4%	2011:Q3	5387.8	5.5%
1984:Q4	1956.8	2.7%	1993:Q4	2179.8	2.0%	2002:Q4	2750.1	4.4%	2011:Q4	5466.1	5.7%
1985:Q1	1877.4	0.3%	1994:Q1	2043.2	-6.2%	2003:Q1	2909.6	9.5%	2012:Q1	5637.9	7.7%
1985:Q2	1923.4	2.5%	1994:Q2	2033.1	-8.8%	2003:Q2	2883.0	6.1%	2012:Q2	5697.3	7.4%
1985:Q3	1963.2	2.3%	1994:Q3	1974.1	-10.8%	2003:Q3	2899.4	5.4%	2012:Q3	5801.0	7.7%
1985:Q4	1983.8	1.4%	1994:Q4	1990.7	-8.7%	2003:Q4	2939.7	6.9%	2012:Q4	5882.5	7.6%
1986:Q1	1969.2	4.9%	1995:Q1	2069.4	1.3%	2004:Q1	3040.8	4.5%	2013:Q1	5953.5	5.6%
1986:Q2	1945.9	1.2%	1995:Q2	2108.9	3.7%	2004:Q2	3087.0	7.1%	2013:Q2	6018.2	5.6%
1986:Q3	1959.2	-0.2%	1995:Q3	2051.3	3.9%	2004:Q3	3144.5	8.5%	2013:Q3	6067.8	4.6%
1986:Q4	1929.6	-2.7%	1995:Q4	2044.6	2.7%	2004:Q4	3177.4	8.1%	2013:Q4	6143.7	4.4%
1987:Q1	1939.0	-1.5%	1996:Q1	2144.8	3.6%	2005:Q1	3210.8	5.6%	2014:Q1	6243.8	4.9%
1987:Q2	2008.0	3.2%	1996:Q2	2193.4	4.0%	2005:Q2	3329.8	7.9%	2014:Q2	6303.1	4.7%
1987:Q3	2014.8	2.8%	1996:Q3	2201.6	7.3%	2005:Q3	3393.1	7.9%	2014:Q3	6364.0	4.9%
1987:Q4	2051.0	6.3%	1996:Q4	2248.9	10.0%	2005:Q4	3416.8	7.5%	2014:Q4	6407.9	4.3%
1988:Q1	2076.9	7.1%	1997:Q1	2295.7	7.0%	2006:Q1	3439.0	7.1%	2015:Q1	6441.8	3.2%
1988:Q2	2144.8	6.8%	1997:Q2	2281.1	4.0%	2006:Q2	3584.0	7.6%	2015:Q2	6466.6	2.6%
1988:Q3	2155.3	7.0%	1997:Q3	2286.8	3.9%	2006:Q3	3653.0	7.7%	2015:Q3	6546.0	2.9%
1988:Q4	2139.0	4.3%	1997:Q4	2260.2	0.5%	2006:Q4	3729.7	9.2%	2015:Q4	6603.7	3.1%
1989:Q1	2056.9	-1.0%	1998:Q1	2246.1	-2.2%	2007:Q1	3765.2	9.5%	2016:Q1	6692.1	3.9%
1989:Q2	2122.9	-1.0%	1998:Q2	2231.8	-2.2%	2007:Q2	3864.4	7.8%	2016:Q2	6719.6	3.9%
1989:Q3	2111.2	-2.0%	1998:Q3	2301.5	0.6%	2007:Q3	3975.7	8.8%	2016:Q3	6786.3	3.7%
1989:Q4	2137.8	-0.1%	1998:Q4	2309.2	2.2%	2007:Q4	4003.6	7.3%	2016:Q4	6800.7	3.0%

Table B11: Quarterly Real GDP Estimates for Sierra Leone (million USD, base-2010)

Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY	Quarter	Real GDP	Growth YoY
1987:Q1	479.3	--	1994:Q3	368.0	-2.0%	2002:Q1	371.9	17.8%	2009:Q3	622.6	4.4%
1987:Q2	467.1	--	1994:Q4	369.3	-5.0%	2002:Q2	402.9	26.5%	2009:Q4	649.6	8.3%
1987:Q3	458.4	--	1995:Q1	355.6	-4.5%	2002:Q3	418.5	32.6%	2010:Q1	639.1	7.2%
1987:Q4	450.6	--	1995:Q2	336.4	-8.9%	2002:Q4	432.4	28.0%	2010:Q2	652.6	6.1%
1988:Q1	433.1	-9.6%	1995:Q3	327.3	-11.1%	2003:Q1	432.7	16.3%	2010:Q3	661.9	6.3%
1988:Q2	429.5	-8.0%	1995:Q4	341.4	-7.6%	2003:Q2	443.0	9.9%	2010:Q4	662.9	2.0%
1988:Q3	429.8	-6.2%	1996:Q1	342.3	-3.7%	2003:Q3	445.9	6.6%	2011:Q1	669.0	4.7%
1988:Q4	431.7	-4.2%	1996:Q2	345.3	2.6%	2003:Q4	456.8	5.6%	2011:Q2	672.1	3.0%
1989:Q1	435.0	0.4%	1996:Q3	341.5	4.4%	2004:Q1	466.4	7.8%	2011:Q3	688.6	4.0%
1989:Q2	427.8	-0.4%	1996:Q4	355.4	4.1%	2004:Q2	473.6	6.9%	2011:Q4	712.7	7.5%
1989:Q3	439.5	2.3%	1997:Q1	332.7	-2.8%	2004:Q3	472.9	6.0%	2012:Q1	731.0	9.3%
1989:Q4	434.4	0.6%	1997:Q2	328.2	-4.9%	2004:Q4	479.6	5.0%	2012:Q2	775.5	15.4%
1990:Q1	431.3	-0.9%	1997:Q3	314.5	-7.9%	2005:Q1	469.2	0.6%	2012:Q3	808.3	17.4%
1990:Q2	439.3	2.7%	1997:Q4	327.7	-7.8%	2005:Q2	500.3	5.6%	2012:Q4	844.0	18.4%
1990:Q3	454.3	3.4%	1998:Q1	314.6	-5.4%	2005:Q3	501.0	6.0%	2013:Q1	893.4	22.2%
1990:Q4	470.0	8.2%	1998:Q2	331.1	0.9%	2005:Q4	503.9	5.1%	2013:Q2	937.8	20.9%
1991:Q1	476.4	10.4%	1998:Q3	336.8	7.1%	2006:Q1	503.3	7.3%	2013:Q3	975.3	20.7%
1991:Q2	470.4	7.1%	1998:Q4	343.8	4.9%	2006:Q2	514.1	2.8%	2013:Q4	1006.6	19.3%
1991:Q3	454.6	0.1%	1999:Q1	323.5	2.8%	2006:Q3	527.5	5.3%	2014:Q1	1024.4	14.7%
1991:Q4	435.8	-7.3%	1999:Q2	333.1	0.6%	2006:Q4	538.7	6.9%	2014:Q2	1034.1	10.3%
1992:Q1	394.0	-17.3%	1999:Q3	320.4	-4.9%	2007:Q1	546.8	8.6%	2014:Q3	992.0	1.7%
1992:Q2	374.4	-20.4%	1999:Q4	323.1	-6.0%	2007:Q2	561.0	9.1%	2014:Q4	936.3	-7.0%
1992:Q3	358.1	-21.2%	2000:Q1	369.2	14.1%	2007:Q3	569.4	7.9%	2015:Q1	849.5	-17.1%
1992:Q4	361.3	-17.1%	2000:Q2	352.0	5.7%	2007:Q4	574.3	6.6%	2015:Q2	799.6	-22.7%
1993:Q1	374.2	-5.0%	2000:Q3	332.0	3.6%	2008:Q1	585.7	7.1%	2015:Q3	753.3	-24.1%
1993:Q2	369.9	-1.2%	2000:Q4	333.5	3.2%	2008:Q2	591.4	5.4%	2015:Q4	767.4	-18.0%
1993:Q3	375.5	4.8%	2001:Q1	315.7	-14.5%	2008:Q3	596.3	4.7%	2016:Q1	817.1	-3.8%
1993:Q4	388.6	7.6%	2001:Q2	318.5	-9.5%	2008:Q4	599.7	4.4%	2016:Q2	847.9	6.0%
1994:Q1	372.5	-0.5%	2001:Q3	315.6	-4.9%	2009:Q1	596.0	1.8%	2016:Q3	842.3	11.8%
1994:Q2	369.1	-0.2%	2001:Q4	337.8	1.3%	2009:Q2	615.1	4.0%	2016:Q4	862.2	12.4%

Figure B3: Estimates of Quartery GDP of India (million USD - Base Year 2010)

