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Investigating The Relationship Between Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) In Two SAARC Countries: Nepal and Pakistan

Md. Saiful Islam[1] & **Dr. Shaikh Mostak Ahammad**[2]

Abstract

This study examines the matter of trends (level and slope), cycle and irregular components in the Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) of two SAARC (South Asian Association for Regional Cooperation) countries: Nepal and Pakistan. SAARC countries produce GDP (PPP) US$ 9.9 trillion and GDP (Nominal) US$ 2.9 trillion and constitute 9.12% of global economy as of 2015. The mentioned two countries from this region are selected due to their importance in the SAARC region and their challenges during last few decades i.e. Political crisis and natural disasters. In this study the multivariate unobserved components model is used to decompose the GDP and HCE and examine the relationships between these two variables of Nepal and Pakistan. The time period of this study is 1970-2014 and Kushnirs statistical data is employed. The maximum likelihood smoother is employed in the trend plus stochastic cycle methodology of Koopman et al. (2009) to estimate the model. It is found here that there have no deficiencies in the diagnostics of normality, auxiliary, prediction, and forecast. And residual diagnostics also present that it is nicely fitted with this model. Empirical results clearly show that there have strong correlations between the GDP and HCE in irregular components in both the countries of Nepal and Pakistan. Finally, in both slope and cycle, the correlations between GDP and HCE of Nepal and Pakistan are found perfectly positive in the short and long run.

Keywords: GDP, Household Consumption Expenditure, UC Model, SAARC, Economy

[1] **Master of Business Administration (MBA)**, *Department of Accounting, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.*

[2] ***Associate Professor***, *Department of Accounting, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.*

1. Introduction

Gross Domestic Product (GDP) is one of the most widely used measures of an economy's output or production-total values of goods and services produces within a country's borders in a specific time period-monthly, quarterly or annually and Household Consumption Expenditure (HCE) shows how much money people spend on goods and services. So the measurement and relations of GDP and HCE is very important as there have inner relationship between these two variables. GDP is an accurate indication of an economy's size, while GDP per capita has a close correlation with the trend in living standards over time, and the GDP growth rate is probably the single best indicator of economic growth. The GDP is able to give an overall picture of the state of the economy to that of a satellite in space that can survey the weather across an entire continent. GDP enables policymakers and central banks to judge whether the economy is contracting or expanding, whether it needs a boost or restraint and if threat such as recession or inflation looms on the horizon. Similarly HCE is an important economic factor because is usually coincides with the overall household consumer confidence in a nation's economy. High consumer confidence indicators usually relate to higher level of household consumption in the economic market. Consumer confidence provides governments and businesses with an analysis on consumer perception. Businesses can use household consumption data in their supply and demand economic calculations. Supply and demand helps businesses produce goods and services at the most favorable consumer price points. Businesses which can achieve the equilibrium price will sell the maximum amount of goods with the highest available profit margin. Household consumption helps companies determine which products have the most value in their economic marketplace. Businesses can also use information fulfill consumer needs and develop new products.

Consumption is normally the largest GDP component. Many persons judge the economic performance of their country mainly in terms of consumption level and dynamics. GDP is sometimes measured as a sum of all domestic and foreign effective demand for national goods. Household consumption is one of the elements of domestic demand. The other elements are government and firm expenditure. Demand for household consumption is not only attracted by national goods but also by imports, which reduce the GDP sum. An increase in effective demand for household consumption will increase GDP, provided national producers can meet the quality/price requirements of buyers. This is not surprising that household consumption constitutes largest share of GDP. Household consumption is 60% and 70% of GDP in US and Germany respectively. As such the pace at which G7 consumption growth will revive is critical to the speed of world GDP growth. Higher GDP volatility-as recently experienced-is associated with a sizeable reduction in consumption growth.

The South Asian Association for regional Cooperation abbreviated as SAARC was founded in Dhaka on the 8th of December 1985. Its secretariat is based in Kathmandu. Its member states are eight at present including Afghanistan, Bangladesh, Bhutan, India, Nepal, the Maldives, Pakistan and Sri Lanka. It is regional intergovernmental organization and geopolitical union in South Asia aiming to promote development, economics and regional integration among the member countries. It launched the South Asian Free Trade Area abbreviated as SAPTA. SAARC compromises 3% of world's area, 9.12% of the global economy, and 9.21% of world's GDP (PPP) from which the studied two countries Nepal and Pakistan constitutes 0.98% of world GDP. Current study indicates that Nepal has faster economic growth as well as household consumption than Pakistan. As there is a large reservoir of political goodwill between Nepal and Pakistan and they have significant impact on SAARC as well as global economy, it is important to assess the GDP and HCE relationships between these two countries and forecast the future trends of GDP growth and HCE status.

On the basis of this matter, this study examines the relationships between GDP and HCE of Nepal and Pakistan using data from 1970 to 2014. These two SAARC countries have been selected considering the importance, mutual understanding, economic background and growth status over the last few decades. The GDP of these two countries constitute 10.60% of SAARC GDP and 0.98% of world's GDP. Household consumption of these two countries is 60-70% of GDP over the years. The GDP of Pakistan is amounted $982 billion (PPP) and $285 billion (nominal) and ranked 26th PPP and 36th nominal in the world with the growth rate of 4.71% in 2016.The GDP of Nepal is amounted $21 billion (nominal) with a growth rate of 5.1%. The household consumption expenditure of Pakistan is amounted $215 billion and of Nepal is amounted $17 billion which are a large part of the overall expenditure of SAARC countries.

The main objective of this study is to apply the multivariate unobserved components model in examining the relationships between the GDP and HCE of Nepal and Pakistan over the last few decades. The second objective of this study is to find the trend, cycle and irregular components in the GDP and HCE of these two countries. The main objective of using the unobserved components model is that it is a flexible econometric tool that is used to decompose the evaluation of time series data into trends, cycle and irregular components, which is not possible to observe directly from the dataset. Long run direction of the economy is represented by the trends, which is referred as permanent component, the fluctuation of the short run economic activity is represented by the cycle, referred a transitory component. And irregular component shows the nature of the unobserved factor. To forecast for the future is another advantage of the UC model. The outliers and structural breaks can also be investigated by the UC model.

The stochastic characteristics of this model improves traditional interpretations and provides an important econometric tool for performing richer statistical analysis for the evaluation behavior of the relationships between GDP and HCE of Nepal and Pakistan. Besides the literature review shows that a large number of studies are occurred for examining the GDP and HCE relationships and also the using of UC model by various writers. The findings of this study also strengthen the using of structural time series model to the analysis of relationships between GDP and HCE of Nepal and Pakistan.

The remainder of this study is presented as follows. The objectives of the study are discussed in section 2. The literature review of the study is discussed in section 3. Section 4 presents empirical unobserved components model in a long run trend, short run deviation (cycle) and irregular components. Section 5 details the details data used this study. Section 6 reports the empirical results of the study. Section 7 reports about discussion of the study. Finally, Section 8 describes the conclusions of the study.

2. Objective of the study

The main objective of the study is to apply multivariate unobserved components model in examining the relationships between Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) and their interdependencies to each other in an economy. Other objectives of the study are to find out and understand certain things about the relationships between Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE). These include the following:

a) To find out the trend, cycle and irregular components in GDP and HCE over the studied period of Nepal and Pakistan.
b) To test the prediction of GDP and HCE in upcoming years based on the current and past situations and forecast GDP and HCE.
c) To know the correlation between GDP and HCE over the period of time.
d) To measure the impact of HCE on GDP as the largest part.
e) To check whether any deficiency is existed in the diagnostic of normality, auxiliary, prediction and forecast.

3. Literature Review

Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) are important elements of the economy of a country. Significant contributions by GDP and HCE to the economy have been seen and a relationship is existed between these two things as they are changing in nature. HCE changing and other house related activities are estimated to account 50-80% of GDP in a country. There have a significant number of investigations on the relationship between GDP and HCE in Nepal and Pakistan. For example, Tapsin and Hepsag (2014) studied about the household consumption expenditure and stated that household consumption expenditures are primary indicators of economy well-being. In also constitutes two third of the gross domestic product. Consumption theories are also analyzed by Keynes' absolute income hypothesis, Friedman's permanent income hypothesis (1957), Modigliani and Brumberg's life cycle income hypothesis (1950), Dusenberry's relative income hypothesis (1949). Bastagli and Hills (2013) observed household consumption patterns and dictates total potential consumption relating to economic growth. Crossley et al. (2009) conducted a research on household consumption through recessions and provided their observation that the household consumption have been affected by the recessions and lower GDP. Household consumption is both the largest component of GDP and the component most immediately connected to the welfare to individuals and households. Anghelache (2011) states about the correlation between GDP and the final consumption. It states that the evolution of the GDP is highly influenced by the evolution of the HCE. Ceritoglu (2013) states about the household expectations and household consumption expenditures. According to this paper the household expectations have a direct role on their consumption and saving behavior in addition to their indirect influence through the income channel.

A significant number of studies use Unobserved Components (UC) Model to capture the permanent components (Trend) and transitory components (cycle) from the time series data. For example Brintha et al. (2014) conducted an investigation relating to annual national coconut production in Sri Lanka. The reason of accepting UC model by them was that the UC model does not make use of the stationary assumption. Besides it breaks down response series into components such as trends, cycles and regression effects which could be useful especially in forecasting the production of perennial crops. Ferrara and Koopman (2010) conducted a research on common business and housing market cycles in the euro area. They used unobserved components model here considering the fact that it is able to assess the common euro area housing cycle to evaluate its relationship with the economic cycle.

Carvalho et al. (2005) conducted a research on convergence in the trends and cycles in the euro-zone income. It stated that multivariate UC time series model are fitted to annual post war observations on real time per capita in countries in the euro-zone. Leamer (2007) pointed out that by using the contributions to GDP growth during the 8 phases of recession covering the whole period, the business cycle is in fact a consumer cycle mainly driven by residential investment. Consequently the author argues that residential investment can be seen as an early warning of oncoming recession. Carvalho and Harvey (2005) conducted a research on growth, cycles and convergence in the US regional time series and stated here that the UC time series model is fitted on the real income per capita in eight regions of the United States. Villamoran (2007) conducted a research on multivariate data analysis. Sinclair and Mitra (2008) studied about output fluctuation in G-7 using UC model successfully.

