Research Square

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Short-Run and Long-Run Income Elasticity of Healthcare Expenditure in India: Role of Domestic Revenue and Public Debt

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Abstract

Existing literature argues that income growth is an important determinant for change in healthcare expenditure in developing economies. Most of them examine the elasticity of public health expenditure concerning per capita income while the role of fiscal policies – public revenue and public debt to determine the level of spending has never been studied. Therefore, this study examines the income elasticity of public health expenditure in both short-run and long-run by controlling domestic revenue, and public debt (i.e. borrowings) in India for the period from 1980-81 to 2015-16. The study follows three steps for empirical analysis. First, we test stationarity properties of variables using the Zivot and Andrews (ZA) unit root test assuming that the Indian economy might have experienced structural breaks at different time points. Second, we examine the cointegrating relationships among variables using the Auto-Regressive Distributed Lag (ARDL) bounds testing approach. Third, we estimate both short-run and long-run elasticity by controlling structural-breaks using the unrestricted Error-Correction Term (ECT). Our result finds that domestic revenue (i.e. tax and non-tax) shows a positive and statistically significant effect while public debt (i.e. domestic and external) shows a negative and statistically significant effect on health expenditure respectively. It implies that a 1 percent increase in revenue leads to a 0.78 percent increment in public health expenditure annually while a 1 percent increase in public debt leads to an -0.51 percent reduction in public health expenditure in the long-run. Our result suggests that conducive public finance policies and alternative revenue mobilization could be a potential strategy to increase the level of health spending in India.

1. Introduction

The expansion of public financing towards healthcare is one of the major strategies to reduce the burden of out-of-pocket expenditure and to achieve health-related Sustainable Development Goals (SDGs) by 2030 in developing economies like India (Lu et al. 2010; Meheus and McIntyre 2017; Marten et al. 2014). The United Nations (UN) general assembly adopted SDGs to achieve the unfinished agenda of Millennium Development Goals (MDGs) namely reduce child mortality, improve maternal health, and combat both communicable and non-communicable diseases (Boerma 2015). While India's progress on the MDGs achievement is below average than the other developing economies (Behera and Dash 2020; Duran et al. 2014; Marten et al. 2014)

As per the WHO (2019) Global Health Expenditure (GHE) database, the share of public health expenditure to Gross Domestic Production (GDP) is around 1.37% in India which is comparatively lower than the countries such as Thailand, Bhutan, Sri Lanka, and Vietnam. The slower growth of public expenditure on healthcare has become a great concern for policymakers, therefore efforts have to be made to generate finance for healthcare through conducive macroeconomic policies such as sustained economic growth, revenue mobilization, and lower level of fiscal imbalance in resource-poor economies (Meheus and McIntyre 2017; Heller 2006; Barroy et al. 2018). They argue that conducive macroeconomic factors are likely to be correlated with each other and the allocation of public health expenditure primarily depends on domestic revenue mobilization. Some country-level studies argue various revenue mobilization

channels – improve existing revenue collection; improving tax administration; reduce unwanted subsidies; health-specific taxation; increase tax base; and remove rigidities in tax structure through which the government could generate additional budgetary resource and priorities health spending (Lu et al. 2010; Meheus and McIntyre 2017; Duran et al. 2014; Reeves et al. 2015).

In the context of developing economies, few studies argue that higher revenue mobilization through conducive macro-fiscal policies and prioritization of health budget could be an alternative strategy to increase the allocation of public expenditure on healthcare (Reeves et al. 2015; Duran et al. 2014). Existing studies have explored the income elasticity of public health expenditure using state-level data by controlling unobserved heterogeneity but they have not measured income elasticity of health expenditure by controlling fiscal components – revenue mobilization strategy and borrowing using aggregate data which subsumes both federal government and state government (Behera and Dash 2019, Meheus and McIntyre 2017)). Additionally, there has no study in the Indian context has examined the elasticity of healthcare expenditure in both short-run and long-run by controlling structural breaks over the longer period from 1980-81 to 2015-16.

Very few studies namely Murthy and Okunade (2016); Chaabouni and Abednnadher (2014) have used a time series econometric model – Auto-Regressive Regression Lag (ARDL) model to examine the short-run and long-run income elasticity of health expenditure but in those studies, they have not taken into consideration fiscal policy components. The estimation procedure of the ARDL model involves three steps. First, it examines the stationarity properties of variables using Zivot and Andrew's (1991) unit-root tests and the advantage of this test is that it captures structural breaks in time series data. Second, examine the long-run associations among variables using the Auto-Regressive Distributed Lag (ARDL) bounds testing approach to cointegration. Third, it estimates both short-run and long-run elasticity of public health expenditure by controlling structural-break using the Unrestricted Error-Correction Model (ECM).

Our result implies that the accumulation of public debt is adverse while the effects of domestic revenue mobilization are positive towards public health expenditure in the long-run. Alternative revenue mobilization through conducive macroeconomic policies could be a suggestive alternative for financing healthcare in India.

This study is organized as follows. Section 2 discusses data and methods. Section 3 contains results and discussion. Section 4 holds conclusions.

2. Data And Methods

This study has formulated the following simple regression model to examine the effects of income growth, domestic revenue, and public debt on public health expenditure in India for the period from 1980-81 to 2015-16.

$$\ln PHE_t = \alpha_0 + \beta_1 EG_t + \beta_2 \ln REV_t + \beta_3 \ln DEBT_t + \mu_t \quad (1)$$

We have taken Public health expenditure (PHE) as our dependent variables which include both medical & public health and family welfare expenditure in both current and capital accounts of the general government (i.e. central and state) in India. We have taken Economic growth (EG), Total Revenue (REV), Total Debt (DEBT) as our independent variables. EG is calculated as the annual percentage change in Gross Domestic Product (GDP). REV includes the revenue generated from both tax and non-tax sources. Tax revenue includes both direct taxes and indirect taxes. Direct taxes include taxes on personal income, property, and capital transactions whereas indirect taxes include taxes on sales of goods & services. Non-tax revenue includes revenue generated from fees & fines, interest receipts from commercial enterprises, royalties from natural resources. Total debt (DEBT) includes both domestic and external liabilities. In Eq. (1) PHE is measured as a percentage of GDP; REV is measured as a percentage of GDP; DEBT is measured as a percentage of GDP; is a disturbance error term; is time; ln is the natural log. The data has been collected from the Handbook of Statistics on the Indian Economy published by RBI (2019). All the data are from combined government finance[1] which includes aggregate public health expenditure, aggregate revenue, and aggregate debt. All variables are in constant (real) prices at base 2004-05 and converted into a natural logarithm except EG for the empirical analysis.