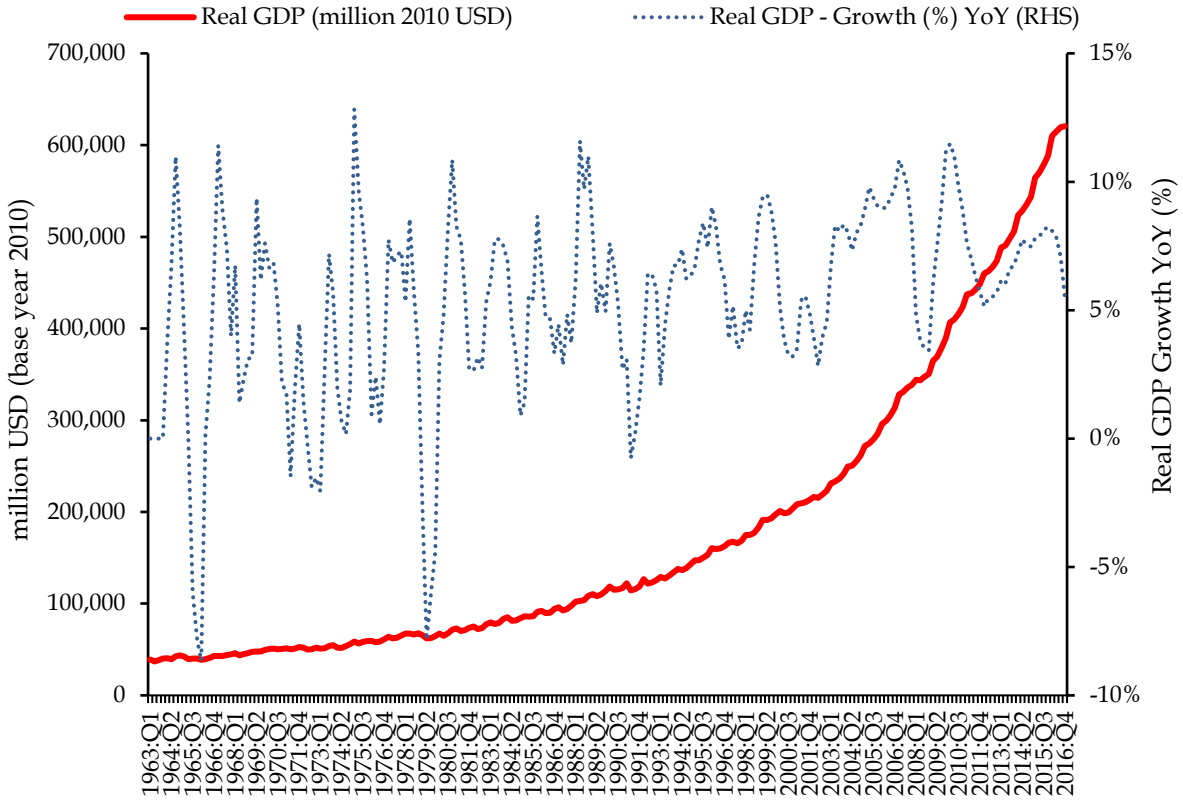


Figure B4: Estimates of Quartery GDP of Pakistan (million PKR - Base Year 2005-06)

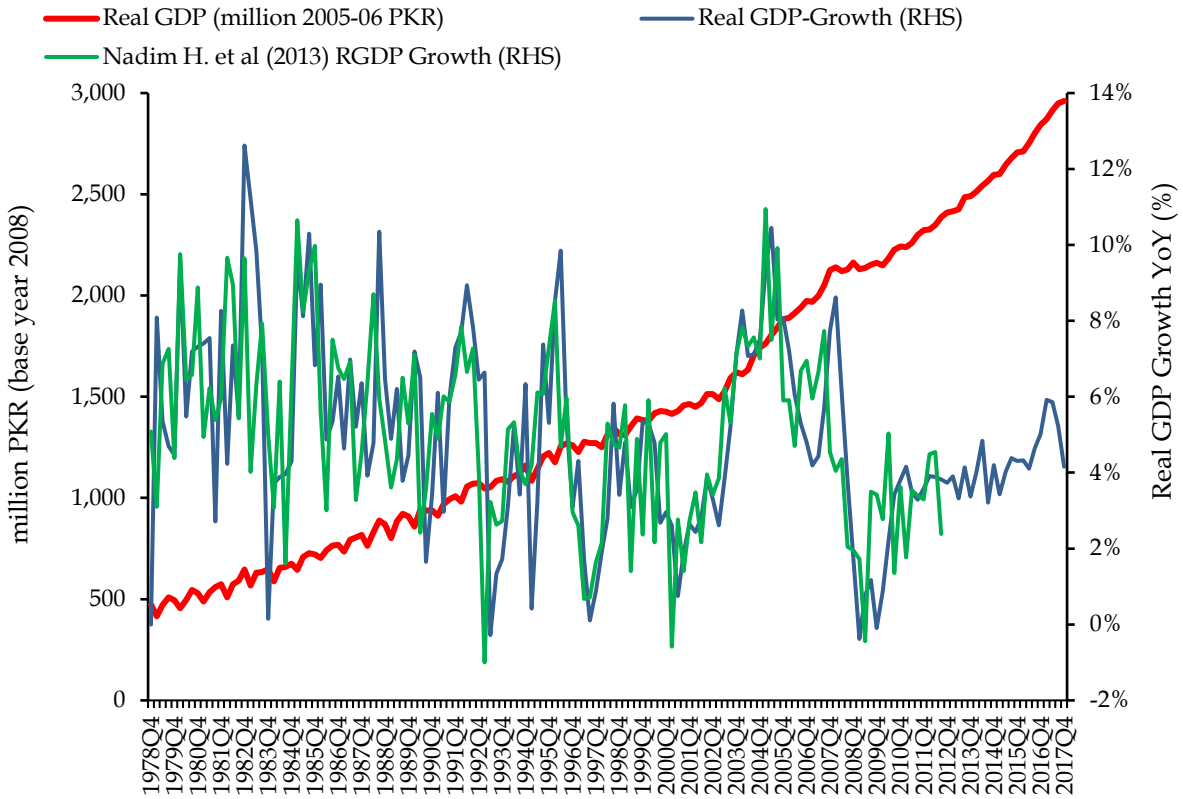


Figure B5: Estimates of Quartery GDP of Bangladesh (million USD - Base Year 2010)

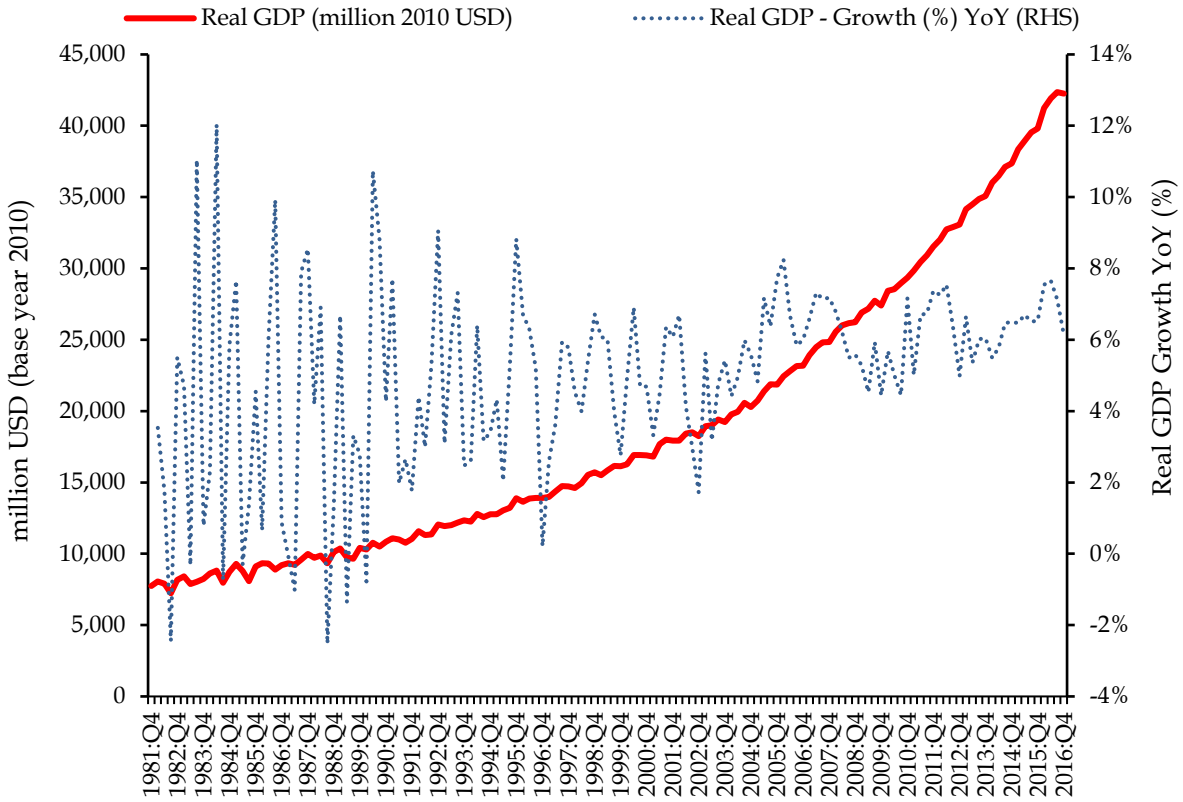


Figure B6: Estimates of Quartery GDP of Ethiopia (million USD - Base Year 2010)