The world bank states that Household Consumption Expenditure (Formerly private consumption) is the market value of all goods and services including durable products (Such as cars, washing machines, and home computers) purchased by households. It excludes purchases of dwellings but includes inputted rent for owner occupied dwellings. It also includes payments and fees to governments to obtain permit and licenses. Here Household Consumption Expenditure includes the expenditures of nonprofit institutions serving households, even when reported separately by the country. This item also includes any statistical discrepancy in the use of resources relative to supply of resources. We have been experiencing from various studies that the increase in GDP of Nepal results in increased household consumption. The GDP of the country has increased significantly in the urban areas. This in turn leads to an increased demand for the household which further has increased the household consumption expenditure. It is believed that the GDP growth has a direct relation with the household consumption along with various other factors which result in the appreciation of the household consumption. The researches show that GDP value of Nepal represents 0.03% of the world economy. GDP of Nepal averaged 5.12 USD Billion from 1960 until 2015, reaching an all-time high of 20.88 USD billion in 2015 and a record low of 0.50 US Billion in 1963. Over the past 39 years the value of HCE has fluctuated greatly and in relation to the trend of GDP. A significant researches show that Pakistan will most likely miss its projected GDP growth rate of 5.1% and it is reflected in the household consumption also as it increases slowly and sometimes falls. Evidences show that household consumption is an important and growing sector in Pakistan. Pakistan spends 202 billion dollars on household consumption in a year. Pakistan Bureau of Statistics states that housing accounts for approximately 70%-80% of GDP and its growing over the years as the growing need for urban planning. So we have been experiencing a positive relationship between GDP and HCE in Pakistan also. Thus having almost same circumstances in the two mentioned areas, the relationship between GDP and HCE has been seen same. A positive relationship is existed here and the researches show that also. So this study intends to observe the relationship between GDP and HCE in two SAARC countries Nepal and Pakistan using multivariate unobserved components model.

4. Empirical Models

This study is about the relationship between Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) in two SAARC countries-Nepal and Pakistan-by using a multivariate UC model as described in some mentioned studies such as Brintha et al (2014), Ferrara and Koopman (2010) and Leamer (2007).

The used multivariate UC model that disintegrates GDP and HCE into trends (μ_t) which is the long run component in the series and indicates the general direction in which the series are moving, cycles and interventions (w_t) is given bellow:

$Y_t=\mu_t+\psi_t+\Lambda w_1+\varepsilon_t \varepsilon_t \sim NID\ (0, \sum_{\varepsilon})$t=1,………..,T, (1)

With the variables of log GDP and HCE that was obtained from time series observations, here, y_t is a 2x1 vector corresponding to the countries Nepal GDP (lgdpn) and Pakistan GDP (lgdpp)and Nepal HCE (lhcen) and Pakistan HCE (lhcep), with t=1 for 1970 and t=T=45 for 2014. $\mu_t$is a 2x1 vector representing smooth trend component, ψ_t denotes 2x1 vector of the stochastic cycle component, and ε_t denotes 2x1 vector of the unobserved irregular component term, which is normally distributed with a mean of 0 and 2×2 covariance matrix $\sum\varepsilon$.

The smooth trend μ_t component in y_t is defined bellow:

$\mu_1=\mu_{t-1}+\beta_{t-1}+\eta_1 \eta_t \sim NID(0, \sum\eta)$, t=1,………,T, (2)

$\beta_t=\beta_{t-1}+\xi_t \xi_t \sim NID\ (0, \sum_{\xi}\ )$ t=1,……….,T, (3)

Where, the slope of the trend component (μ_t) is β_t, which is a 2x1 vector with t=1 for 1970 and t=T=45 for 2014. The level disturbance η_t and the slope disturbance ξ_t are uncorrelated with each other. Each of the $\sum\eta$ and $\sum\xi$ is a 2x2 covariance matrix. When $\sum\eta$ is not 0 but $\sum\xi$ is 0 y_t is called a "random walk plus drift"; however a deterministic linear trend is generated when $\sum\eta$ and $\sum\xi$ are both 0. When $\sum\eta$ is 0 but $\sum\xi$ is not 0, the trend is called a "smooth trend". This model is often referred to as the integrated random walk (IRW). In this chapter the integrated random walk (IRW) smoother is applied. Stated from Carvalho and Harvey (2005), this model often allows a clearer separation into trend and cycle.

The short term movement has been represented by multivariate cyclical component and is defined as follows:

$$\begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix} = \left\{ \rho \begin{bmatrix} \cos\lambda_c \sin\lambda_c \\ -\sin\lambda_c \cos\lambda_c \end{bmatrix} \otimes I_n \right\} \begin{bmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{bmatrix} + \begin{bmatrix} k_t \\ k_t^* \end{bmatrix}, \qquad t=1,\ldots\ldots,T, \qquad (4)$$

Where ψ_t and ψ_t^* are cyclical components of 2x1 vectors with t=1 for 1970 and t=T=45 for 2014, and κ_t and κ_t^* are 2x1 vectors of disturbances i.e.

$$E(k_t k_t^{'}) = E(k_t^* k_t^{*'}) = \sum_k \qquad \text{and} \qquad E(k_t^* k_t^{*'}) = 0 \qquad (5)$$

Here, $\sum_k$ is a 2x2 covariance matrix. The fluctuations of cycles are defined by the cyclical frequency λ_c which will satisfy $0 \leq \lambda_c \leq \pi$. The dumping factor on the cycle amplitude is ρ which satisfies $0 \leq \rho < 1$. The period related to frequency is important nature of the cycle. The period of the cycle is given as $2\pi/\lambda_c$. Here one stochastic cycle is considered. The covariance matrix of ψ_t is given by:

$$\sum_\psi = (1-\rho^2)^{-1} \sum_k \qquad (6)$$

In equation 1.1, to capture outlier and structural breaks, intervention dummies have been used by including w_t, which is a 2x1 vector of interventions. Parameter matrix Λ could specify some elements to zero that denote particular equations can produce certain variables. Here, an outlier is a temporary event of irregular disturbance which is structured by taking the value of 1 at the time of the outlier, and zero otherwise. A structural break is a permanent change in the level of the time series which shifts it up or down permanently.

By using the maximum likelihood (exact score) approach, the measurement of the unobserved components model can be formulated. At the time of making the estimation the fitted model will be checked for serial correlation, normality and heteroskedasticity by using standard time series diagnostics. Also to detect any deficiencies of this model, graphs of residual diagnostics, auxiliary residuals, prediction tests and forecasting are used.

5. Data

The used dataset is yearly data on the logarithm of the Gross Domestic Product of Nepal (lgdpn) and Pakistan (lgdpp) and logarithm of the Household Consumption Expenditure of Nepal (lhcen) and Pakistan (lhcep) from 1970-2014. It was obtained from the Kushnirs statistical dataset (http://www.kushnirs.org).

The GDP of Nepal (lgdpn) showed an upward trend smoothly with little fluctuations before reaching the highest point in 2014 and HCE of Nepal (lhcen) showed an upward trend with no outlier before reaching the highest point in 2010. The GDP of Pakistan (lgdpp) showed an upward trend with some fluctuations and HCE of Pakistan (lhcep) showed same trend with a level break in 1987 before reaching the highest point in 2014.

6. Empirical Results

Using the maximum likelihood approach models (1.1) and (1.7) can be used as mentioned in Harvey (1989). Using a smoothing algorithm, the smooth trend and the stochastic cycle components can be extracted as mentioned in Koopman (1992). The empirical results obtained by using the STAMP 8.2 package of Koopman et al. (2009) indicate strong convergence.

Table 1 reports some diagnostics and goodness-of-fit statistics such as N (x_2^2) (the normality test following a χ^2 distribution with two degrees of freedom), H_{14} ($F_{14, 14}$) (the heteroskedasticity) test following an F distribution with (14, 14) degrees of freedom, Q(10, 5)(the Ljung Box statistics based on the first 10 autocorrelations, which is tested against a χ^2distribution with five degrees of freedom), and Rd^2 (coefficient of determination). The mentioned statistics do not show any deficiencies in the estimated model.

Table 1: Diagnostics and goodness-of-fit statistics

Statistics	lgdpn	lhcen	lgdpp	lhcep
N (x_2^2)	1.2782 (0.5278)	0.93718 (0.6259)	12.576 (0.0019)	13.304 (0.0013)
H_{14} ($F_{14,14}$)	1.1353 (0.4078)	1.0838 (0.4412)	0.17016 (0.9990)	0.13716 (0.9997)
Q (10, 5)	7.0742 (0.2152)	10.038 (0.0742)	7.7388 (0.1712)	10.064 (0.0734)
Rd^2	-0.54423	-0.44919	0.014075	0.056376

Note: Values in parenthesis are p-values

Additional information about the estimated model is presented in Figure 1 and 2 such as graphs of the standardized residuals and the spectral density. The residuals are standardized one-step ahead prediction errors or innovations (Koopman et al. 1999), and they are assumed to be normally and independently distributed for a correctly-specified model. The statistics referred in table 1 and the residual graphs presented in Figure 1 and 2 are used to check the validity of the model.