Table 1 represents the descriptive statistics and pairwise correlation results of variables. We have found that the mean percentage of revenue (i.e. as a ratio of GDP) and the mean percentage of public debt (i.e. as a ratio of GDP) is 21% and 68% respectively in India. Similarly, the mean annual growth of GDP and mean percentage of PHE (i.e. a ratio of GDP) is 6% and 1.27% respectively. The gap between minimum and maximum range values of variables – DEBT and REV is larger but there is a very little gap between minimum and maximum values in PHE. The pair-wise correlation result shows that there is a positive association between PHE and REV while a negative association between PHE and DEBT. The simple correlation analysis could not be produced the strength of the association between variables. Therefore, we have employed advanced econometric methods to examine the short-run and long-run relationships between PHE and other macro-fiscal factors – EG, REV, and DEBT for the last 36 years of the Indian economy.

Table 1. Descriptive statistics and pairwise correlation

Variables	Definition	Mean	Std. Dev.	Min	Max	Pairwise correlation			
						PHE	EG	REV	BOR
PHE	Public Health Expenditure (as a percent of GDP)	1.272	0.102	1.135	1.549	1			
EG	Economic Growth (annual growth rate of GDP)	6.350	2.068	1.430	10.159	-0.177	1		
REV	Public Revenue (as a percent of GDP)	20.586	1.237	17.870	23.372	0.331	0.188	1	
DEBT	Public Debt (as a percent of GDP)	67.833	8.577	47.936	83.228	-0.293	0.134	0.262	1

Note: GDP: Gross Domestic Product; All variables are constant 2004-05 base year prices.

Source: Author's estimation from the Handbook of Statistics on Indian Economy, RBI (2019).

2.1 The Autoregressive Distributive Lag (ARDL) approach to Cointegration

To estimate Eq. (1), we have applied the Autoregressive Distributive Lag (ARDL) approach to cointegration, proposed by Pesaran et al. (2001).

$$\Delta \ln PHE_t = \alpha_0 + \sum_{i-1}^{n-1} \alpha_{1i} \Delta \ln PHE_{t-1} + \sum_{i=1}^{n-1} \alpha_{2i} \Delta EG_{t-1} + \sum_{i=1}^{n-1} \alpha_{3i} \Delta \ln REV_{t-1} + \sum_{i=1}^{n-1} \alpha_{4i} \Delta \ln DEBT_{t-1} + \beta_1 \ln PHE_{t-1} + \beta_2 EG_{t-1} + \beta_3 \ln REV_{t-1} + \beta_4 \ln DEBT_{t-1} + \mu_t \quad (2)$$

Eq. (2), Δ denotes the first difference operator of the respective variables and non-stochastic drift parameter. To find out whether there is a long-run cointegrating relationship among variables - PHE, EG, REV, and DEBT, we test the null that: H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ and the alternative hypothesis, H_a: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ by following a non-standard F-test statistics. If it rejects the null hypothesis of no cointegration in Eq. (2) statistically, we can say that there is a long-run association exists among the variables.

After getting a long-run association among variables using the ARDL bounds testing approach to cointegration, we can estimate the short-run and long-run elasticity of public health expenditure using the

following unrestricted Error-Correction Model (ECM):

$$\Delta \ln PHE_t = \alpha_0 + \sum_{i=1}^{n-1} \alpha_1 \Delta \ln PHE_{t-1} + \sum_{i=1}^{n-1} \alpha_2 \Delta EG_{t-1} + \sum_{i=1}^{n-1} \alpha_3 \Delta \ln REV_{t-1} + \sum_{i=1}^{n-1} \alpha_4 \Delta \ln DEBT_{t-1} + \lambda ECT_{t-1} + \upsilon_t \quad (3)$$

where λ is the speed of adjustment parameter and ECT (Error Correction Term) is the residuals from the estimated model in Eq. (3).

3. Results And Discussion

3.1 Results of Structural Break Unit Root Test

Table 2 shows the result of the Zivot-Andrews (1992) structural break unit root test. It is often the case that the series may suffer from structural breaks due to changes in macroeconomic policies, political and environmental factors. The traditional unit root tests - Augmented Dickey-Fuller (1979) and Phillips and Perron (1988) do not provide the information about the unknown structural break dates, thereby it provides a biased result. Therefore, to overcome this limitation, we have employed Zivot and Andrew's single structural break unit root test to check the existence of structural breaks if any in the level series (Shahbaz et al. 2016).

Table 2 results show that all the variables have unit roots in their levels and are found to be stationary at their first difference except for EG. The structural breaks are found in 1998, 2005, 1993, and 2000 in the level series of PHE, EG, REV, and DEBT respectively. Figure 2 also shows the graphical representation of structural breaks of all adopted variables. We have found that the structural break in REV is observed in the year 1993, which is closely associated with the tax system reform initiated by the tax reform committee in 1991. As a result, the direct tax-GDP ratio was improved from 2 percent in 1991-92 to 4.3 percent in 2004-05 (MOF, 2015)). Similarly, the structural break date of DEBT is found in 2000 and is partially due to fiscal adjustment before the enactment of the Fiscal Responsibility of Budget Management (FRBM) act. Further, we have found a break date – 1998 for PHE that obviously due to higher GDP growth envisaged during the ninth five-year plan (1997–2002). The GDP growth momentum continues till the tenth five-year plan (2002–2007) and this plan aims to achieve double per capita income. So, it might be a reason, we have got a break-data – 2005 for EG. It has been argued that since economic reforms, many macroeconomic policies have been adopted by the central government to strengthening the fiscal space at the state level and the resulting Indian economy has achieved double-digit growth around the eleventh five-year plan period (2007–2011). Overall breakpoint analysis over the entire study period implies that most of the macroeconomic uncertainties have occurred between 1991 and 2005 due to many fiscal restructuring arrangements in terms of tax reform, expenditure management, and debt swap schemes in the Indian economies.