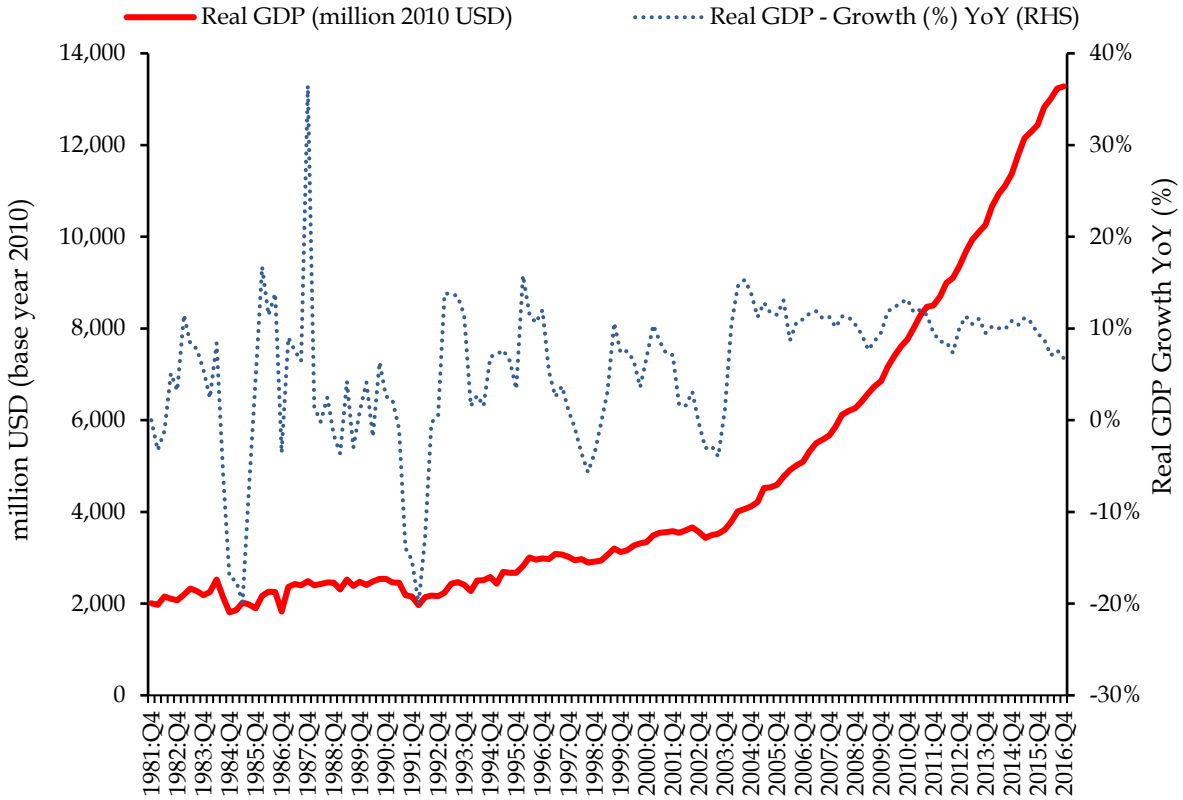


Figure B7: Estimates of Quartery GDP of Ghana (million USD - Base Year 2010)

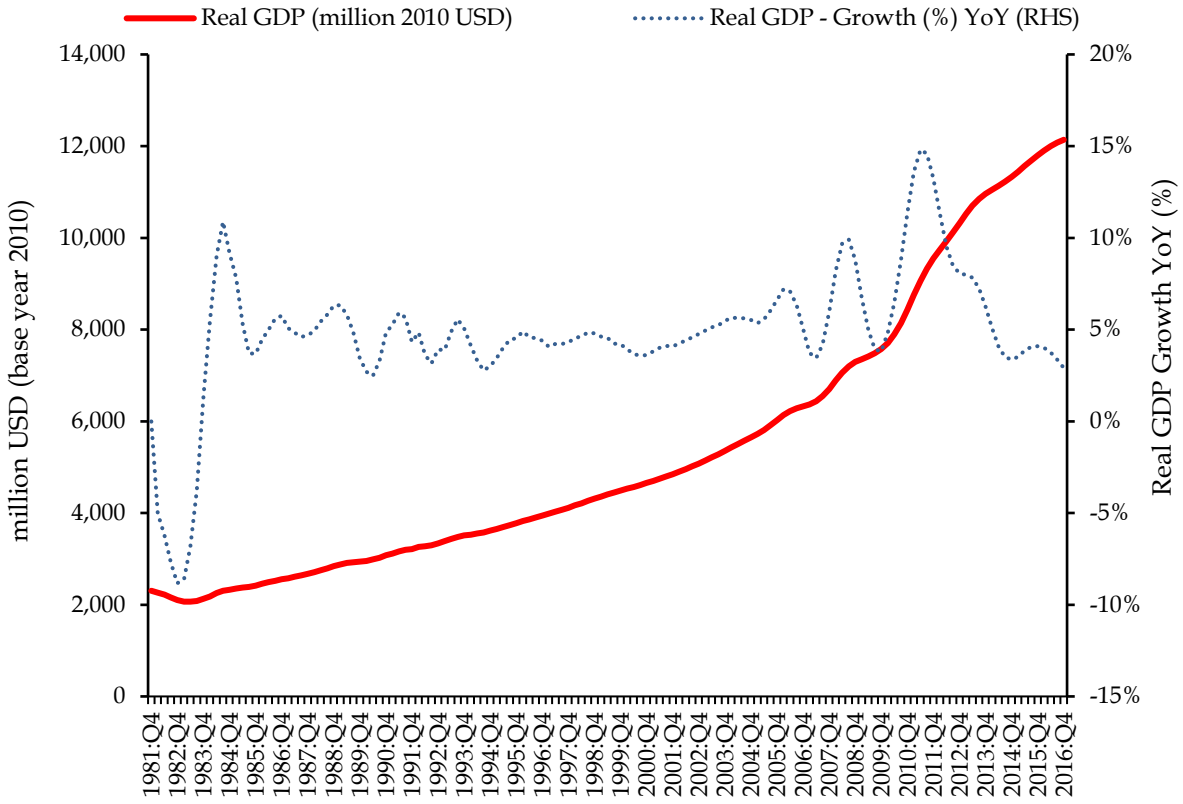


Figure B8: Estimates of Quartery GDP of Liberia (million USD - Base Year 2010)

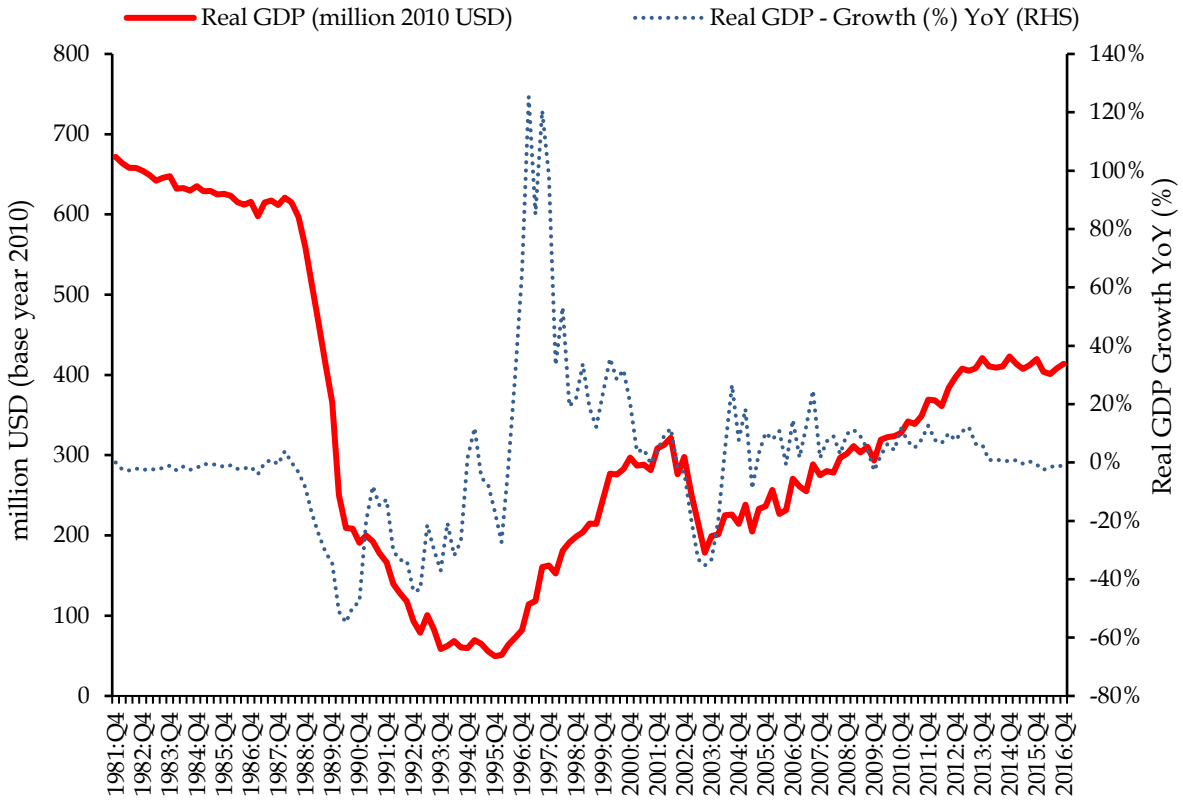


Figure B9: Estimates of Quartery GDP of Mozambique (million USD - Base Year 2010)