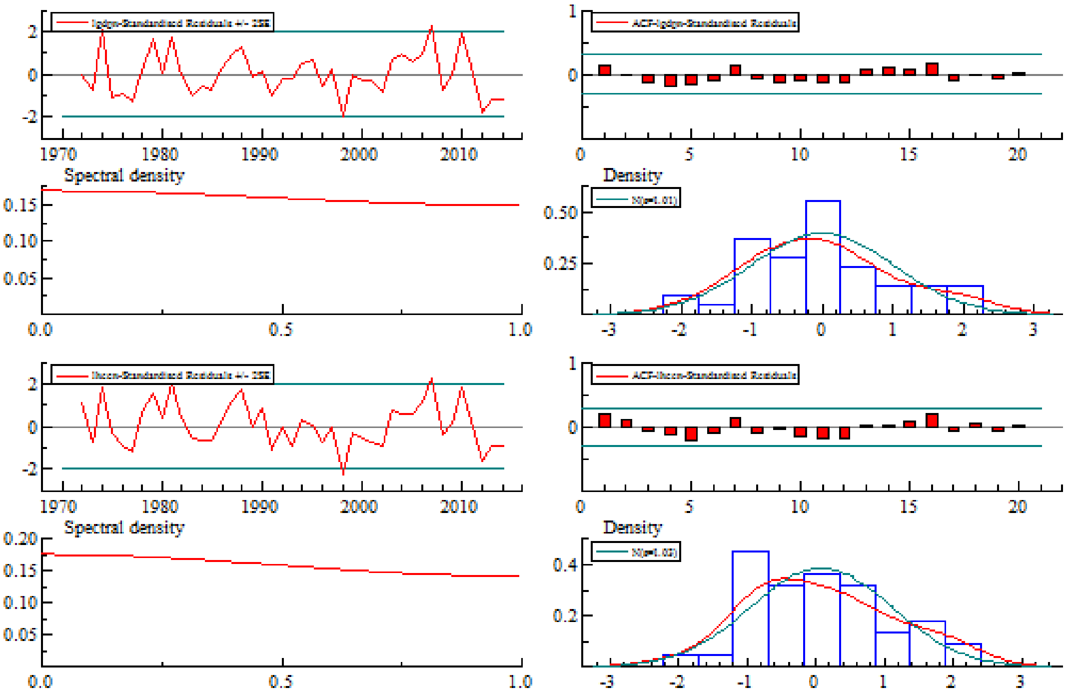

Figure 1: Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) index residuals (Nepal)

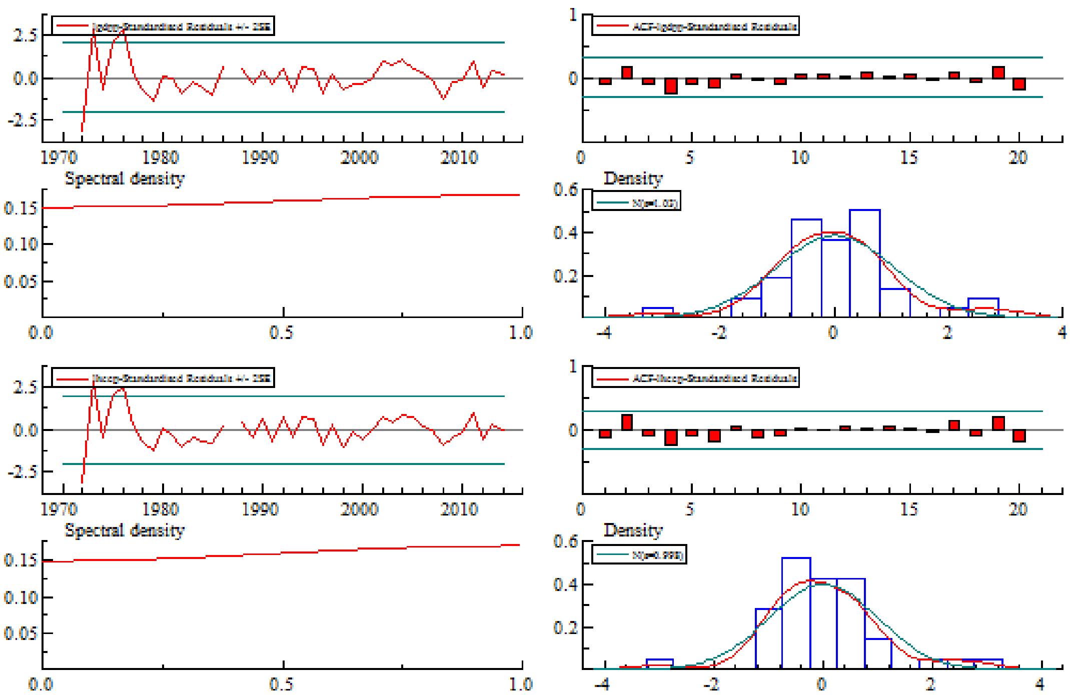

Figure 2: Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) index residuals (Pakistan)

Figure 3 and 4 presents the decomposed components of the structural time series model for trends (Level and Slope) and for cycle. A deeper look of cycle in Figure 3 and 4 indicates that cyclical activities of lgdpn, lhcen, lgdpp and lhcep in cycle are firstly increase and then fluctuating year by year.

As shown in Table 2 the q ratio in the level and slope of all variables is 0, since it is deterministic. The q ratio of slope of lhcen is also 0 indicating that most of the variations of this variable are coming from cycle and irregular. In the case of lgdpn, most of the variations are coming from irregular component, followed by slope and cycle. The q-ratios of lgdpp indicate that most of the variations are coming from irregular component, followed by slope and cycle. And q-ratios of lhcen indicate that most of the variations are coming from irregular component, followed by cycle component. In case of lhcep, most of the variations are coming from irregular component, followed by slope and cycle. Furthermore, the q-ratios of the variables under considerations indicate that fluctuations in the irregular components are the most important sources of variations. The irregular components are due to unpredictable short-term fluctuations brought on by events such as unpredicted political unrest, economic recession, changing social attitudes towards household consumptions, Debt overhang, and change in economic policies, among others. The unexpected events might pay a pivotal role in the variation of the GDP and HCE of Nepal and Pakistan as natural disasters, financial disasters, changes in government, political strike, sometimes takes place in these countries.

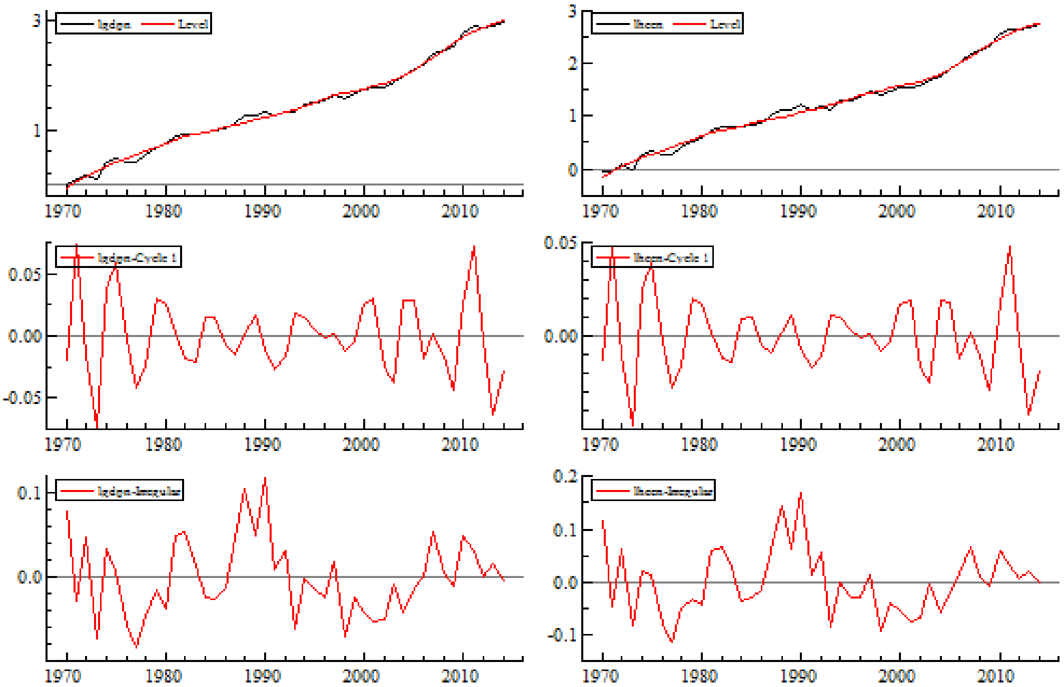

Figure 3: Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) index decomposition (Nepal)

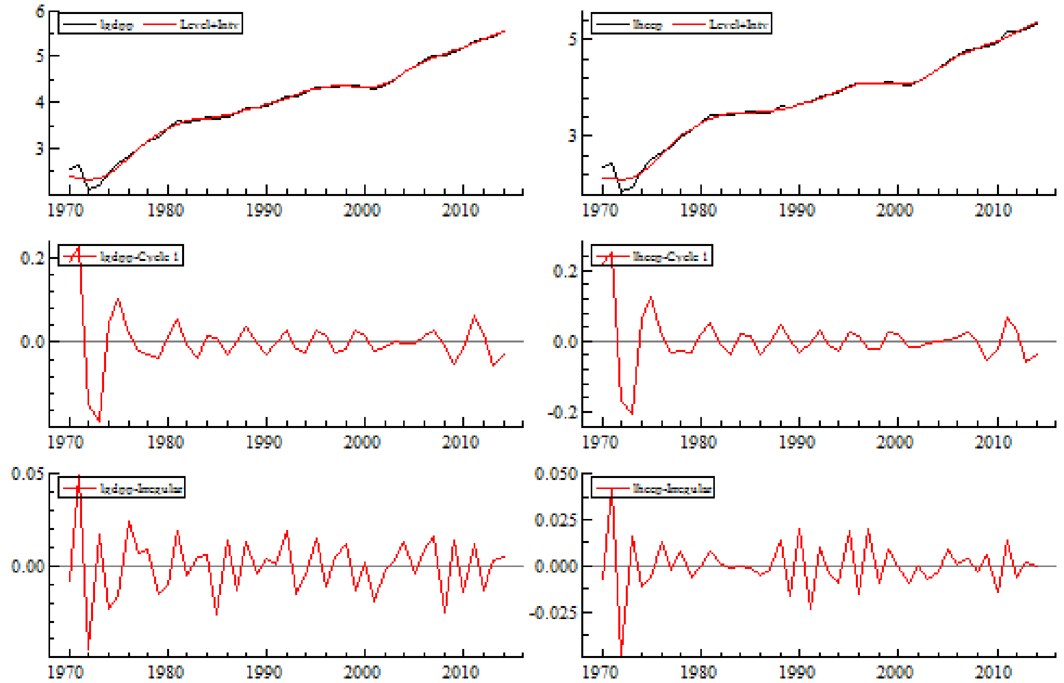

Figure 4: Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) index decomposition (Pakistan)

Table 2: Variance of disturbances: values and q-ratio (Nepal)

Variance of disturbances	lgdpn	lhcen
Level	0.000000 (0.0000)	0.000000 (0.0000)
Slope	0.000401176 (0.2167)	0.000000 (0.0000)
Cycle	0.000128242 (0.06928)	4.97685e-007 (0.0002689)
Irregular	0.00185098 (1.000)	8.97226e-005 (0.04847)

Variance of disturbances: values and q-ratio (Pakistan)

Variance of disturbances	lgdpp	lhcep
Level	0.000000 (0.0000)	0.000000 (0.0000)
Slope	0.00240672 (2.736)	2.06324e-005 (0.02346)
Cycle	0.000318658 (0.3623)	7.55118e-006 (0.008585)
Irregular	0.000879620 (1.000)	0.000172400 (0.1960)

Note: Values in parentheses are the q-ratio. q ratio is the ratio of each variance to the largest

Table 3: Parameters of cycle

Parameters	Nepal (Values)	Pakistan (Values)
Number of order (n)	2	2
Period ($2\pi / \lambda_c$) in years	4.40822	4.29134
Frequency (λ_c)	1.42533	1.46416
Dumping factor (ρ_ψ)	0.66866	0.77723

Table 4: State vector analysis in the final state at time 2014 (Nepal)

	lgdpn	lhcen
Level	3.00299 [0.00]	2.74556 [0.00]
Slope	0.05448 [0.08]	0.05159 [0.08]
Cycle amplitude	0.04877	0.03203

Note: Values in brackets are p-values

State vector analysis in the final state at time 2014 (Pakistan)

	lgdpn	lhcen
Level	5.54940 [0.00]	5.41802 [0.00]
Slope	0.09589 [0.16]	0.09834 [0.16]
Cycle amplitude	0.05477	0.05477
Interventions		
		Level break 1987
Coefficient		-0.07243 [0.00064]

Note: Values in brackets are p-values

Table 3 presents descriptive information on the cyclical parameters of the model. The results show that the cycle has a period of 4.41 years (Nepal) and 4.29 years (Pakistan) and a dumping factor of 0.669 (Nepal), 0.777(Pakistan). These findings indicate that the cycle exhibits a high degree of persistence, and that the series are stationary, since the dumping factor of cycle is less than 1 in both countries.