Table 2
Zivot-Andrews (1992) structural break unit root test

Variables	Level		First Difference		
	T-statistics	Break	T-statistics	Break	Decision
ln PHE_t	-4.044 (1)	1998	-6.292* (0)	1985	I(1)
EG_t	-6.178* (0)	2005	----	----	I(0)
ln REV_t	-3.006 (0)	1993	-6.978* (0)	1999	I(1)
ln $DEBT_t$	-3.485 (2)	2000	-4.933** (0)	1997	I(1)

Notes: *, ** and *** denote the significance at 1%, 5%, and 10% level; parenthesis shows the lag order for estimation; ln denotes natural logarithm; I (1) denotes the integration of order 1 or first difference stationary series whereas I (0) denotes the integration of order 0 or level stationary series.

Source: Author's representation

3.2 Result of ARDL Bound Testing approach to Cointegration

The Traditional cointegration test by Engle and Granger (1987); Johansen and Juselius (1990) have provided efficient parameter estimates but fails to accommodate the structural breaks in the series. This issue is overcome by applying the most widely used ARDL procedure to cointegration proposed by Pesaran et al. (2001) in the presence of structural breaks. The application of the ARDL model has several advantages over alternative traditional models. First, the ARDL model does not require the order of integration of the variables used in the analysis. Second, the ARDL bounds test produces robust results for small sample sizes ranging from 30 to 80 and as our sample size falls in this range, we use the critical bounds values provided by Narayan (2005); Third, the ARDL technique solves the issue of endogeneity in the model estimation due to the incorporation of lagged values of both dependent and independent variable in the model (Shahbaz et al. 2016).

Table 3 reports the results of the Pesaran et al. (2001) ARDL bounds testing approach to cointegration. The calculated F-statistics are found to be greater than the upper bounds critical values when PHE, EG, REV, and DEBT are used as dependent variables (see column 4). This implies that the ARDL bounds test confirms the existence of long-run relationships among variables over the period from 1980-81 to 2015-16. The long-run relationships among variables have been exhibited by ARDL bounds testing cointegration graphs (See Fig. 3).

Table 3
Results of ARDL bounds testing approach to cointegration

(1)	(2)	(3)	(4)
Estimated equation	**Optimal lag**	**Breaks**	**F- statistics**
$lnPHE_t = f(EG_t, lnREV_t, lnDEBT_t)$	3, 2, 2, 4	1998	15.276*
$EG_t = f(lnPHE_t, lnREV_t, lnDEBT_t)$	1, 4, 4, 1	2005	12.925*
$lnREV_t = f(EG_t, lnPHE_t, lnDEBT_t)$	4, 3, 1, 4	1993	14.121*
$lnDEBT_t = f(lnREV_t, EG_t, lnPHE_t)$	1, 4, 0, 4	2000	5.775**
Narayan (2005) significance level	t = 36, k = 4		
	I(0)	I(I)	
	5.17	6.36	1%
	4.01	5.07	5%
	3.47	4.45	10%
Notes: *, ** and *** denote the significance at 1%, 5% and 10% level.			

Source

Author's estimation

3.3 Result of Short-Run and Long-Run Elasticity of Public Health Expenditure

The existence of long-run association among variables using the ARDL bounds testing approach to cointegration leads us to examine the short-run and long-run effects of domestic revenue and public debt on public health expenditure by controlling economic growth and structural break – 1998 dummy. Using structural break – 1998 dummy as one of the explanatory variables while the measuring elasticity of PHE would provide the significance of the particular reform during that period.

Table 4 presents the long-run ARDL model which estimates the long-run elasticity of public health expenditure. It shows that the effects of EG and REV on PHE are positive, while the effects of DEBT on PHE are negative in the long-run. The estimated coefficient of EG and REV implies that a 1 percent increase in GDP growth annually leads to a 0.04 percent increment in PHE on average, while a 1 percent rise in revenue productivity leads to a 0.78 percent increment in PHE. Earlier studies found similar positive relationships between per capita public health expenditure and per capita tax revenue in selected Indian states, find that a 1 percent rise in tax revenue leads to a 0.73 percent increment in per capita public health expenditure in the long-run (Behera and Dash, 2019b). Similarly, we have found that DEBT shows a

negative and statistically significant relationship with PHE. The estimated coefficient implies that a 1 percent increase in total debt annually, leads to a 0.51 percent reduction in PHE in the long-run.

Table 4
Long-run ARDL bound testing cointegration test

Dependent variable = ln PHE_t			
Variable	Coefficient	Std. error	T - statistics
EG_t	0.045***	0.025	1.780
ln REV_t	0.780*	0.075	10.309
ln $DEVT_t$	-0.513*	0.061	-8.410
Break dummy – 1998	0.032	0.023	1.393
Constant	-0.035	0.350	-0.101
R^2	0.845	...	...
Diagnostic tests			
Tests		F-statistics	Prob. value
Jarque-Bera Normality test		1.021	0.600
BG Serial Correlation tests		0.802	0.469
Heteroscedasticity ARCH test		0.081	0.777
Ramsey RESET test		0.012	0.914
Stability test			
CUSUM		Stable	5%
$CUSUM_{sq}$		Stable	5%
Notes: *, ** and *** denote the significance at 1%, 5% and 10% level.			