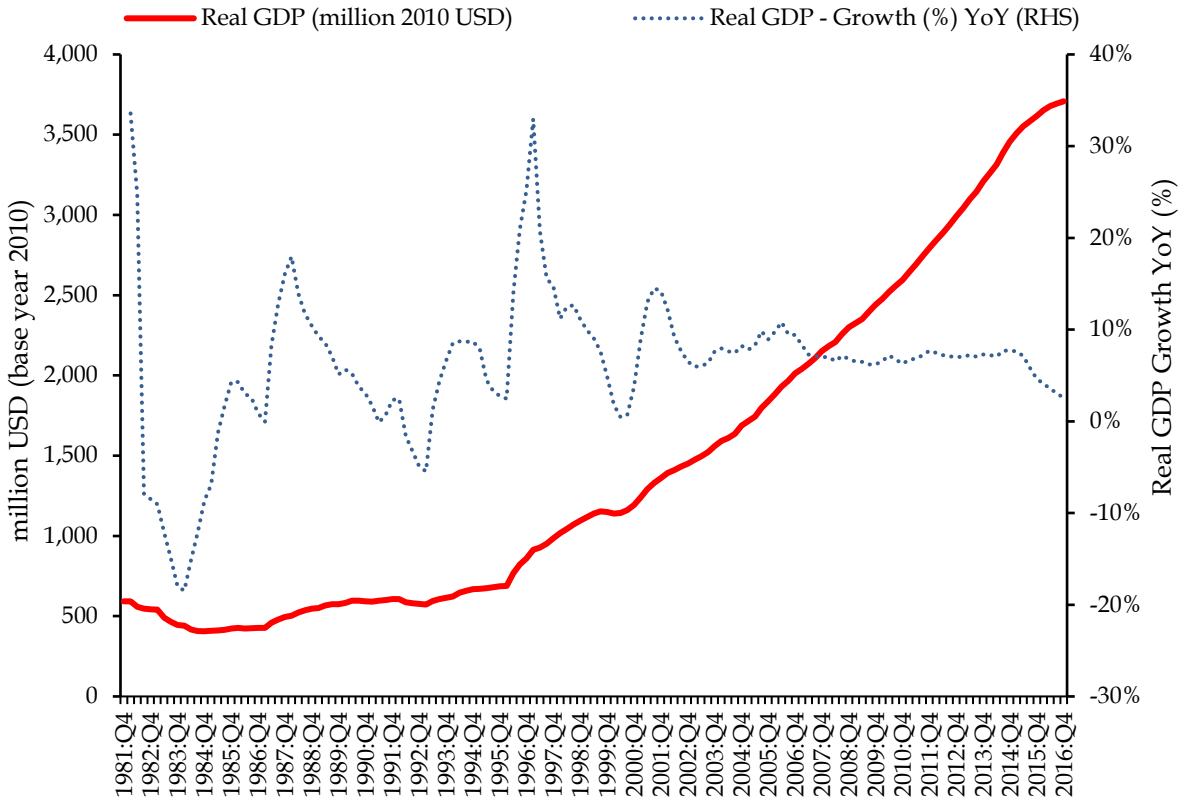


Figure B10: Estimates of Quartery GDP of Rwanda (million USD - Base Year 2010)

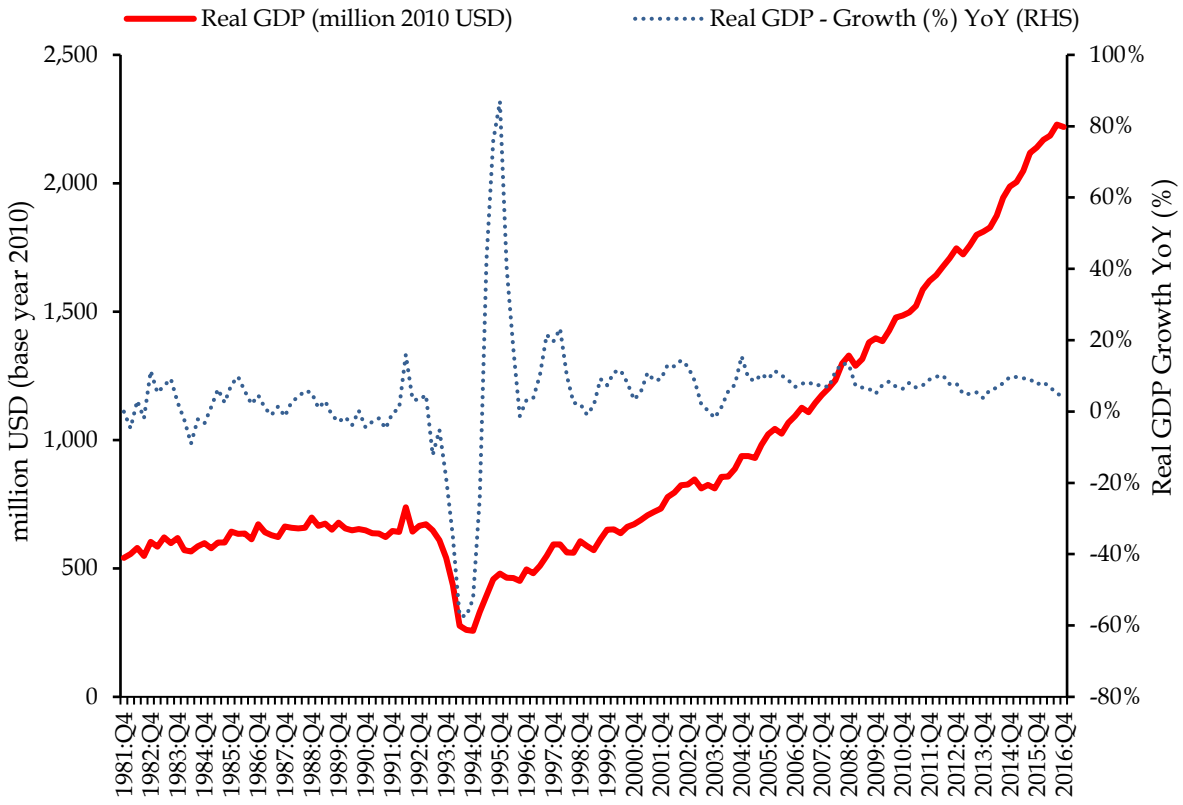


Figure B11: Estimates of Quartery GDP of Uganda (million USD - Base Year 2010)

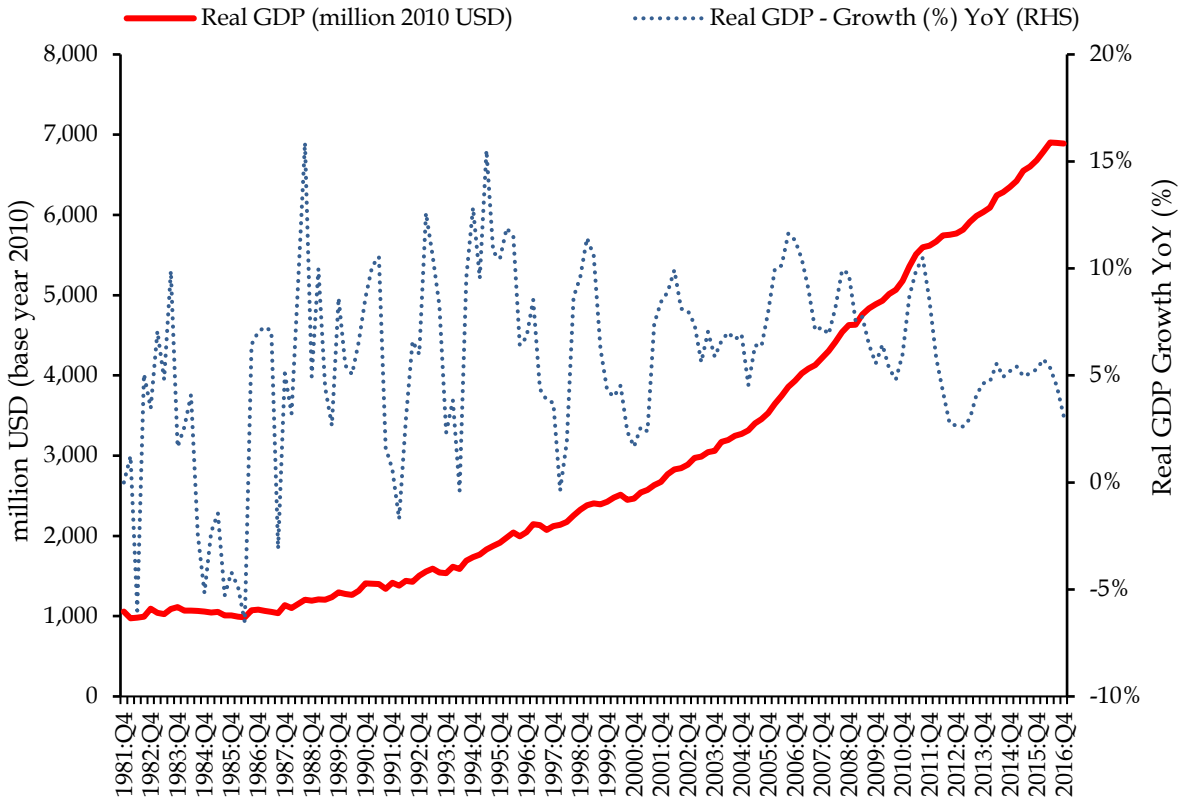


Figure B12: Estimates of Quartery GDP of Zambia (million USD - Base Year 2010)