Table 4 reports the maximum likelihood estimates of the final state vector and intervention dummies.

The level values of lgdpn and lgdpp are 3.00299, 5.54940 respectively, which are statistically significant, while the anti-log analysis of the levels produces the values of 20.15 and 202.98 respectively. And the level values of lhcen and lhcep are 2.74556 and 5.41802 respectively, while the anti-log analysis of the levels produces the values of 15.57 and 162.91 respectively. The slope yields a yearly growth rate of about 5.44 and 9.59% for lgdpn and lgdpp respectively and 5.16 and 9.83% for lhcen and lhcep respectively. The growth rate of both countries is statistically significant. It is also observed that the amplitude of cycle as a percentage of the trend is 4.88 and 5.48% for lgdpn and lgdpp respectively and 3.20 and 5.48% for lhcei and lhcep respectively.

Pakistan's high growth rate might be the initiatives taken by the Pakistan government such as strong service sector, concentrating on manufacturing and agriculture sector, effective planning by the concerned authority and removing corruption and mismanagement in a better way than Nepal. The amplitude of cycle as a percentage of the trend for Pakistan indicates that Pakistan takes more time to respond against the short run shocks of gross domestic product and household consumption expenditure than Nepal and also it takes more time to come closer to the equilibrium level.

Table 5: Normality test (χ^2 test) for auxiliary residuals: irregular, level and slope (Nepal)

	Lgdpn			lhcen		
	Irregular	Level	Slope	Irregular	Level	Slope
Skewness	0.79343	5.0452	0.12087	1.7183	4.6175	0.12322
	(0.37)	(0.02)	(0.73)	(0.19)	(0.03)	(0.73)
Kurtosis	0.12891	0.52337	0.086676	0.15595	0.69642	0.077161
	(0.72)	(0.47)	(0.77)	(0.69)	(0.40)	(0.78)
Bowman-	0.92234	5.5686	0.20754	1.8743	5.314	0.20039
Shenton	(0.63)	(0.06)	(0.90)	(0.39)	(0.07)	(0.90)

Normality test (χ^2 test) for auxiliary residuals: irregular, level and slope (Pakistan)

	Lgdpp			lhcep		
	Irregular	Level	Slope	Irregular	Level	Slope
Skewness	0.33235	0.10068	4.4279	0.054125	0.12259	5.2559
	(0.56)	(0.75)	(0.04)	(0.82)	(0.73)	(0.02)
Kurtosis	0.60622	0.95109	0.038936	0.30302	1.0674	0.00040836
	(0.44)	(0.33)	(0.84)	(0.58)	(0.30)	(0.98)
Bowman-	0.93857	1.0518	4.4669	0.35714	1.19	5.2563
Shenton	(0.63)	(0.59)	(0.11)	(0.84)	(0.55)	(0.07)

Note: Values in parentheses are p-values

Table 5 presents the diagnostic test statistics of the auxiliary residuals that are smoothed estimates of irregular, level and slope disturbances. These statistics show that, in general, the auxiliary residuals behave well.

The graphs of the t-values of corresponding estimated auxiliary residuals are reported in Figure 5 and 6.

The interventions presented in Table 4 are negative and statistically significant and capture decreases in GDP and HCE. In particular, the 1987 level breaks corresponding to Pakistan indicates a decrease in the country's household consumption expenditure (lhcep) as a result of operation

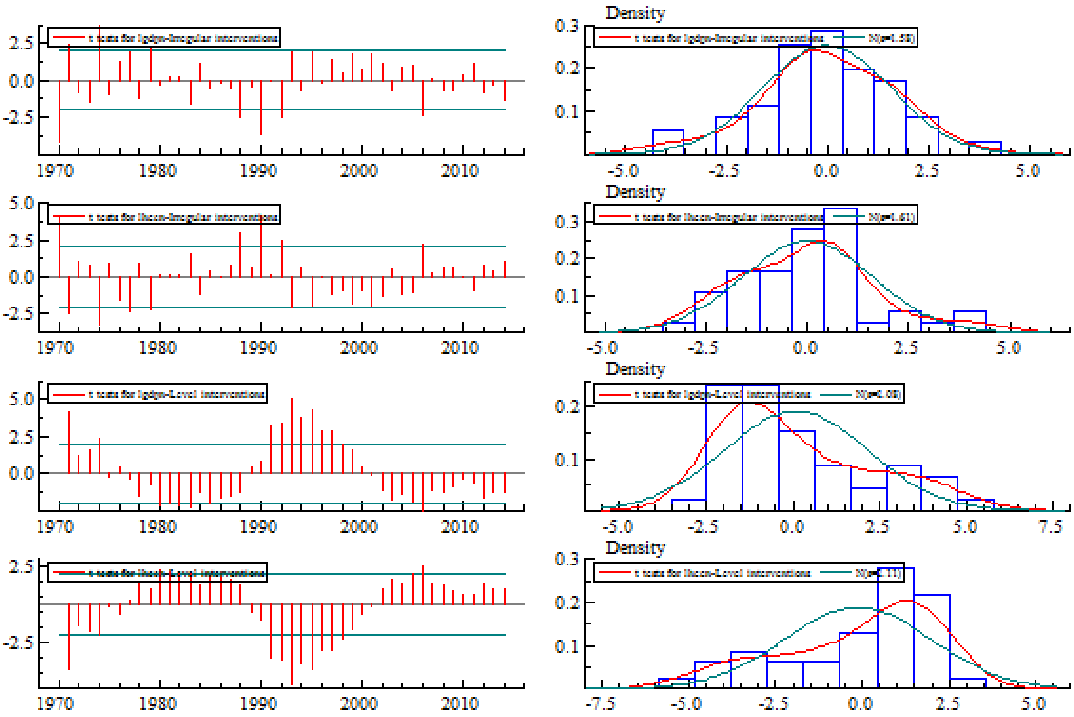

Figure 5: Auxiliary residuals: Irregular and Level (Nepal)

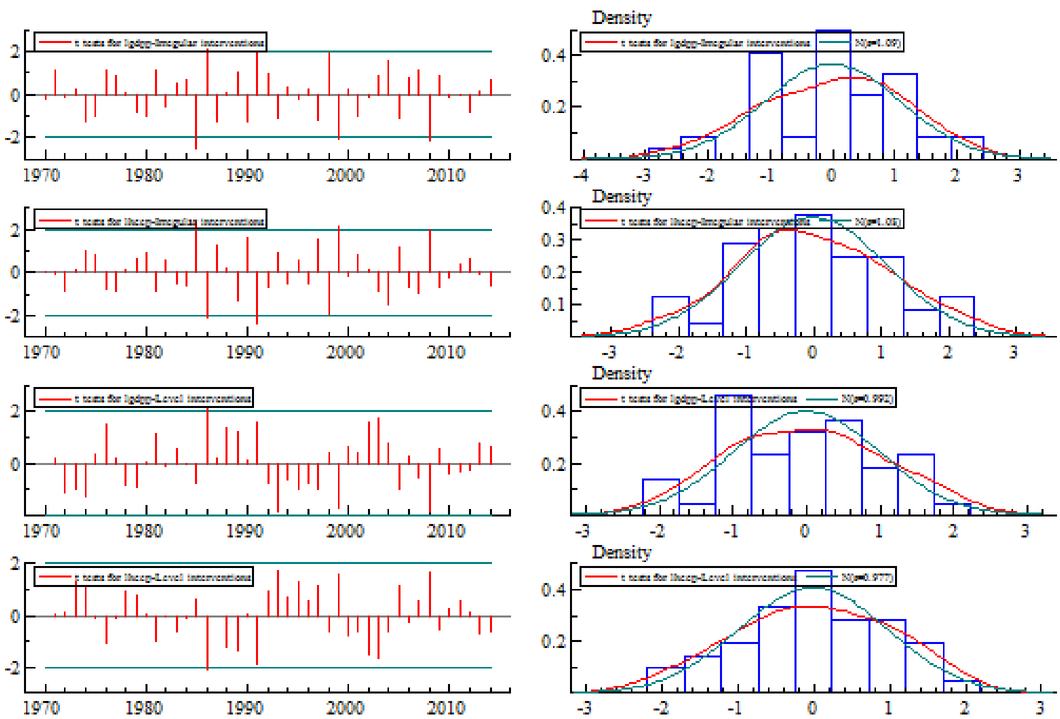

Figure 6: Auxiliary residuals: Irregular and Level (Pakistan)

brasstacks (the largest of its kind in south asia) conducted by India in 1987 and Pakistani mobilization in response raised tensions and fears that it could lead to another war between these two neighbors, as a result of Siachen conflict, further clashes erupted in the glacial area in 1987 as Pakistan sought, without success, to oust India from its stronghold, and Political crisis in that year by returning Benazir from exile to lead PPP in campaign for fresh elections.