Source

Author's estimation

Table 4 also presents the results of the structural dummy. We have added the structural break dummy in our ADDL estimated equation to examine the effects of fiscal reform in the year 1998 on the growth of PHE in India. We find that there is a positive association between PHE and fiscal reform which took place during the period 1991 to 2000. The study has argued that from 1993 to 1998 was a period of initial economic reforms in the country and fiscal restructuring arrangements were undertaken at the state level.

So, the policies adopted in 1998 for fiscal consolidation show a positive effect on PHE but not a statistically significant impact on the rise of health expenditure in the long-run.

Table 5
Short-run ARDL bound testing cointegration test

Dependent variable = ln PHE			
Variable	**Coefficient**	**Std. error**	**T - statistics**
Δ ln PHE_{t-1}	0.679*	0.172	3.930
Δ ln PHE_{t-2}	0.380	0.202	0.080
Δ EG_t	-0.000964	0.024	-0.039
Δ EG_{t-1}	-0.034	0.024	-1.414
Δ ln REV_t	0.164	0.198	1.827
Δ ln REV_{t-1}	-0.620*	0.206	-3.011
Δ ln $DEBT_t$	-0.011	0.283	-0.038
Δ ln $DEBT_{t-1}$	1.124*	0.312	3.596
Δ ln $DEBT_{t-2}$	0.720**	0.274	2.625
Δ ln $DEBT_{t-3}$	0.451**	0.195	2.303
Break Dummy – 1998	0.050	0.035	1.448
Trend	-0.001	0.001	-0.712
ECT $_{t-1}$	-1.561*	0.213	-7.317
Notes: *, ** and *** denote the significance at 1%, 5% and 10% level.			

Source

Author's estimation

Table 5 presents the short-run ARDL model which estimates the short-run elasticity of public health expenditure. The elasticity of PHE concerning EG and REV shows that the effect of REV is positive and statistically insignificant, while the effects of EG are negative and statistically insignificant to the growth of PHE in the short-run. The result implies that the short-run income growth and domestic revenue generation do not affect the current level of health spending rather it has positively contributed to generate finance for healthcare in the long-run. On the contrary, the elasticity of PHE to DEBT is negative and insignificant in the short-run ARDL model. The result implies that the accumulation of DEBT in the

current period has negative consequences on the allocation of expenditure on healthcare in the long-run. It implies that lag DEBT has positive and significant relationships with the growth of PHE in the short-run. Our result is similar to those of Lu et al. (2010) and Reeves et al. (2015) who have suggested the positive effects of domestic revenue on public health expenditure in low and middle-income countries. Further our result is similar to those of Lora and Olivera (2007) find that higher debt ratios reduce public health expenditure in the long-run using cross-country samples.

The result of the error-correction term, (ECT_{t-1}) presents in Table 5 and which is significant at the 1 percent level and exhibits the expected negative sign. It implies that 1.56 percentage of short-run disequilibrium in healthcare demand and supply originating from the past macroeconomic shocks adjusted in the current period, and the speed of adjustment towards long-run equilibrium is relatively faster.

3.3.1 Diagnostic and Stability test of ARDL model

Table 4 presents the diagnostic test results of the selected ARDL long-run model. The diagnostic tests in our analysis suggest that error terms of short-run models are normally distributed; free from serial correlation, heteroscedasticity (ARCH), and multicollinearity (RESET).

Figure 4 presents the stability of the ARDL cointegration model, using the cumulative sum of recursive residuals (CUSUM) and the CUSUM of the square (CUSUMSQ) tests suggested by Brown et al. (1975). The graphs for both the tests fall within the critical bounds at 5 percent levels of significance that implies the estimated coefficients of the ARDL cointegration model of PHE (3, 2, 2, 4) is stable. The advantage of using a stability test is that it provides a consistent and unbiased parameter by rectifying any model misspecification in the model (Murthy and Okunade 2016; Shahbaz et al. 2016).

4. Conclusions

Measuring income elasticity of healthcare expenditure in both short-run and long-run by controlling fiscal policies and structural breaks have been overlooked by the health financing literature. Using a time-series econometric framework, this study examines the effects of domestic revenue and public debt on healthcare expenditure in India for the period from 1980-81 to 2015-16. The empirical results have found the following insights. First, the ARDL bounds testing approach to cointegration confirms that healthcare expenditure shows a long-run comovement with other macroeconomic factors - domestic revenue; public debt, and economic growth. Second, domestic revenue (tax and non-tax) shows an important factor to rise in healthcare expenditure while public debt (domestic and external) shows a detrimental impact on health expenditure in the long-run respectively. The elasticity coefficient shows that a 1 percent increase in domestic revenue leads to a 0.78 percent increment in healthcare expenditure annually while a 1 percent increase in public debt leads to a -0.51 percent reduction in health expenditure. Third, 1.56 percentage of short-run disequilibrium originating from the past shocks (i.e. structural breaks) adjusted in the current period, and the speed of adjustment towards long-run equilibrium in healthcare demand and

supply is relatively faster. Our result concludes that the conducive public finance policies through higher revenue mobilization could be the potential source of financing healthcare in India.

This study makes an initial effort in analyzing the potential long-run effects of revenue mobilization – domestic revenue and public debt on financing healthcare in an emerging economy. This paper does not consider other sources of revenue such as health-specific taxes and external health grants due to the lack of data. The empirical work on the assessment of public expenditure on health in a time-series framework has been sparse, therefore this work will help design effective public financing policies in other resource-poor economies.

Declarations

Ethics approval and consent to participate

Not Applicable

Consent for publication

Not Applicable

Availability of data and materials

The data used for this study can be obtained from the Handbook of Statistics of Indian Economy of the Reserve Bank of India (RBI). These data are available in the public domain for research purposes.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

DKB and UD equally contributed to the design of the study, data analysis, and writing of the manuscript. DKB estimated the empirical results and UD verified the results. All authors read and approved the final manuscript.