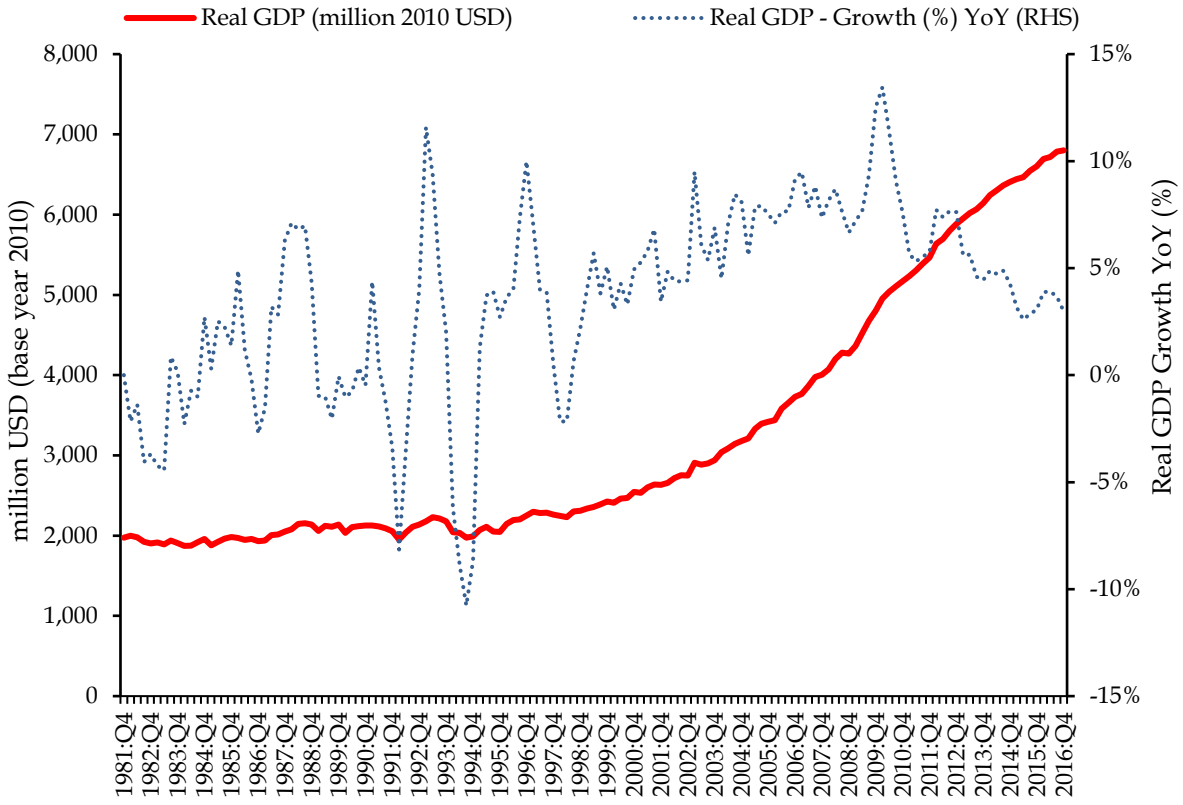
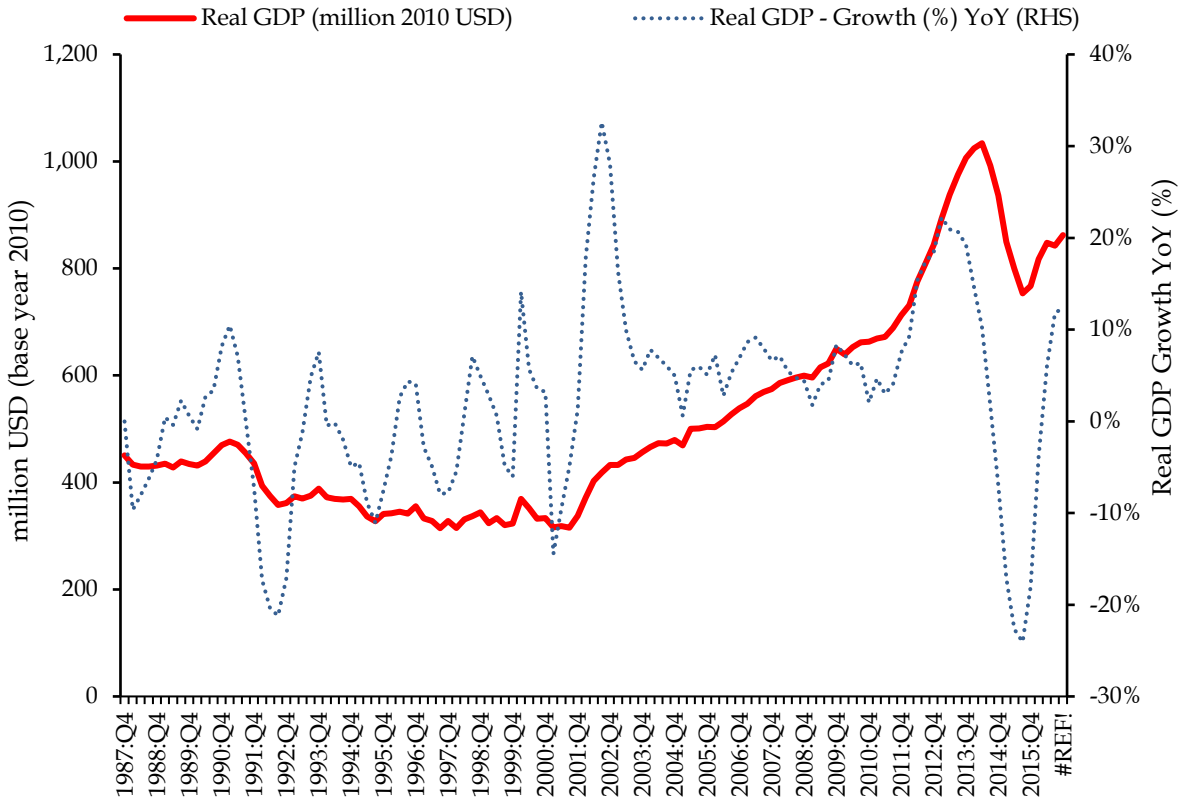
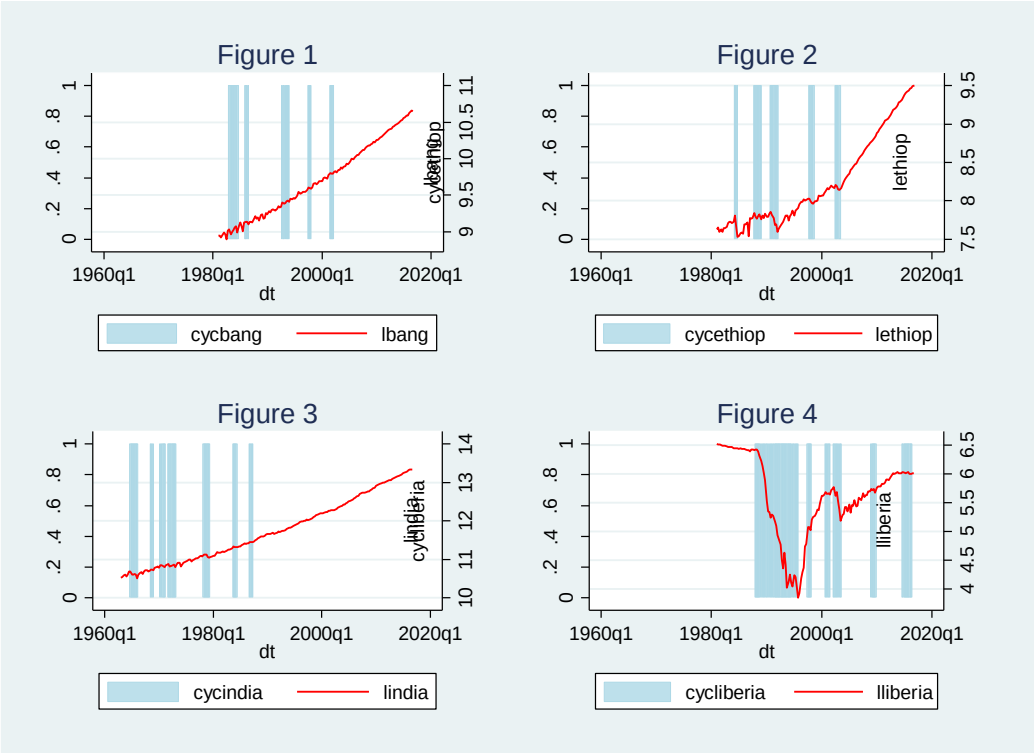
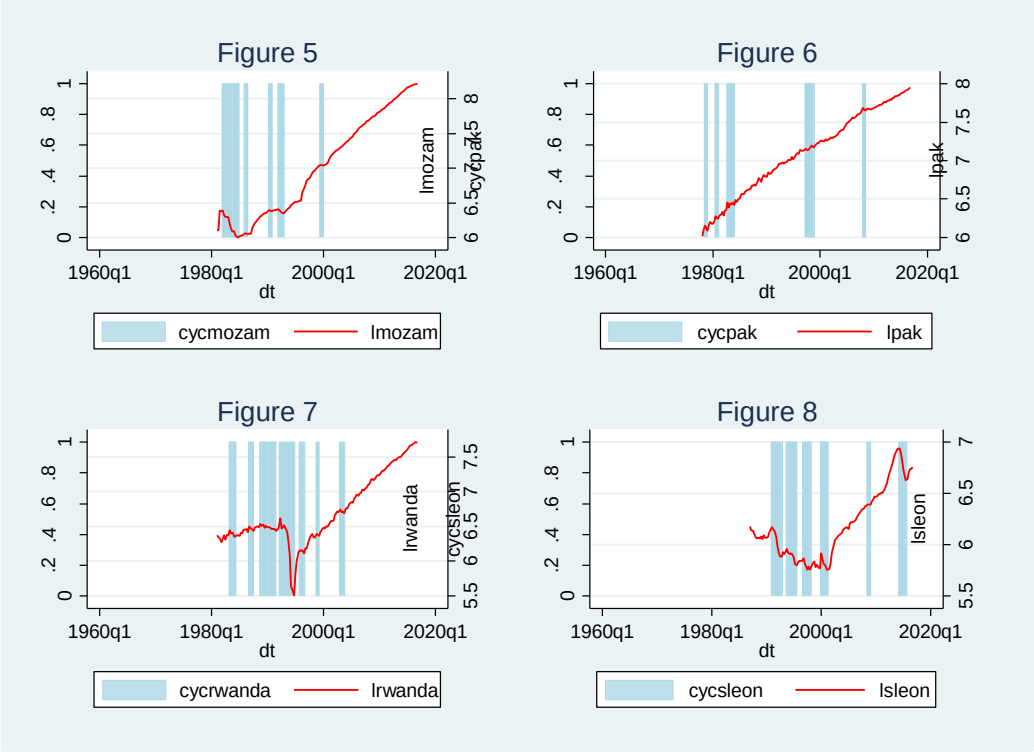