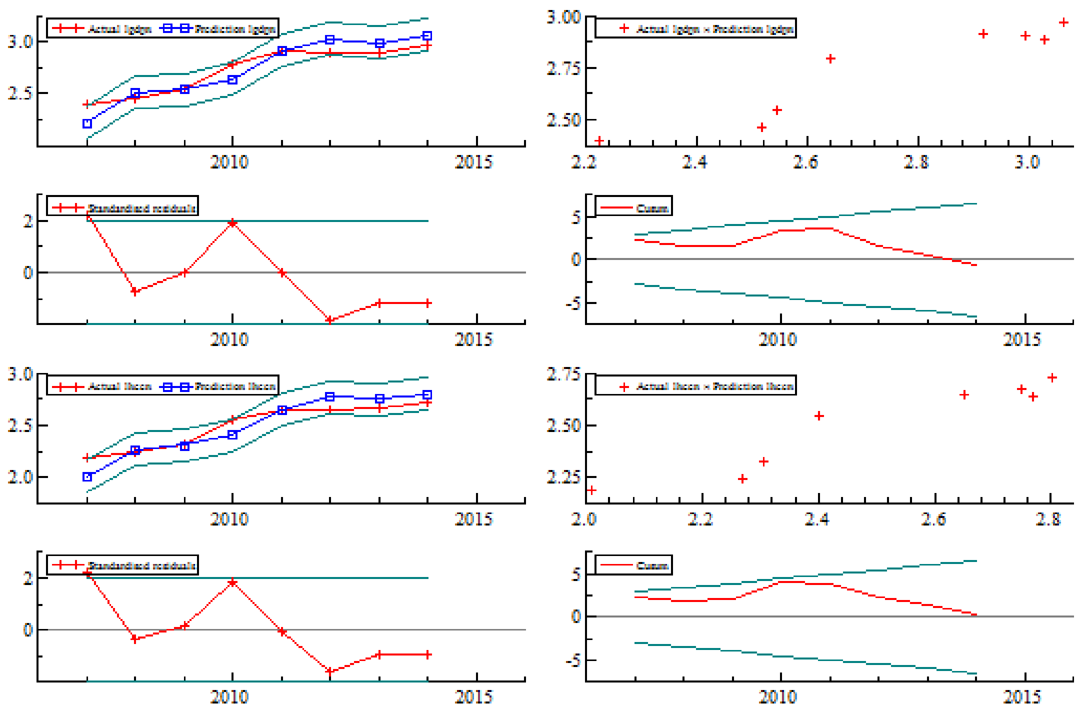

Figure 7: Prediction testing for the GDP and HCE of lgdpn and lhcen (Nepal)

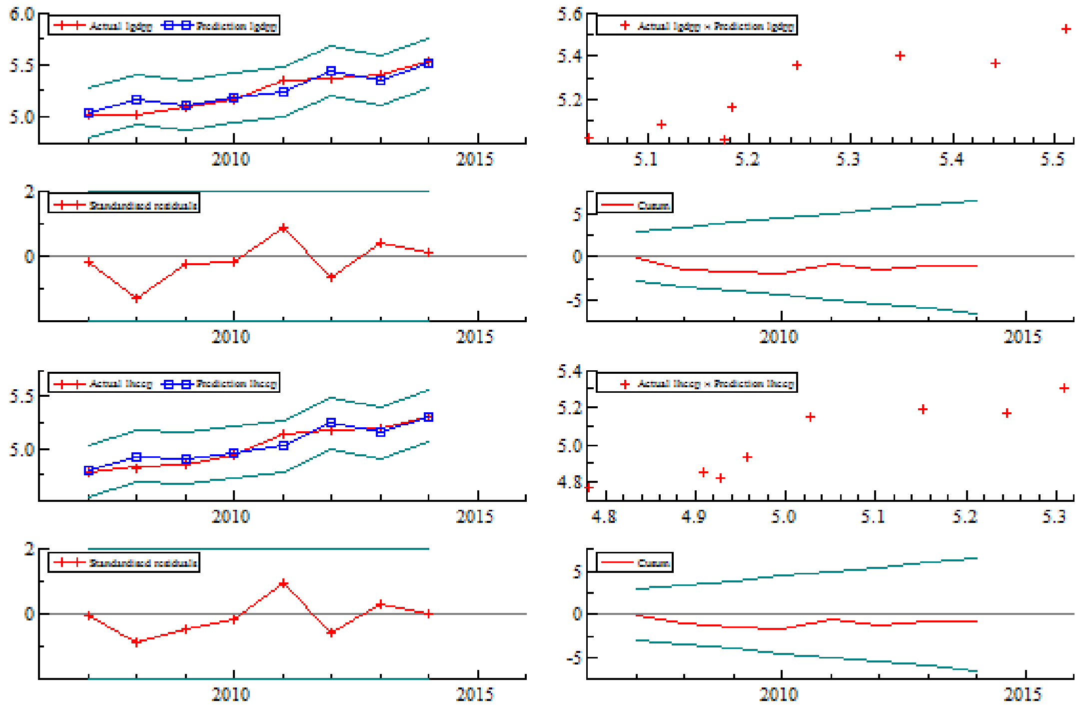

Figure 8: Prediction testing for the GDP and HCE of lgdpp and lhcep (Pakistan)

Figure 7 and 8 presents the prediction graphics of GDP and HCE for lgdpn, lgdpp, lhcen and lhcep generated by estimating the model from 1970-2014. In this estimation, the years 2007-2014 are reserved for the out-of-simple forecast. The first predictions were made using information from 2007, and are updated each time a new observation is captured. The graphs show that the predicted values and residuals of lgdpn, lgdpp, lhcen and lhcep are within the prediction intervals, indicating that the forecast of the trend has no more than two standard errors.

Figure 9 and 10 presents the forecast of the GDP and HCE of lgdpi, lhcei, lgdpp and lhcep for four years (2015-2018).The forecasted values are given within a band of 1 root mean square error on either side. The forecast graph of lgdpp shows that the GDP will be increasing with a fluctuation in 2017. And the forecast graph of lhcep also shows that HCE will be increasing with a fluctuation in 2017. On the other hand the forecast graph of lgdpn shows that it will be increasing with a decrease in 2016 and the forecast graph of lhcen shows in the same way as lgdpn.

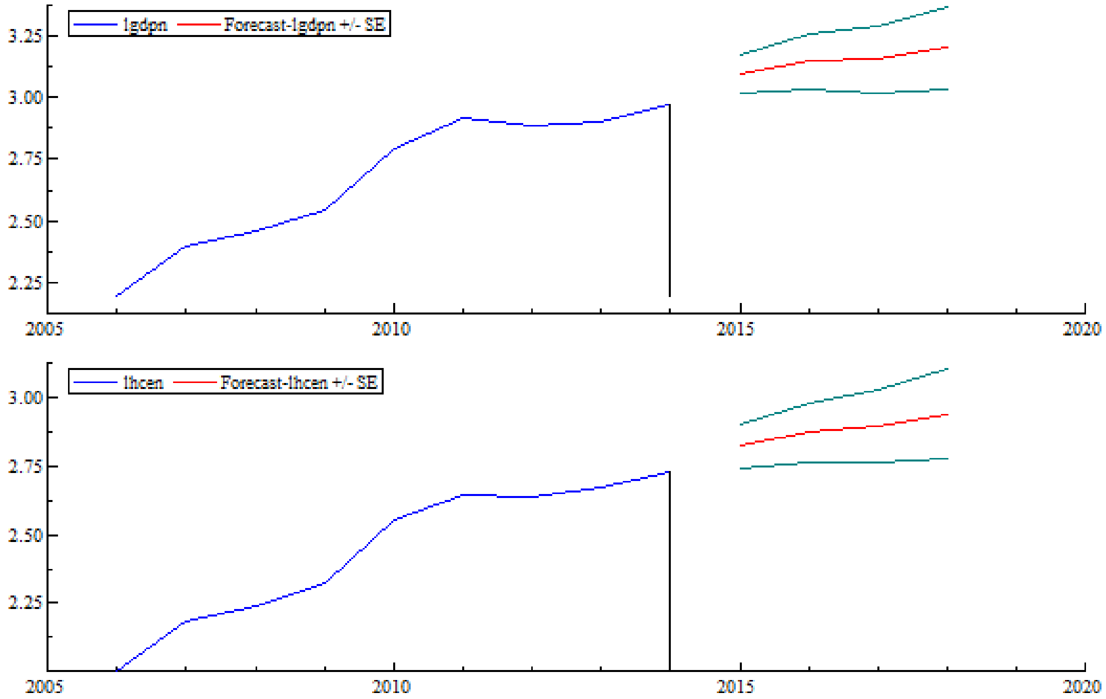

Figure 9: Forecasting of the GDP and HCE of lgdpn and lhcen (Nepal)

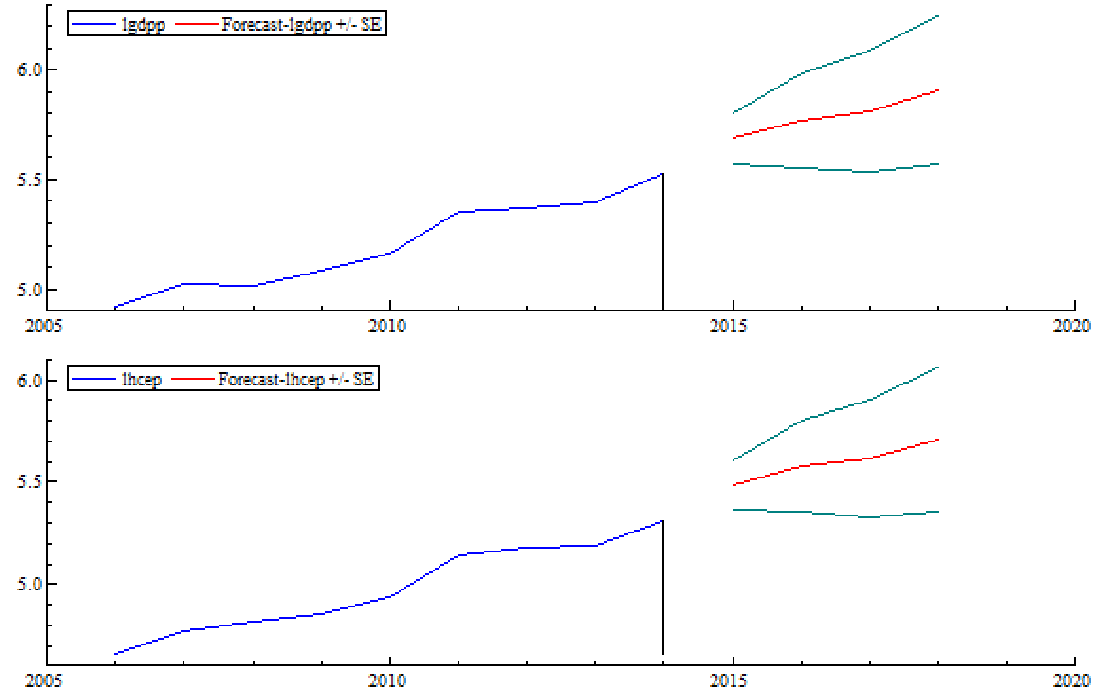

Figure 10: Forecasting of the GDP and HCE of lgdpp and lhcep (Pakistan)

7. Discussions

Table 6 presents disturbance covariance and corresponding correlations of irregular components, slope and cycle. Level components are not reported here since this chapter uses multivariate smooth trend plus cycle models, i.e., level-fixed, slope-stochastic, and stochastic cycle.