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Figures

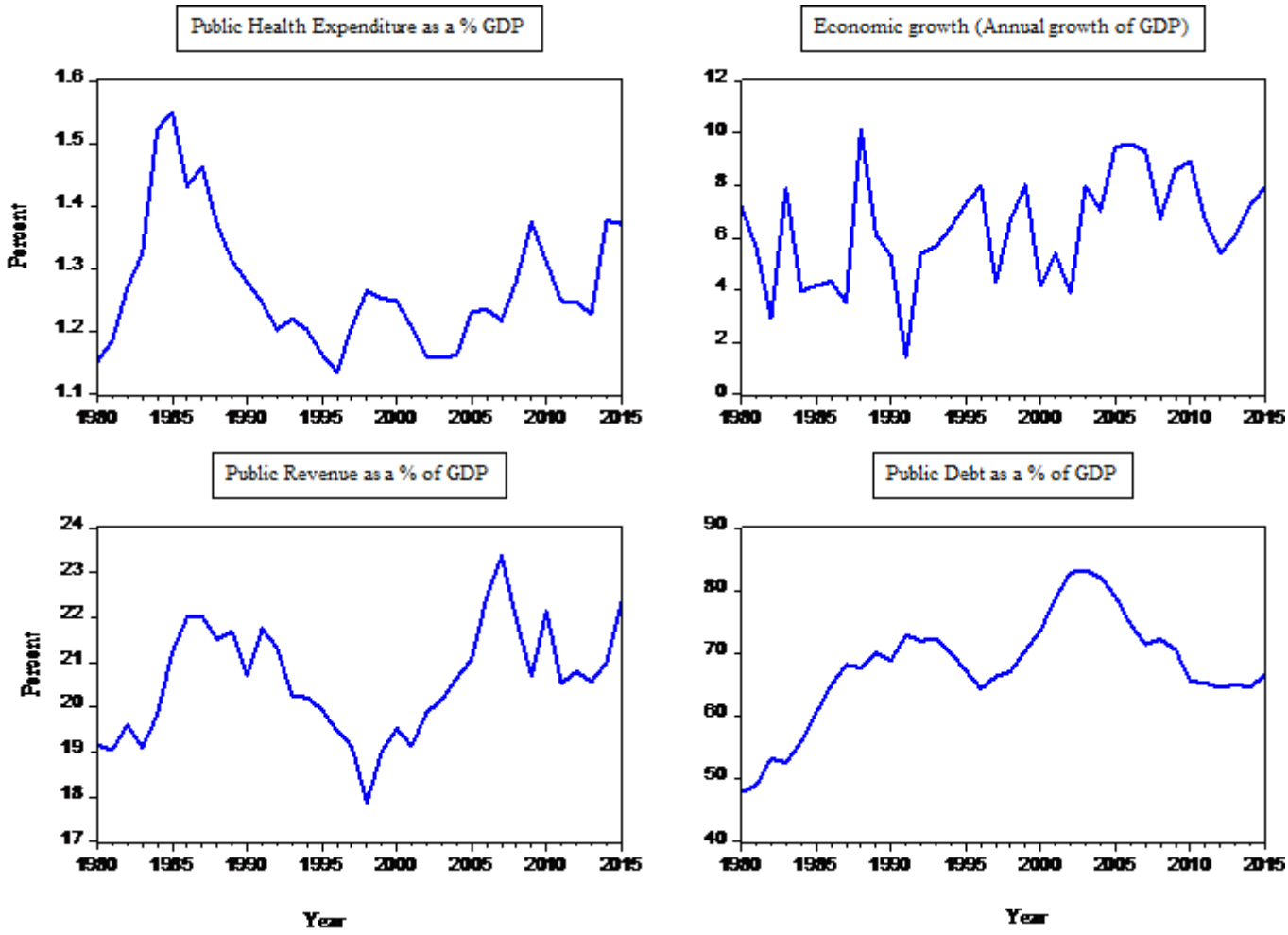


Figure 1

Trends in the variables (1980-2015).