Figure B13: Estimates of Quartery GDP of Sierra Leone (million USD - Base Year 2010)



Annexure C: Business Cycle Dating





Figures C9-C10: Trajectory of Country's GDP and Business Cycles

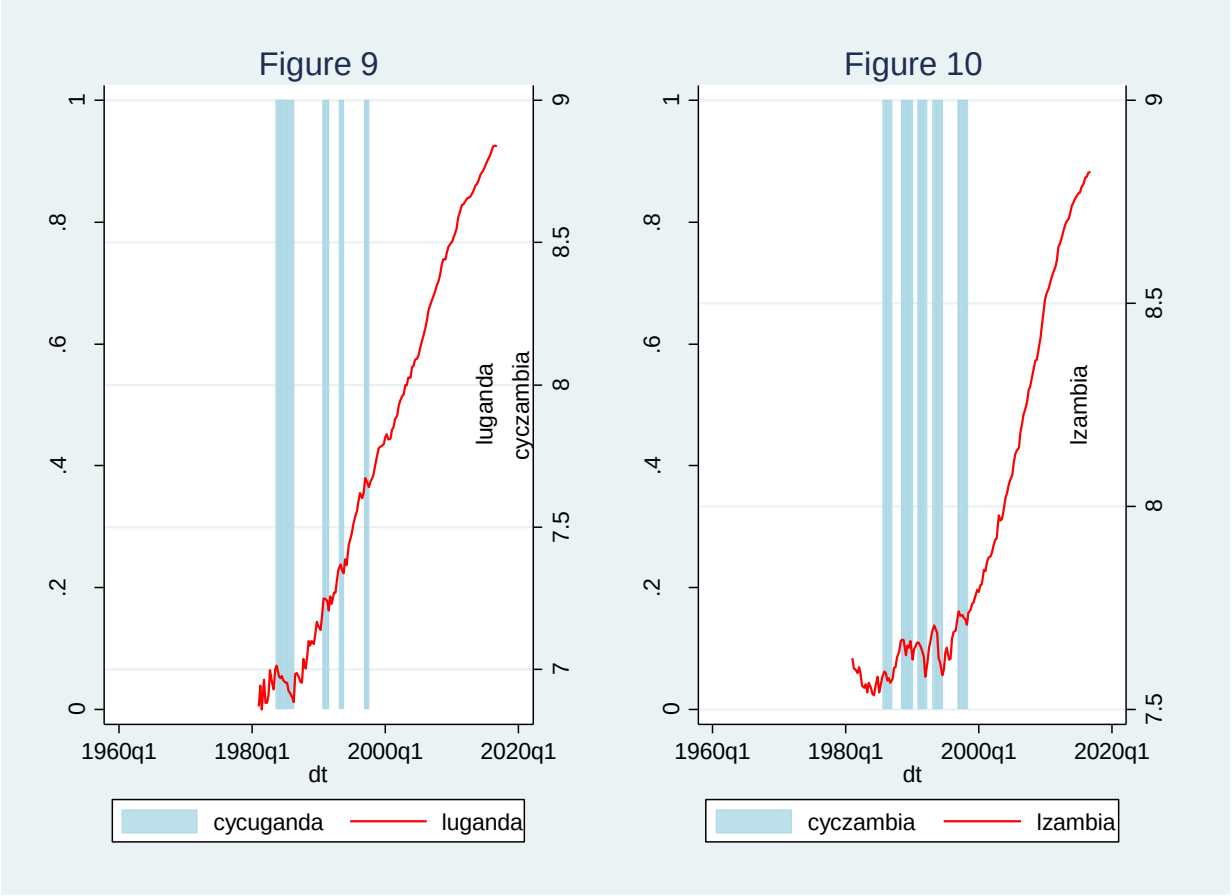


Table C1: Business Cycle Dating for IGC Partner Countries

Peak	Trough
Bangladesh	
Mar-83	Sep-84
Mar-86	Sep-86
Dec-92	Mar-94
Sep-97	Mar-98
Sep-01	Mar-02

Peak	Trough
Ethiopia	
Jun-84	Dec-84
Dec-87	Mar-89
Dec-90	Mar-92
Dec-97	Sep-98
Sep-02	Jun-03

Peak	Trough
India	
Dec-64	Mar-66
Sep-68	Mar-69
Jun-70	Mar-71
Dec-71	Mar-73
Jun-78	Jun-79
Dec-83	Jun-84
Dec-86	Jun-87

Peak	Trough
Liberia	
Mar-88	Dec-95
Sep-97	Mar-98
Dec-00	Sep-01
Jun-02	Sep-03
Mar-09	Dec-09
Dec-14	Jun-16

Peak	Trough
Mozambique	
Mar-82	Dec-84
Mar-86	Sep-86
Jun-90	Dec-90
Mar-92	Mar-93
Sep-99	Mar-00

Pakistan	
Sep-78	Mar-79
Sep-80	Mar-81
Dec-82	Mar-84
Jun-97	Dec-98
Mar-08	Sep-08

Rwanda	
Jun-83	Jun-84
Dec-86	Sep-87
Dec-88	Sep-91
Jun-92	Dec-94
Dec-95	Sep-96
Dec-98	Jun-99
Mar-03	Dec-03

Sierra Leone	
Mar-91	Dec-92
Dec-93	Sep-95
Dec-96	Mar-98
Mar-00	Jun-01
Sep-08	Mar-09
Jun-14	Sep-15

Uganda	
Dec-83	Jun-86
Dec-90	Sep-91
Jun-93	Dec-93
Mar-97	Sep-97

Zambia	
Dec-85	Dec-86
Sep-88	Mar-90
Mar-91	Mar-92
Jun-93	Sep-94
Mar-97	Jun-98

Note: The dates have been determined via Bry & Boschan (1971) algorithm.

Table C2: Country Stylized Facts about Business Cycles

	Contractions		Expansions		Business Cycle		
	Duration	Growth	Duration	Growth	P-to-P	T-to-T	Overall
Banglade	4.40	-0.44	20.33	1.18	19.50	18.50	19.00
Ethiopia	4.60	-3.28	20.17	1.87	19.25	19.50	19.38
India	4.29	-1.54	23.25	1.46	15.67	15.17	15.42
Liberia	9.33	-6.04	12.57	2.15	22.40	17.40	19.90
Mozambi	5.20	-1.81	19.67	2.10	18.50	16.25	17.38
Pakistan	4.40	-0.57	22.33	1.19	30.50	30.50	30.50
Rwanda	6.14	-3.45	12.63	1.75	14.17	14.00	14.08
Sierra Le	6.17	-2.78	11.86	1.46	19.60	19.20	19.40
Uganda	5.25	-1.13	24.60	1.50	18.67	16.00	17.33
Zambia	5.80	-1.10	19.17	1.17	12.25	12.50	12.38

Note: (i) Averages for duration and growth rates. (ii) Duration in quarters and growth rates in percent.