The irregular components show strong correlations between Nepal GDP and HCE and Pakistan GDP and HCE. The correlation between Nepal GDP and HCE (0.98) is very strong indicating that an uncertain event in GDP strongly affects the HCE of Nepal. And the correlation between Pakistan GDP and HCE (0.89) is also strong. Any GDP increase or decrease here will positively affect the HCE of the country. This is because in Nepal and Pakistan and almost all developing countries, GDP is a major factor for standard of living and consumption. Income is by far the most important factor that determines a community's propensity to consume. Household consumption is the largest GDP component. Here an equation is used:

$$GDP=PC+PS+CB$$

Where, PC is the private consumption that is converted today as household consumption, PS is public spending that is social spending and CB is the commercial balance as a result of the difference between exportation and importation.

So, clearly the household consumption expenditure depends on GDP. The more the GDP, the more the household consumption expenditure. A clear example of this situation, it's the case of Spain (Which represents the same trends than other European countries). Spain has suffered a cut policy, where the tax rate have experienced a general rise, the unemployment has increased, the consequence of this factors have been that the families' consumption and companies' investments have dramatically dropped, what made the GDP fall. That's why any event concerning to the GDP will strongly affect the household consumption expenditure of Nepal and Pakistan.

The correlation of slope presents that there is perfect positive correlation (1) between GDP and HCE of Nepal and GDP and HCE of Pakistan. It indicates that Nepal GDP and HCE have similarities in the long run trends. Pakistan GDP and HCE show that also. In the long run, in case of increase or decrease in household consumption expenditure, it must indicate the same way in the event of GDP. The long run household consumption increase or decrease illustrates that since GDP in the long run is not fully consumed, is saved, so the more or less savings will affect perfectly in the household consumption. As illustrated earlier, the larger saving in GDP will increase household consumption in the same proportion as savings.

The measured correlations of cycle are also reported in the lower part of the table 6. In this case the correlations are also positive perfectly. The cycle used (within five years) must reveal at the end same direction of GDP and HCE. It argues this considering that in a cycle the consumption will depend on the availability of ability to consume that will be reflected by amount of GDP in the cycle of both the countries of Nepal and Pakistan.

Through a deeper look at the cycle correlations, it is observed that GDP and HCE are perfectly correlated in both the countries of Nepal and Pakistan. Not only these two countries, based on the

Table 6 Disturbance, covariance and correlation of irregular, slope and cycle (Nepal)

	Lgdpn	lhcen
Irregular		
lgdpn	0.001851	0.9832
lhcen	0.002197	0.002697
Slope		
lgdpn	0.0004012	1
lhcen	0.0003807	0.0003613
Cycle		
lgdpn	0.0001282	1
lhcen	8.463e-005	5.612e-005

Disturbance, covariance and correlation of irregular, slope and cycle (Pakistan)

	Lgdpp	lhcep
Irregular		
lgdpn	0.0008796	0.8922
lhcen	0.0007692	0.0008451
Slope		
lgdpn	0.002407	1
lhcen	0.002465	0.002544
Cycle		
lgdpn	0.0003187	1
lhcen	0.0003442	0.0003747

Note: The lower triangular elements are the covariance and the upper triangular elements are the corresponding correlations

Table 7: Diagnostics and goodness-of-fit statistics

Statistics	lgdpn	lhcen	lgdpp	lhcep
N (x_2^2)	1.2782 (0.5278)	0.93718 (0.6259)	12.576 (0.0019)	13.304 (0.0013)
H_{14} ($F_{14,14}$)	1.1353 (0.4078)	1.0838 (0.4412)	0.17016 (0.9990)	0.13716 (0.9997)
Q (10, 5)	7.0742 (0.2152)	10.038 (0.0742)	7.7388 (0.1712)	10.064 (0.0734)
Rd^2	-0.54423	-0.44919	0.014075	0.056376

Note: Values in parenthesis are p-values

observation it can be said that it will be occurred in all countries as there have no options to consume more than the amount of GDP.

The estimated cycle of this model has a period of 4.41 years (Nepal) and 4.29 years (Pakistan), with a frequency of 1.43 (Nepal) and 1.46 (Pakistan), and a dumping factor of 0.67 (Nepal) and 0.78 (Pakistan). The empirical results are also satisfactory since there is no major deviation from the model.

8. Conclusions

This study begins with the aim of examining the relationships between Gross Domestic Product (GDP) and Household Consumption Expenditure (HCE) in two SAARC countries: Nepal and Pakistan. The mentioned two countries are selected from SAARC organization due to several reasons. SAARC (The South Asian Association for Regional Cooperation) is an economic and political organization of eight countries in south Asia. In terms of population, it is the largest of any regional organizations. The agreed five areas for cooperation involve agriculture and rural development first. And it involves greatly the GDP and HCE in their activities. Nepal and Pakistan have great influence on SAARC and face such difficulties as political crisis, natural disasters etc. during the last few decades. It is thought that these two countries can reveal the whole picture of all SAARC countries. The multivariate unobserved components model is used to decompose the GDP and HCE of Nepal and Pakistan into trends, cycle, interventions and irregular components. This approach provides some results about the relationship between GDP and HCE of Nepal and Pakistan. Smooth trend plus stochastic cycle components are considered for the specifications of this model, i.e., level-fixed, slope-stochastic, stochastic cycle and irregular components. It is indicated by the empirical results of this chapter that the time series of the relationship between GDP and HCE in Nepal and Pakistan are best fitted by smooth trend plus stochastic cycle model, since there are no deficiencies in the diagnostic statistics. Also interventions dummies have been included, which accurately captured shocks.

The findings of this chapter are that the irregular components show a strong correlation between GDP and HCE of both the countries of Nepal and Pakistan. This is because HCE is the largest component of GDP. Household consumption, savings and public spending is occurred from GDP of a country. That's why strong positive correlation between GDP and HCE indicate any change in GDP will affect positively HCE of Nepal and Pakistan.

Considering the slope, the correlation between GDP and HCE is perfectly positive. This indicates in the long run, the GDP and HCE behave in the same way as the GDP is not terminated quickly, rather is is save from time to time. So the amount of saving is a major factor in household consumption. The more or less in savings will result the HCE more or less. For this reason the same direction must be found in GDP and HCE in the long run in both Nepal and Pakistan.

And in the cycle component (within five years), the correlations are found perfectly positive that indicates that the ending of a cycle provides the same direction of GDP and HCE of Nepal and Pakistan. In a cycle the amount of saved GDP in a country directs the HCE of the country. Considering the fluctuations in the cycle years, it does not affect the aggregate amount of GDP, thus does not affect the household consumption expenditure. So, the GDP trend and HCE trend will be the same in both Nepal and Pakistan. Finally, this chapter exposes the forecasted values of GDP and HCE of Nepal and Pakistan from 2015 to 2018. It shows that the value of GDP of Nepal will be increasing with a decrease in 2016 and HCE of Nepal also will be increasing with a decrease in 2016. The GDP of Pakistan will be increasing with a fluctuation in 2017 and HCE of Pakistan will also be increasing with a fluctuation of 2017.

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Appendix

Nepal:

```
---- OxMetrics 6.01 started at 13:37:42 on 16-Jul-2016 ----
Nepal.xls loaded from C:\Users\user\Desktop\MY COMPUTER\Shimul
Thesis2\Information\Nepal.xls
Ox Professional version 6.00 (Windows/U) (C) J.A. Doornik, 1994-2009
STAMP 8.20 (C) S.J. Koopman and A.C. Harvey, 1995-2009
---- STAMP 8.20 session started at 13:38:15 on 16-07-2016 ----
Starting estimation process...
EM Step .
ML Init ....
MaxLik iterating ...
it   10 lik =      2.95297637 crit1 =   0.00025 crit2 =   0.00154 crit3 =   0.01842 dstep =
1.0000
it   20 lik =      2.95470421 crit1 =   0.00000 crit2 =   0.00110 crit3 =   0.00000 dstep =
0.0000
it   24 lik =      2.95470465 crit1 =   0.00000 crit2 =   0.00087 crit3 =   0.00000 dstep =
0.0000
 Strong convergence relative to 1e-007
 - likelihood cvg 0
 - gradient cvg 0.000866764
 - parameter cvg 0
 - number of bad iterations 5
EM Step .
ML Init ....
MaxLik iterating ...
it   10 lik =      2.87421789 crit1 =   0.00014 crit2 =   0.00366 crit3 =   0.01729 dstep =
1.0000
it   20 lik =      2.87481595 crit1 =   0.00005 crit2 =   0.00371 crit3 =   0.00607 dstep =
1.0000
it   30 lik =      2.87535228 crit1 =   0.00000 crit2 =   0.00728 crit3 =   0.00416 dstep =
0.3150
it   40 lik =      2.87563143 crit1 =   0.00007 crit2 =   0.00871 crit3 =   0.01722 dstep =
1.0000
it   50 lik =      2.87594443 crit1 =   0.00010 crit2 =   0.00336 crit3 =   0.00741 dstep =
1.0000
it   60 lik =      2.87601753 crit1 =   0.00000 crit2 =   0.00281 crit3 =   0.00000 dstep =
0.0000
 Strong convergence relative to 1e-007
 - likelihood cvg 0
 - gradient cvg 0.00280973
 - parameter cvg 0
 - number of bad iterations 5
 Estimation process completed.
UC( 1) Estimation done by Maximum Likelihood (exact score)
```

The database used is C:\Users\user\Desktop\MY COMPUTER\Shimul Thesis2\Information\Nepal.xls

The selection sample is: 1970 - 2014 (T = 45, N = 2)

The dependent vector Y contains variables:

lgdpn lhcen

The model is: Y = Trend + Irregular + Cycle 1

Component selection: 0=out, 1=in, 2=dependent, 3=fix

	lgdpn	lhcen
Level	1	1
Slope	1	1
Cycle	1	1
Irregular	1	1

Steady state........... found without full convergence

Log-Likelihood is 259.003 (-2 LogL = -518.006).