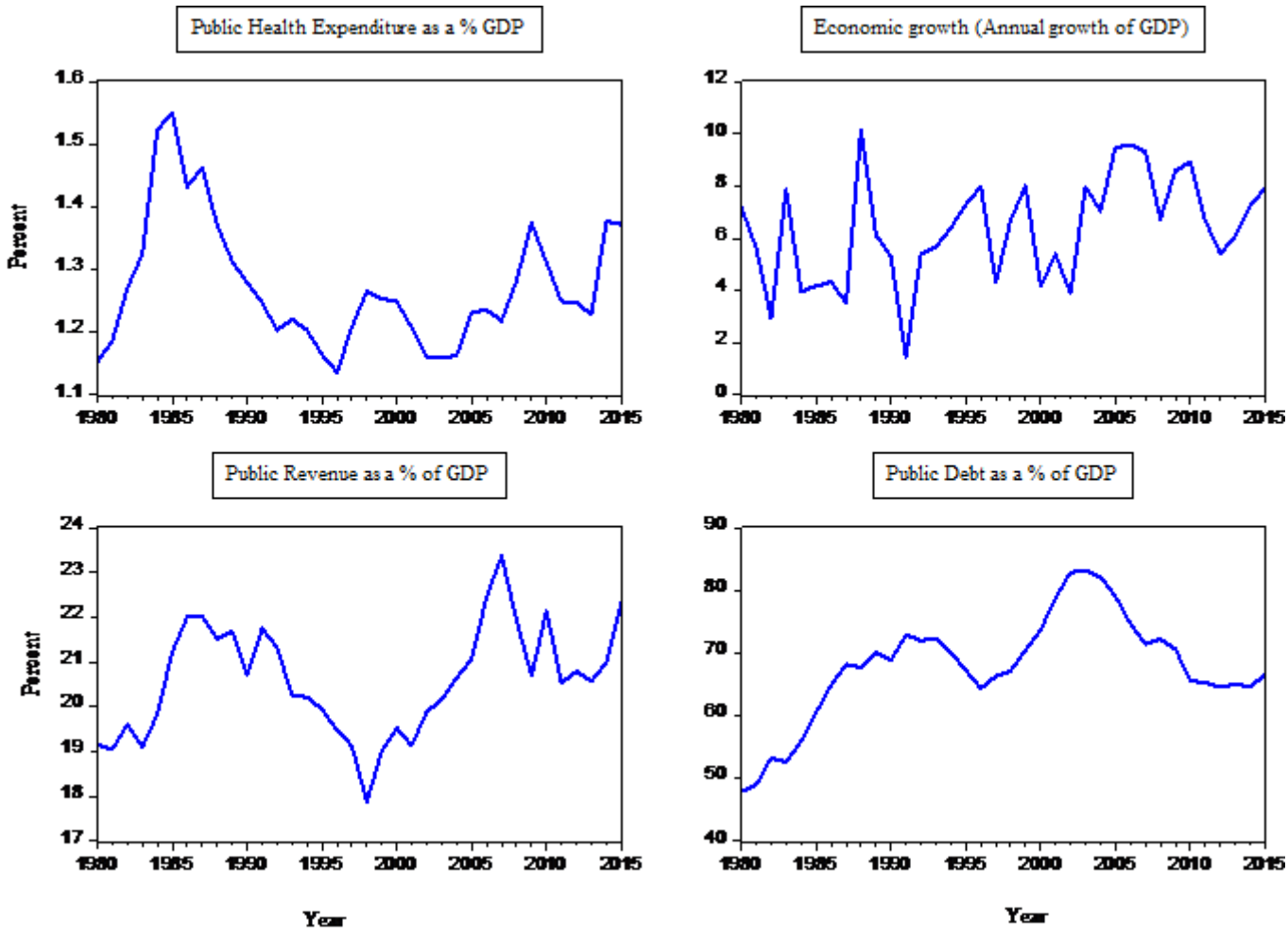


Figure 1

Trends in the variables (1980-2015).

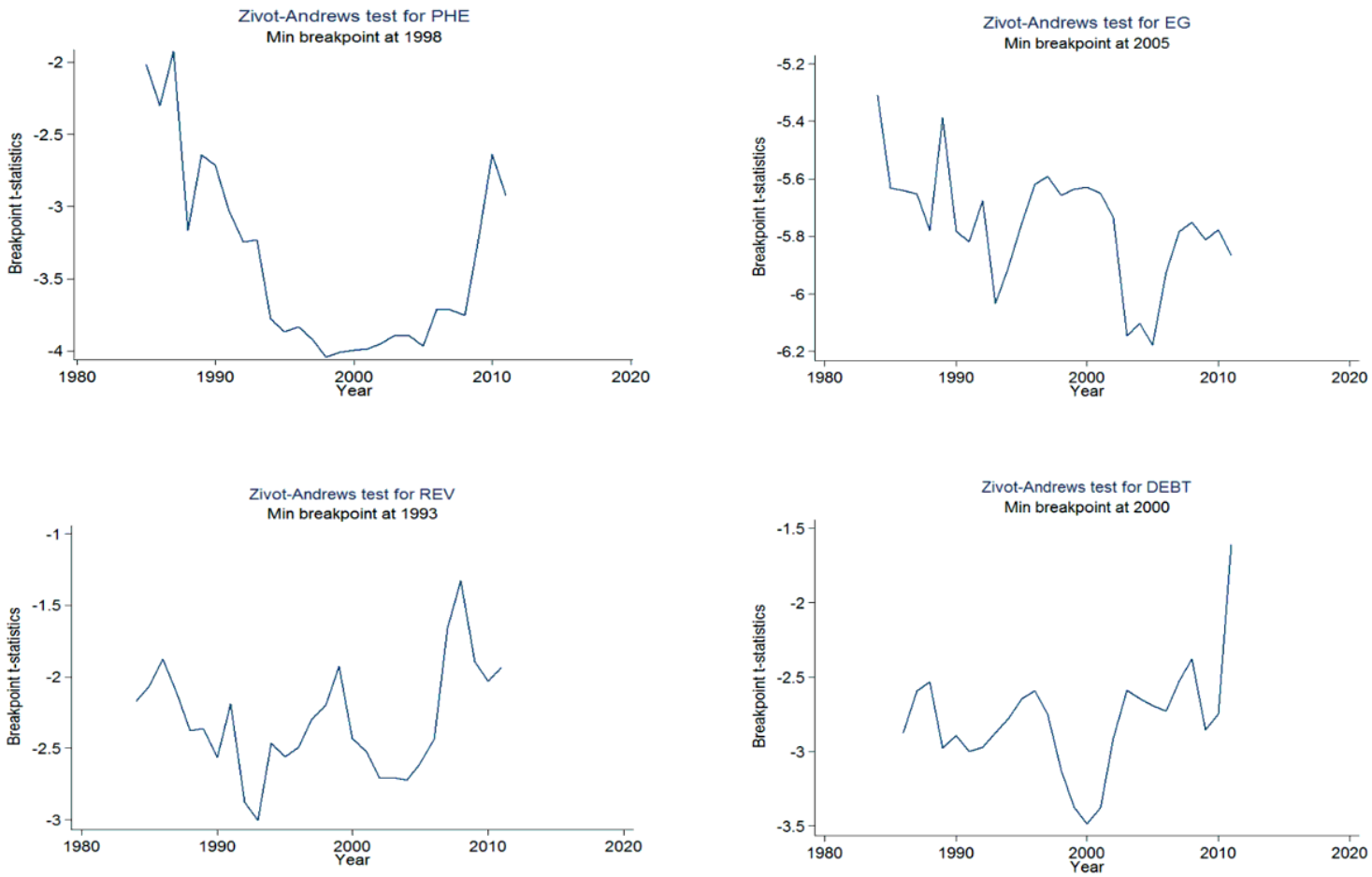
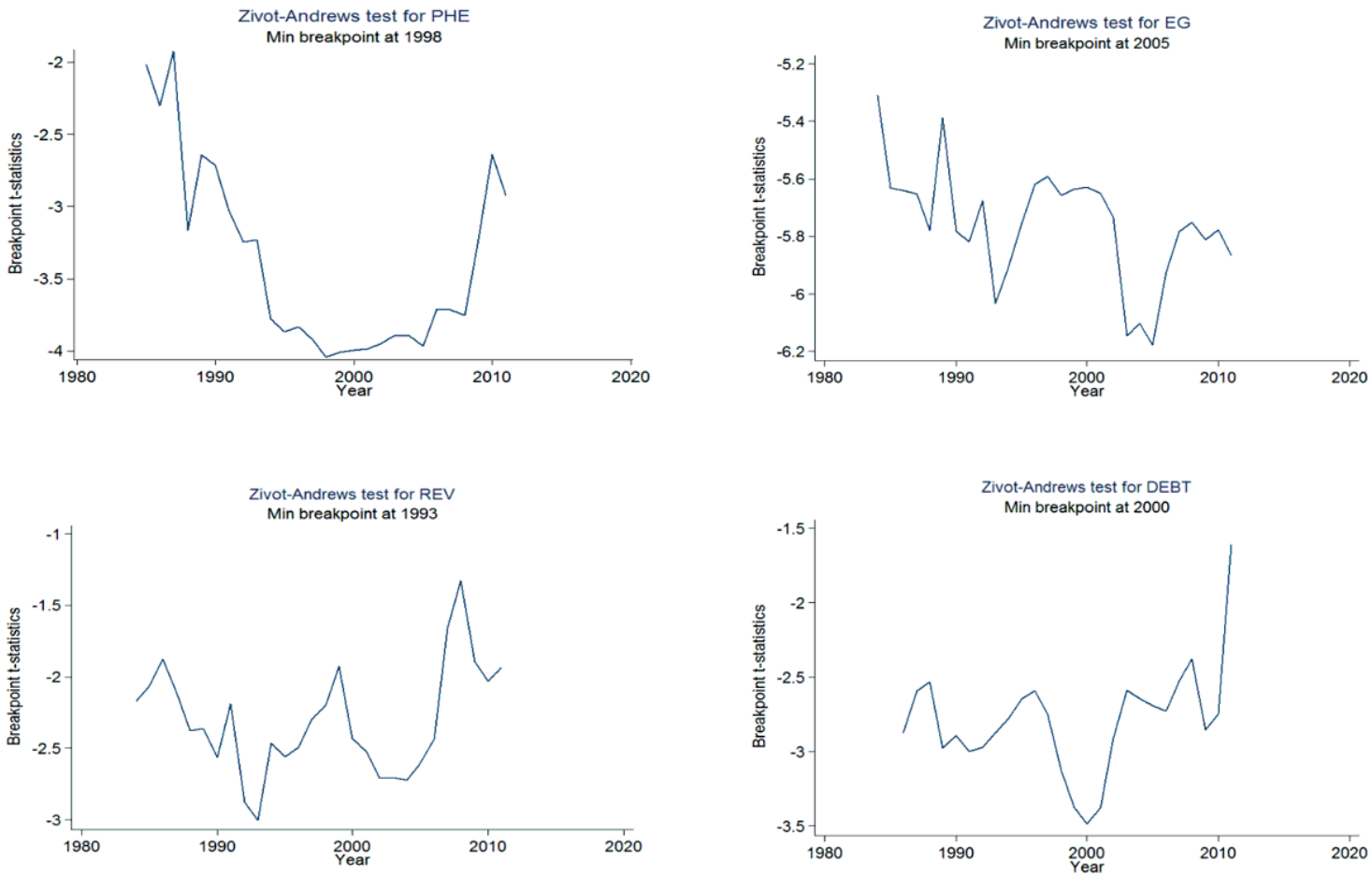