Annexure D: Estimates of Output Gap

Figure B.1: Output Gap Estimates for Pakistan on Quarterly Data Frequency

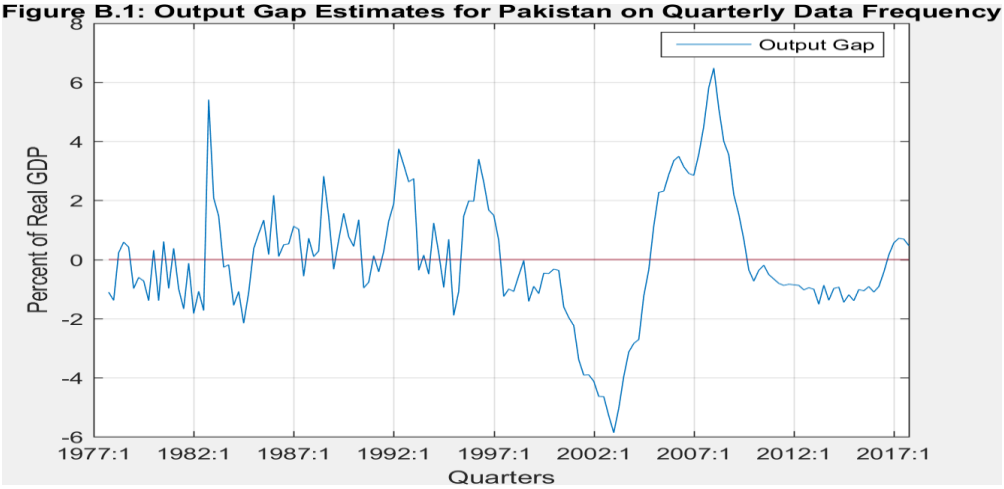


Figure B.2: Output Gap Estimates for India on Quarterly Data Frequency

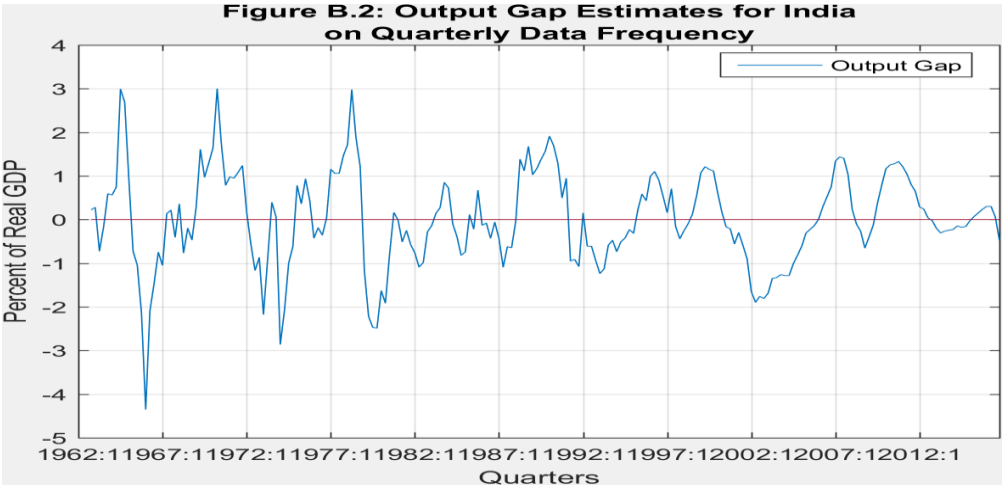
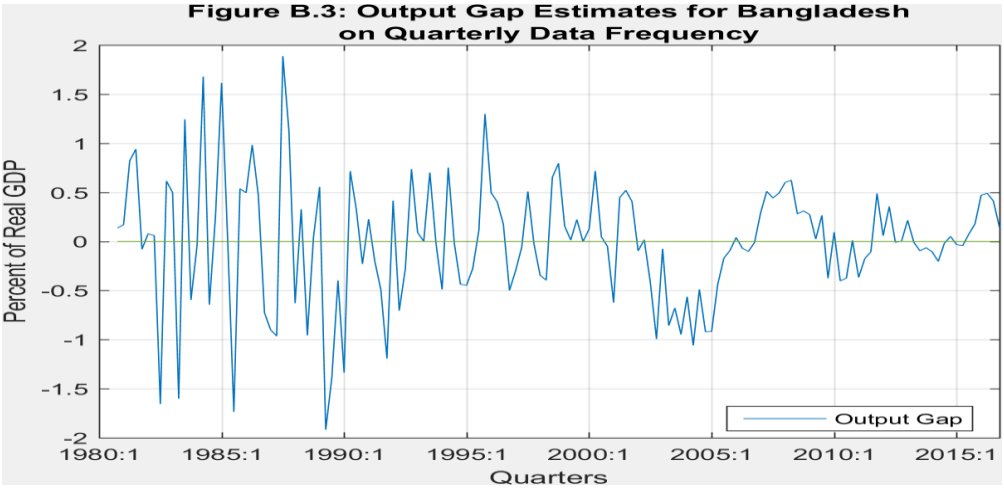


Figure B.3: Output Gap Estimates for Bangladesh on Quarterly Data Frequency



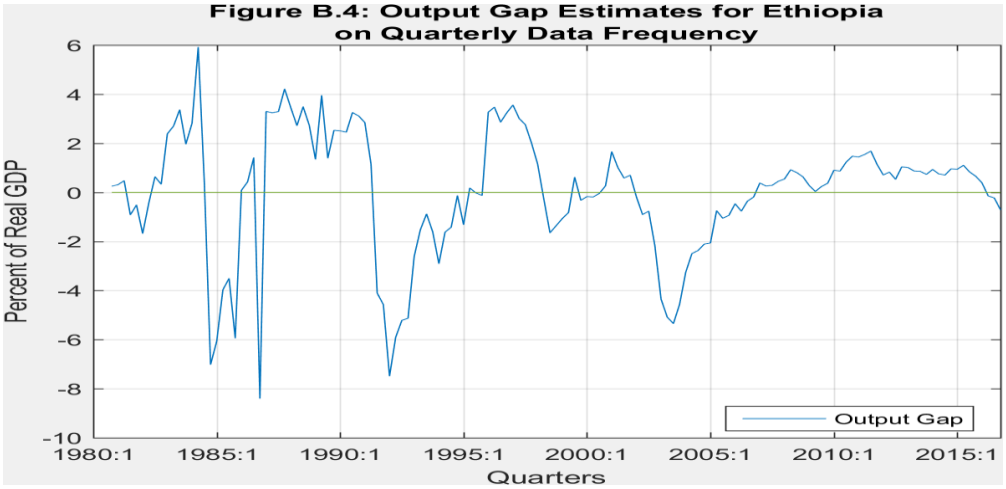


Figure B.4: Output Gap Estimates for Ethiopia
on Quarterly Data Frequency
Percent of Real GDP
Quarters
Output Gap
6
4
2
0
-2
-4
-6
-8
-10
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

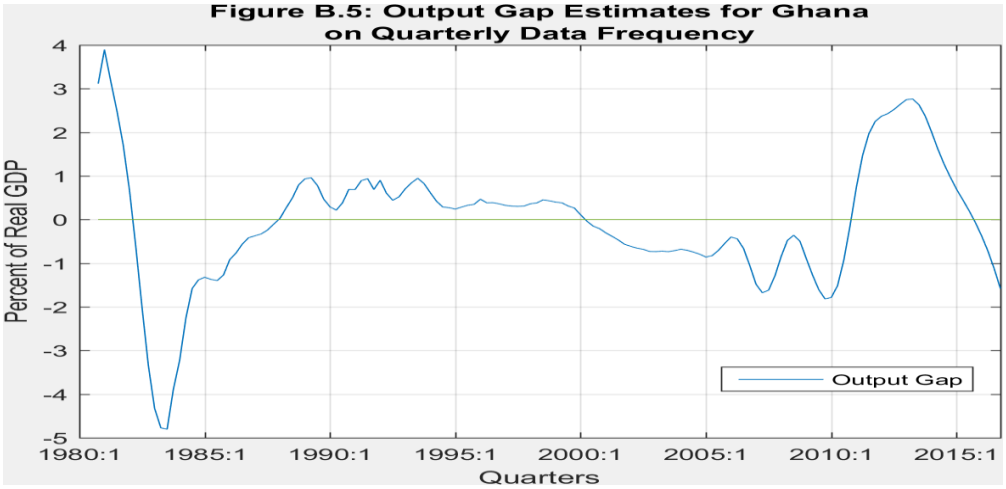


Figure B.5: Output Gap Estimates for Ghana
on Quarterly Data Frequency
Percent of Real GDP
Quarters
Output Gap
4
3
2
1
0
-1
-2
-3
-4
-5
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

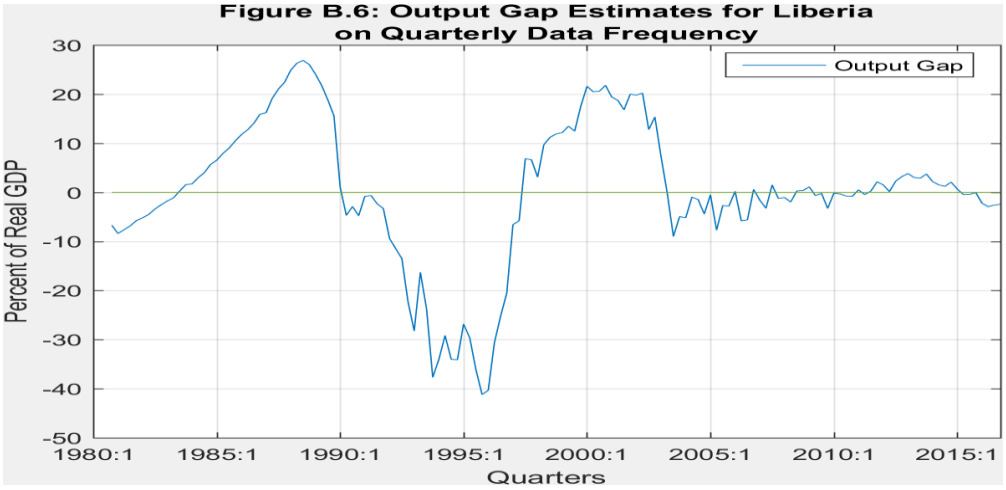


Figure B.6: Output Gap Estimates for Liberia
on Quarterly Data Frequency
Percent of Real GDP
Quarters
Output Gap
30
20
10
0
-10
-20
-30
-40
-50
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