Prediction error variance/correlation matrix is

	lgdpn	lhcen
lgdpn	0.00984	0.98071
lhcen	0.00973	0.00999

Summary statistics

	lgdpn	lhcen
T	45.000	45.000
p	5.0000	5.0000
std.error	0.099209	0.099965
Normality	1.2782	0.93718
H(14)	1.1353	1.0838
DW	1.7176	1.5137
r(1)	0.12536	0.21549
q	10.000	10.000
r(q)	-0.093189	-0.16178
Q(q,q-p)	7.0742	10.038
Rd^2	-0.54423	-0.44919

Variances of disturbances in Eq lgdpn:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.000401176	(0.2167)
Cycle	0.000128242	(0.06928)
Irregular	0.00185098	(1.000)

Variances of disturbances in Eq lhcen:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.000000	(0.0000)
Cycle	4.97685e-007	(0.0002689)
Irregular	8.97226e-005	(0.04847)

Level disturbance scalar variance matrix:

	lgdpn	lhcen
lgdpn	0.0000	0.0000
lhcen	0.0000	0.0000

Slope disturbance variance/correlation matrix:

	lgdpn	lhcen
lgdpn	0.0004012	1.000

lhcen 0.0003807 0.0003613
Cycle disturbance variance/correlation matrix:

	lgdpn	lhcen
lgdpn	0.0001282	0.9975
lhcen	8.463e-005	5.612e-005

Irregular disturbance variance/correlation matrix:

	lgdpn	lhcen
lgdpn	0.001851	0.9832
lhcen	0.002197	0.002697

Cycle other parameters:

Period	4.40822
Frequency	1.42533
Damping factor	0.66866
Order	2.00000

Cycle variance/correlation matrix:

	lgdpn	lhcen
lgdpn	0.0002319	0.9975
lhcen	0.0001531	0.0001015

State vector analysis at period 2014
Equation lgdpn

	Value	Prob
Level	3.00299	[0.00000]
Slope	0.05448	[0.08163]
Cycle 1 amplitude	0.04877	[.NaN]

Equation lhcen

	Value	Prob
Level	2.74556	[0.00000]
Slope	0.05159	[0.08224]
Cycle 1 amplitude	0.03203	[.NaN]

Standard deviations of disturbances in Eq lgdpn:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.0200294	(0.4656)
Cycle	0.0113244	(0.2632)
Irregular	0.0430230	(1.000)

Standard deviations of disturbances in Eq lhcen:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.000000	(0.0000)
Cycle	0.000705468	(0.01640)
Irregular	0.00947220	(0.2202)

Variance/correlation matrix

	lgdpn	lhcen
lgdpn	0.0000	0.0000
lhcen	0.0000	0.0000

Variance/correlation matrix

	lgdpn	lhcen
lgdpn	0.0004012	1.000
lhcen	0.0003807	0.0003613

Variance/correlation matrix

	lgdpn	lhcen
lgdpn	0.0002319	0.9975
lhcen	0.0001531	0.0001015

Variance/correlation matrix

	lgdpn	lhcen
lgdpn	0.001851	0.9832
lhcen	0.002197	0.002697

State vector anti-log analysis at period 2014

It is assumed that time series is in logs.

Equation lgdpn

	Value	Prob
Level (anti-log)	20.14568	[0.00000]
Level (bias corrected)	20.15869	[.NaN]
Slope (yearly %growth)	5.44778	[0.08163]
Cycle 1 amplitude (%trend)	4.87659	[.NaN]

Equation lhcen

	Value	Prob
Level (anti-log)	15.57338	[0.00000]
Level (bias corrected)	15.58297	[.NaN]
Slope (yearly %growth)	5.15853	[0.08224]
Cycle 1 amplitude (%trend)	3.20263	[.NaN]

Equation lgdpn: state vector at period 2014

	Coefficient	RMSE	t-value	Prob
Level	3.00299	0.03593	83.57062	[0.00000]
Slope	0.05448	0.03055	1.78312	[0.08163]
Cycle 1	-0.02847	0.01874	-1.51926	[0.13602]
Cycle 1 2	0.05067	0.02059	2.46061	[0.01796]
Cycle 1 3	0.00518	0.01439	0.36023	[0.72044]
Cycle 1 4	0.00921	0.01402	0.65675	[0.51484]

Equation lhcen: state vector at period 2014

	Coefficient	RMSE	t-value	Prob
Level	2.74556	0.03509	78.25407	[0.00000]
Slope	0.05159	0.02899	1.77939	[0.08224]
Cycle 1	-0.01868	0.01262	-1.48059	[0.14601]
Cycle 1 2	0.03330	0.01379	2.41377	[0.02012]
Cycle 1 3	0.00340	0.00953	0.35714	[0.72274]
Cycle 1 4	0.00604	0.00929	0.65022	[0.51901]

Normality test for Residuals lgdpn

	Value
Sample size	43.000
Mean	0.0042733
St.Dev	1.0084
Skewness	0.36675
Excess kurtosis	-0.31129
Minimum	-2.0182
Maximum	2.2422

	Chi^2	prob
Skewness	0.96398	[0.3262]
Kurtosis	0.17361	[0.6769]
Bowman-Shenton	1.1376	[0.5662]

Goodness-of-fit based on Residuals lgdpn

	Value
Prediction error variance (p.e.v)	0.0098424
Prediction error mean deviation (m.d)	0.0077712
Ratio p.e.v. / m.d in squares	1.0212
Coefficient of determination R^2	0.9862
... based on differences Rd^2	-0.54423
Information criterion Akaike (AIC)	-4.4877
... Bayesian Schwartz (BIC)	-4.3673

Normality test for Residuals lhcen

	Value
Sample size	43.000
Mean	0.086791
St.Dev	1.0318
Skewness	0.26619
Excess kurtosis	-0.53934
Minimum	-2.2050
Maximum	2.2441

	Chi^2	prob
Skewness	0.5078	[0.4761]
Kurtosis	0.52117	[0.4703]
Bowman-Shenton	1.029	[0.5978]

Goodness-of-fit based on Residuals lhcen

	Value
Prediction error variance (p.e.v)	0.009993
Prediction error mean deviation (m.d)	0.0084439
Ratio p.e.v. / m.d in squares	0.89162
Coefficient of determination R^2	0.98447
... based on differences Rd^2	-0.44919
Information criterion Akaike (AIC)	-4.4725
... Bayesian Schwartz (BIC)	-4.3521

Normality test for Equation lgdpn: Irregular residual

	Value
Sample size	45.000
Mean	-0.020390
St.Dev	1.5825
Skewness	-0.32525
Excess kurtosis	0.26221
Minimum	-4.2114
Maximum	3.6324

	Chi^2	prob
Skewness	0.79343	[0.3731]
Kurtosis	0.12891	[0.7196]

Bowman-Shenton 0.92234 [0.6305]

Normality test for Equation lgdpn: Level residual

	Value
Sample size	44.000
Mean	0.10115
St.Dev	2.0780
Skewness	0.82945
Excess kurtosis	-0.53430
Minimum	-2.4898
Maximum	5.0979

	Chi^2	prob
Skewness	5.0452	[0.0247]
Kurtosis	0.52337	[0.4694]
Bowman-Shenton	5.5686	[0.0618]

Normality test for Equation lgdpn: Slope residual

	Value
Sample size	43.000
Mean	-0.83257
St.Dev	1.2275
Skewness	-0.12987
Excess kurtosis	-0.21995
Minimum	-4.2114
Maximum	1.1619

	Chi^2	prob
Skewness	0.12087	[0.7281]
Kurtosis	0.086676	[0.7684]
Bowman-Shenton	0.20754	[0.9014]

Normality test for Equation lhcen: Irregular residual

	Value
Sample size	45.000
Mean	0.011539
St.Dev	1.6124
Skewness	0.47866
Excess kurtosis	0.28840
Minimum	-3.1484
Maximum	4.1613

	Chi^2	prob
Skewness	1.7183	[0.1899]
Kurtosis	0.15595	[0.6929]
Bowman-Shenton	1.8743	[0.3917]

Equation lhcen: values larger than 5 for Level residual:

	Value	prob
1993	-5.14329	[0.00000]

Normality test for Equation lhcen: Level residual

	Value
Sample size	44.000
Mean	-0.11315
St.Dev	2.1133
Skewness	-0.79351
Excess kurtosis	-0.61633

Minimum -5.1433
Maximum 2.5298
Chi^2 prob
Skewness 4.6175 [0.0316]
Kurtosis 0.69642 [0.4040]
Bowman-Shenton 5.314 [0.0702]
Normality test for Equation lhcen: Slope residual
Value
Sample size 43.000
Mean 0.80815
St.Dev 1.2102
Skewness 0.13113
Excess kurtosis -0.20753
Minimum -1.1700
Maximum 4.1613
Chi^2 prob
Skewness 0.12322 [0.7256]
Kurtosis 0.077161 [0.7812]
Bowman-Shenton 0.20039 [0.9047]

Pakistan:

Ox Professional version 6.00 (Windows/U) (C) J.A. Doornik, 1994-2009
STAMP 8.20 (C) S.J. Koopman and A.C. Harvey, 1995-2009
---- STAMP 8.20 session started at 13:45:32 on 16-07-2016 ----
Starting estimation process...
EM Step .
ML Init ....
MaxLik iterating ...
it 5 lik = 2.71084694 crit1 = 0.00000 crit2 = 0.01014 crit3 = 0.00000 dstep = 0.0000
Strong convergence relative to 1e-007
- likelihood cvg 0
- gradient cvg 0.0101426
- parameter cvg 0
- number of bad iterations 5
EM Step .
ML Init ....
MaxLik iterating ...
it 10 lik = 2.65877107 crit1 = 0.00000 crit2 = 0.00985 crit3 = 0.00014 dstep = 0.0009
it 20 lik = 2.65877127 crit1 = 0.00000 crit2 = 0.00983 crit3 = 0.00000 dstep = 0.0000
Strong convergence relative to 1e-007
- likelihood cvg 0
- gradient cvg 0.0098268
- parameter cvg 0
- number of bad iterations 3
Estimation process completed.
UC(1) Estimation done by Maximum Likelihood (exact score)
The database used is C:\Users\user\Desktop\MY COMPUTER\Shimul Thesis2\Information\Pakistan.xls