Figure 2

Zivot-Andrews Structural breaks in level series



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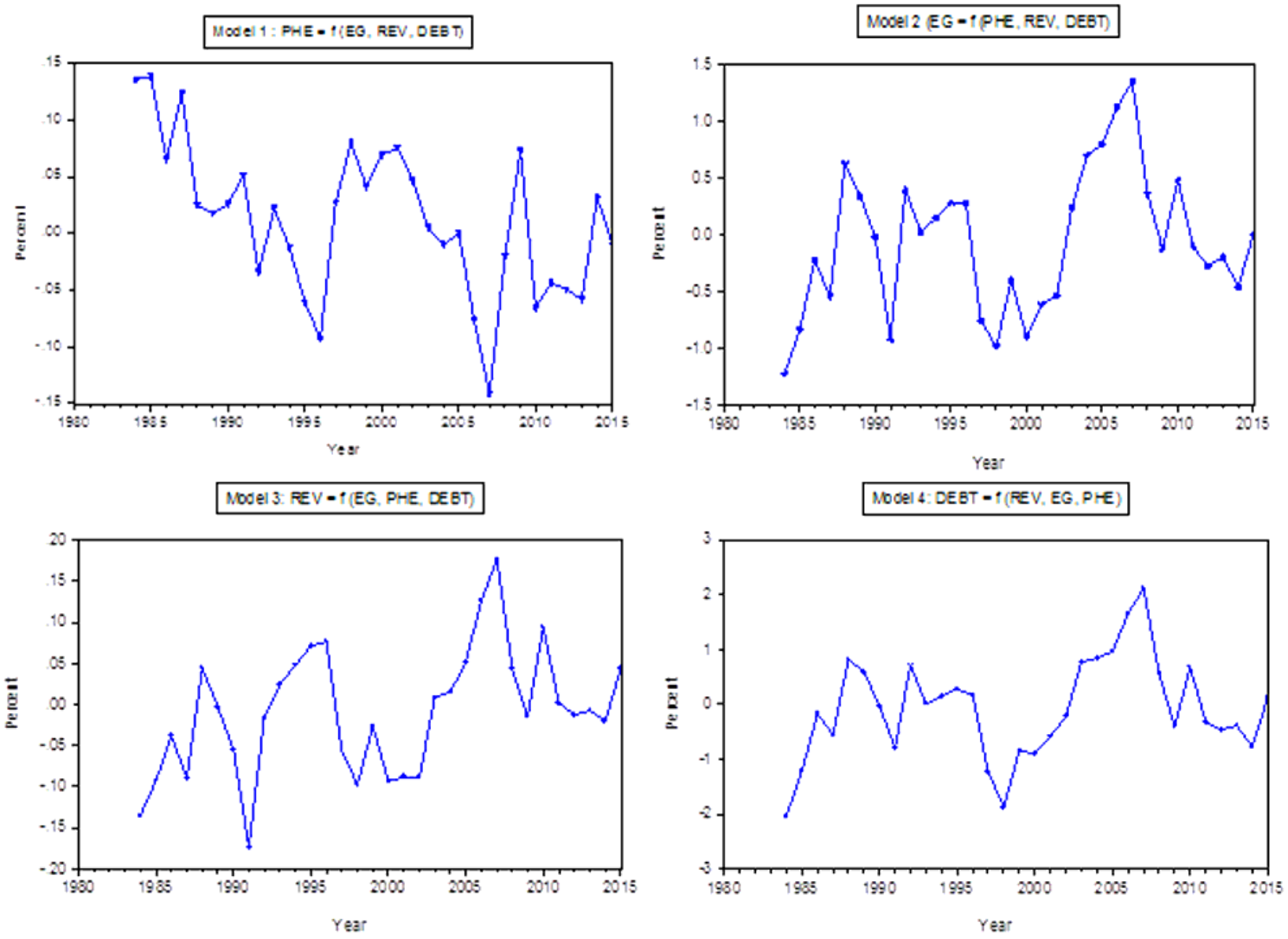