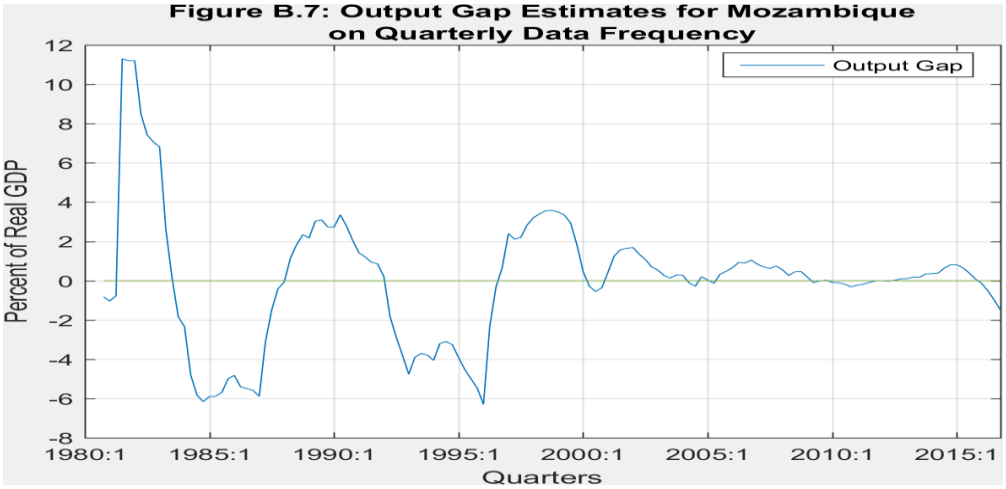


Figure B.7: Output Gap Estimates for Mozambique
on Quarterly Data Frequency
Output Gap
Percent of Real GDP
Quarters
12
10
8
6
4
2
0
-2
-4
-6
-8
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

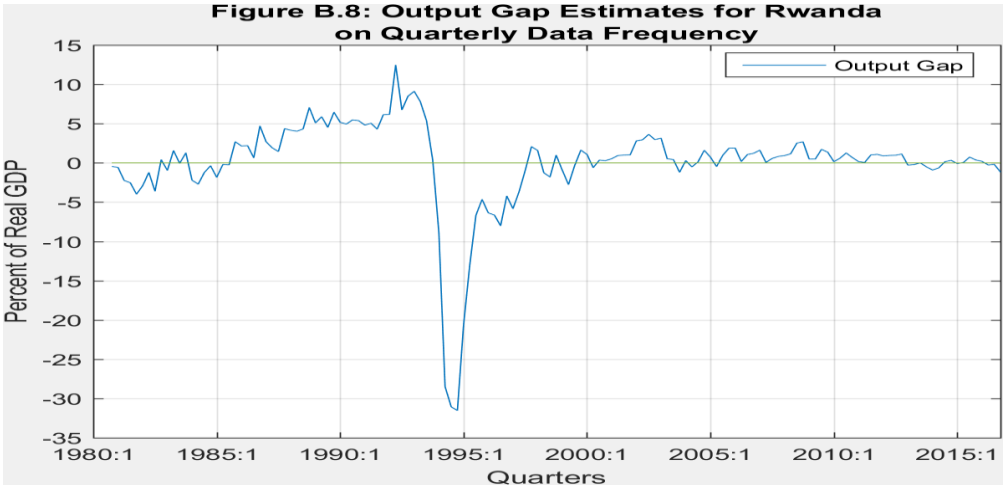


Figure B.8: Output Gap Estimates for Rwanda
on Quarterly Data Frequency
Output Gap
Percent of Real GDP
Quarters
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

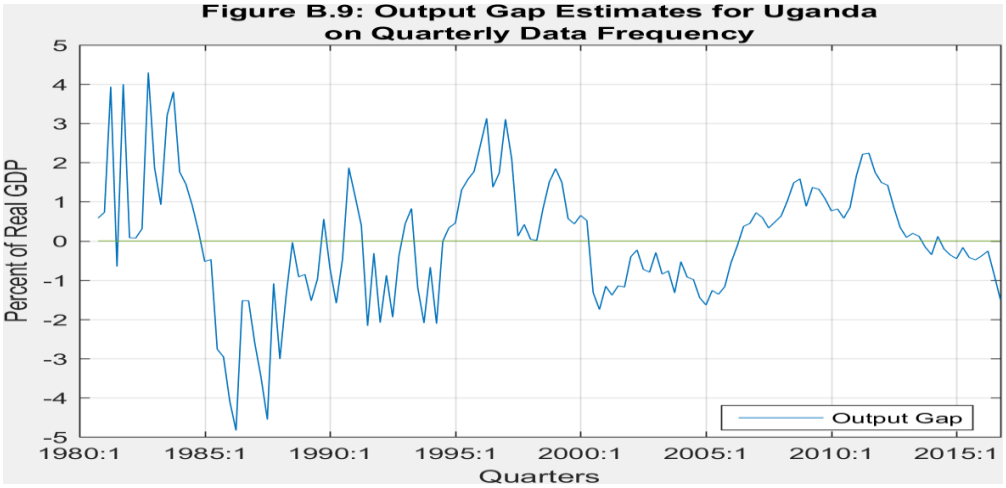


Figure B.9: Output Gap Estimates for Uganda
on Quarterly Data Frequency
Output Gap
Percent of Real GDP
Quarters
5
4
3
2
1
0
-1
-2
-3
-4
-5
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

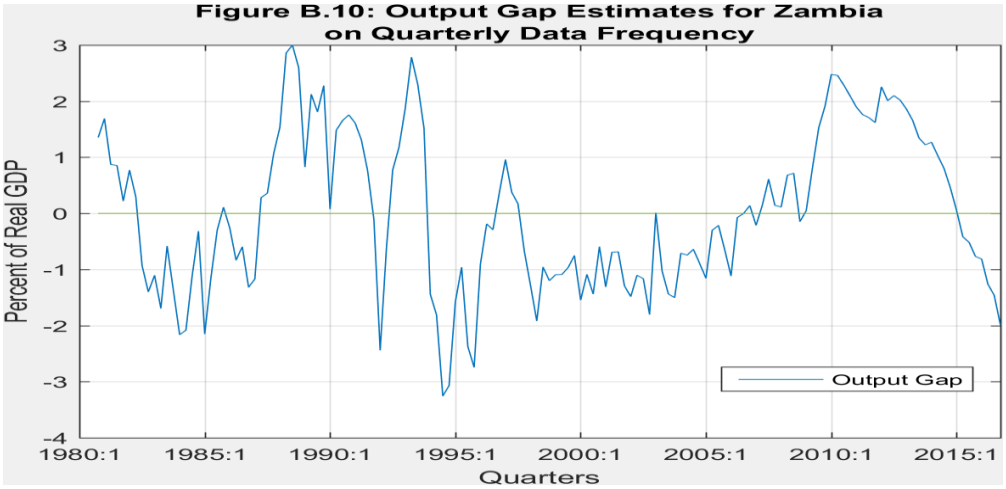


Figure B.10: Output Gap Estimates for Zambia
on Quarterly Data Frequency
Percent of Real GDP
Quarters
Output Gap
3
2
1
0
-1
-2
-3
-4
1980:1
1985:1
1990:1
1995:1
2000:1
2005:1
2010:1
2015:1

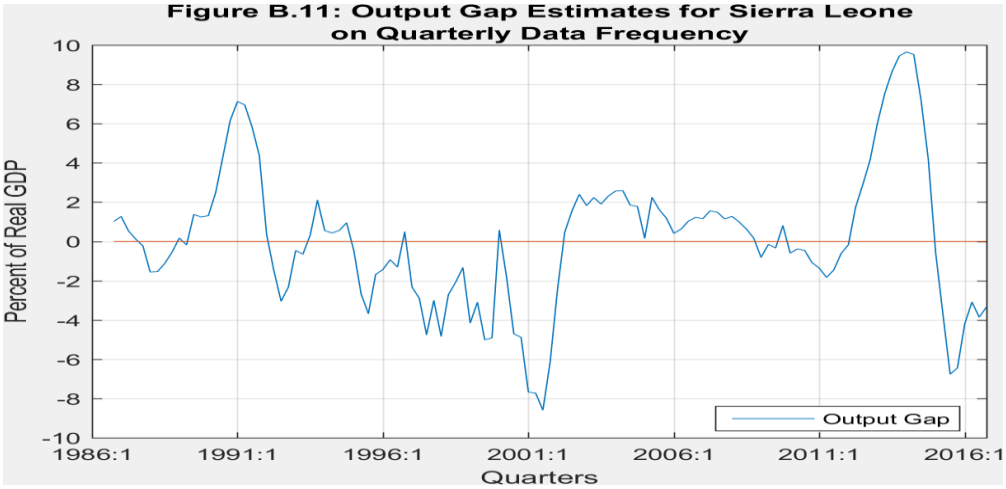


Figure B.11: Output Gap Estimates for Sierra Leone
on Quarterly Data Frequency
Percent of Real GDP
Quarters
Output Gap
10
8
6
4
2
0
-2
-4
-6
-8
-10
1986:1
1991:1
1996:1
2001:1
2006:1
2011:1
2016:1