The selection sample is: 1970 - 2014 (T = 45, N = 2)
The dependent vector Y contains variables:
lgdpp lhcep
The model is: Y = Trend + Irregular + Cycle 1 + Interventions
Component selection: 0=out, 1=in, 2=dependent, 3=fix

	lgdpp	lhcep
Level	1	1
Slope	1	1
Cycle	1	1
Irregular	1	1

Steady state. found
Log-Likelihood is 244.177 (-2 LogL = -488.353).
Prediction error variance/correlation matrix is

	lgdpp	lhcep
lgdpp	0.01415	0.98182
lhcep	0.01449	0.01539

Summary statistics

	lgdpp	lhcep
T	44.000	45.000
p	5.0000	5.0000
std.error	0.11896	0.12406
Normality	12.576	13.304
H(14)	0.17016	0.13716
DW	1.9931	1.5461
r(1)	-0.10632	0.099672
q	10.000	10.000
r(q)	0.039534	-0.062201
Q(q,q-p)	7.7388	10.064
Rd^2	0.014075	0.056376

Variances of disturbances in Eq lgdpp:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.00240672	(2.736)
Cycle	0.000318658	(0.3623)
Irregular	0.000879620	(1.000)

Variances of disturbances in Eq lhcep:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	2.06324e-005	(0.02346)
Cycle	7.55118e-006	(0.008585)
Irregular	0.000172400	(0.1960)

Level disturbance scalar variance matrix:

	lgdpp	lhcep
lgdpp	0.0000	0.0000
lhcep	0.0000	0.0000

Slope disturbance variance/correlation matrix:

	lgdpp	lhcep
lgdpp	0.002407	0.9959
lhcep	0.002465	0.002544

Cycle disturbance variance/correlation matrix:

	lgdpp	lhcep
lgdpp	0.0003187	0.9960
lhcep	0.0003442	0.0003747

Irregular disturbance variance/correlation matrix:

	lgdpp	lhcep
lgdpp	0.0008796	0.8922
lhcep	0.0007692	0.0008451

Cycle other parameters:

Period	4.29134
Frequency	1.46416
Damping factor	0.77723
Order	2.00000

Cycle variance/correlation matrix:

	lgdpp	lhcep
lgdpp	0.0008049	0.9960
lhcep	0.0008693	0.0009465

State vector analysis at period 2014

Equation lgdpp

	Value	Prob
Level	5.54940	[0.00000]
Slope	0.09589	[0.15667]
Cycle 1 amplitude	0.04986	[.NaN]

Equation lhcep

	Value	Prob
Level	5.41802	[0.00000]
Slope	0.09834	[0.15891]
Cycle 1 amplitude	0.05477	[.NaN]

Equation lhcep: regression effects in final state at time 2014

	Coefficient	RMSE	t-value	Prob
Level break 1987(1)	-0.07243	0.01962	-3.69193	[0.00064]

Standard deviations of disturbances in Eq lgdpp:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.0490583	(1.654)
Cycle	0.0178510	(0.6019)
Irregular	0.0296584	(1.000)

Standard deviations of disturbances in Eq lhcep:

	Value	(q-ratio)
Level	0.000000	(0.0000)
Slope	0.00454229	(0.1532)
Cycle	0.00274794	(0.09265)
Irregular	0.0131301	(0.4427)

Variance/correlation matrix

	lgdpp	lhcep
lgdpp	0.0000	0.0000
lhcep	0.0000	0.0000

Variance/correlation matrix

	lgdpp	lhcep
lgdpp	0.002407	0.9959
lhcep	0.002465	0.002544

Variance/correlation matrix

	lgdpp	lhcep
lgdpp	0.0008049	0.9960
lhcep	0.0008693	0.0009465

Variance/correlation matrix

	lgdpp	lhcep
lgdpp	0.0008796	0.8922
lhcep	0.0007692	0.0008451

State vector anti-log analysis at period 2014

It is assumed that time series is in logs.

Equation lgdpp

	Value	Prob
Level (anti-log)	257.08428	[0.00000]
Level (bias corrected)	257.43332	[.NaN]
Slope (yearly %growth)	9.58916	[0.15667]
Cycle 1 amplitude (%trend)	4.98629	[.NaN]

Equation lhcep

	Value	Prob
Level (anti-log)	225.43259	[0.00000]
Level (bias corrected)	225.80844	[.NaN]
Slope (yearly %growth)	9.83430	[0.15891]
Cycle 1 amplitude (%trend)	5.47672	[.NaN]

Equation lgdpp: state vector at period 2014

	Coefficient	RMSE	t-value	Prob
Level	5.54940	0.05209	106.53062	[0.00000]
Slope	0.09589	0.06652	1.44154	[0.15667]
Cycle 1	-0.02722	0.04664	-0.58364	[0.56251]
Cycle 1 2	0.04906	0.04312	1.13757	[0.26160]
Cycle 1 3	0.00550	0.02529	0.21762	[0.82875]
Cycle 1 4	0.00305	0.02577	0.11821	[0.90645]

Equation lhcep: state vector at period 2014

	Coefficient	RMSE	t-value	Prob
Level	5.41802	0.05772	93.86658	[0.00000]
Slope	0.09834	0.06857	1.43423	[0.15891]
Cycle 1	-0.03565	0.04995	-0.71359	[0.47943]
Cycle 1 2	0.05000	0.04629	1.07999	[0.28631]
Cycle 1 3	0.00567	0.02740	0.20711	[0.83692]
Cycle 1 4	0.00421	0.02790	0.15097	[0.88072]

Equation lhcep: regression effects in final state at time 2014

	Coefficient	RMSE	t-value	Prob
Level break 1987(1)	-0.07243	0.01962	-3.69193	[0.00064]

Normality test for Residuals lgdpp

	Value
Sample size	42.000
Mean	0.019727
St.Dev	1.0344
Skewness	0.26881
Excess kurtosis	2.0729
Minimum	-3.1151
Maximum	2.8179

	Chi^2	prob
Skewness	0.50583	[0.4770]
Kurtosis	7.5198	[0.0061]
Bowman-Shenton	8.0256	[0.0181]

Goodness-of-fit based on Residuals lgdpp

	Value
Prediction error variance (p.e.v)	0.014151
Prediction error mean deviation (m.d)	0.010661
Ratio p.e.v. / m.d in squares	1.1216
Coefficient of determination R^2	0.98325
... based on differences Rd^2	0.014075
Information criterion Akaike (AIC)	-4.1246
... Bayesian Schwartz (BIC)	-4.0042

Normality test for Residuals lhcep

	Value
Sample size	42.000
Mean	0.012154
St.Dev	0.99817
Skewness	0.28808
Excess kurtosis	2.1805
Minimum	-3.0597
Maximum	2.8634

	Chi^2	prob
Skewness	0.58095	[0.4459]
Kurtosis	8.3208	[0.0039]
Bowman-Shenton	8.9018	[0.0117]

Goodness-of-fit based on Residuals lhcep

	Value
Prediction error variance (p.e.v)	0.015391
Prediction error mean deviation (m.d)	0.011214
Ratio p.e.v. / m.d in squares	1.1992
Coefficient of determination R^2	0.98119
... based on differences Rd^2	0.056376
Information criterion Akaike (AIC)	-3.9962
... Bayesian Schwartz (BIC)	-3.8356

Normality test for Equation lgdpp: Irregular residual

	Value
Sample size	45.000
Mean	0.0047978
St.Dev	1.0893

Skewness	-0.21051
Excess kurtosis	-0.56861
Minimum	-2.4661
Maximum	2.0404

	Chi^2	prob
Skewness	0.33235	[0.5643]
Kurtosis	0.60622	[0.4362]
Bowman-Shenton	0.93857	[0.6254]

Normality test for Equation lgdpp: Level residual

	Value
Sample size	44.000
Mean	0.0035333
St.Dev	0.99191
Skewness	0.11717
Excess kurtosis	-0.72026
Minimum	-1.8449
Maximum	2.1191

	Chi^2	prob
Skewness	0.10068	[0.7510]
Kurtosis	0.95109	[0.3294]
Bowman-Shenton	1.0518	[0.5910]

Normality test for Equation lgdpp: Slope residual

	Value
Sample size	43.000
Mean	0.15380
St.Dev	0.94327
Skewness	-0.78603
Excess kurtosis	-0.14742
Minimum	-2.3211
Maximum	1.4862

	Chi^2	prob
Skewness	4.4279	[0.0354]
Kurtosis	0.038936	[0.8436]
Bowman-Shenton	4.4669	[0.1072]

Normality test for Equation lhcep: Irregular residual

	Value
Sample size	45.000
Mean	-0.0071581
St.Dev	1.0753
Skewness	0.084951
Excess kurtosis	-0.40201
Minimum	-2.3241
Maximum	2.2816

	Chi^2	prob
Skewness	0.054125	[0.8160]
Kurtosis	0.30302	[0.5820]
Bowman-Shenton	0.35714	[0.8365]

Normality test for Equation lhcep: Level residual

	Value
Sample size	43.000
Mean	-0.0016954
St.Dev	0.97730
Skewness	-0.13079
Excess kurtosis	-0.77185
Minimum	-2.0739
Maximum	1.7409

	Chi^2	prob
Skewness	0.12259	[0.7262]
Kurtosis	1.0674	[0.3015]
Bowman-Shenton	1.19	[0.5516]

Normality test for Equation lhcep: Slope residual

	Value
Sample size	43.000
Mean	-0.14007
St.Dev	0.93240
Skewness	0.85637
Excess kurtosis	0.015097
Minimum	-1.4637
Maximum	2.3986

	Chi^2	prob
Skewness	5.2559	[0.0219]
Kurtosis	0.00040836	[0.9839]
Bowman-Shenton	**5.2563**	**[0.0722]**

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