Figure 3

ARDL bound testing cointegration

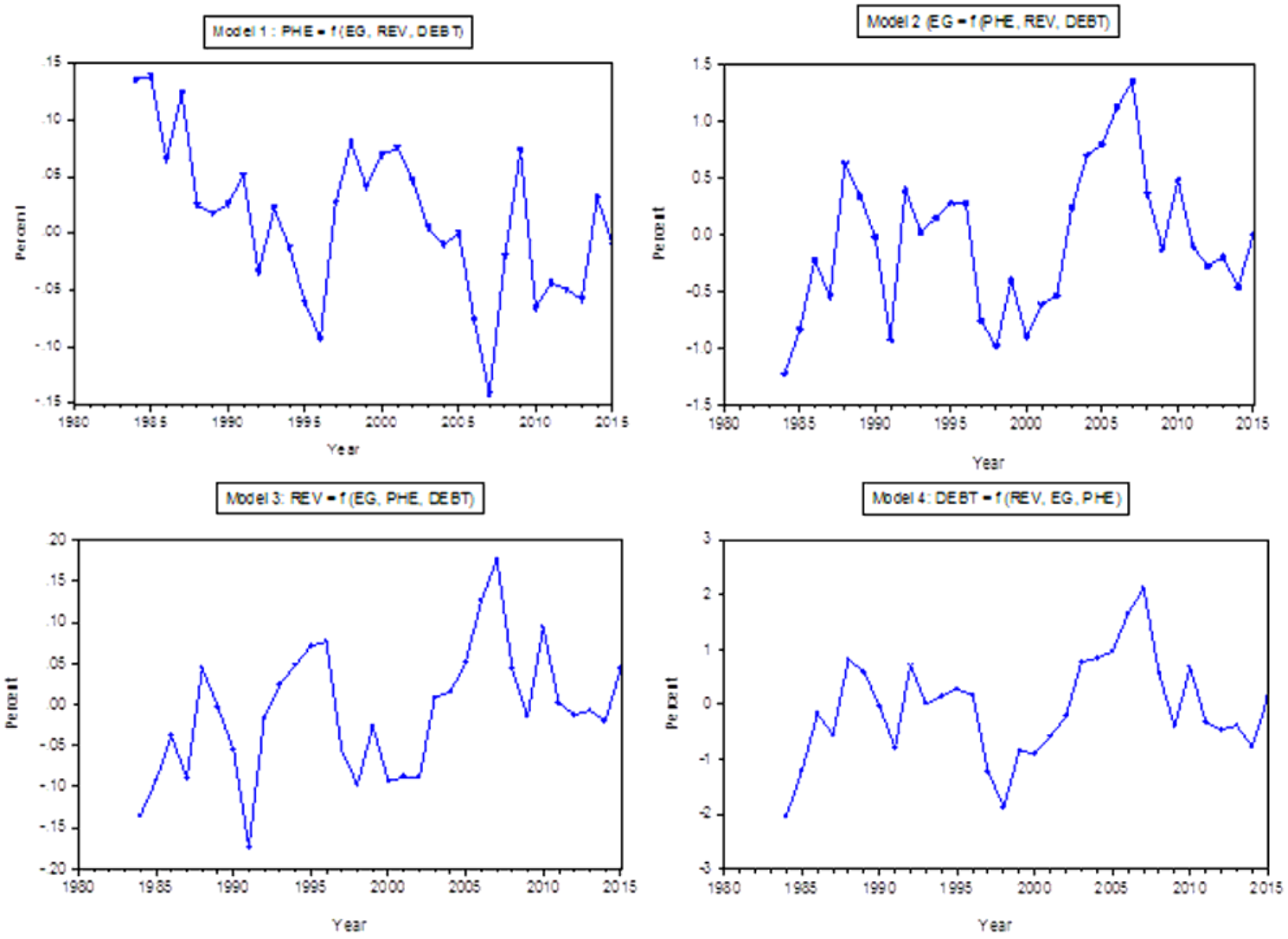


Figure 3

ARDL bound testing cointegration

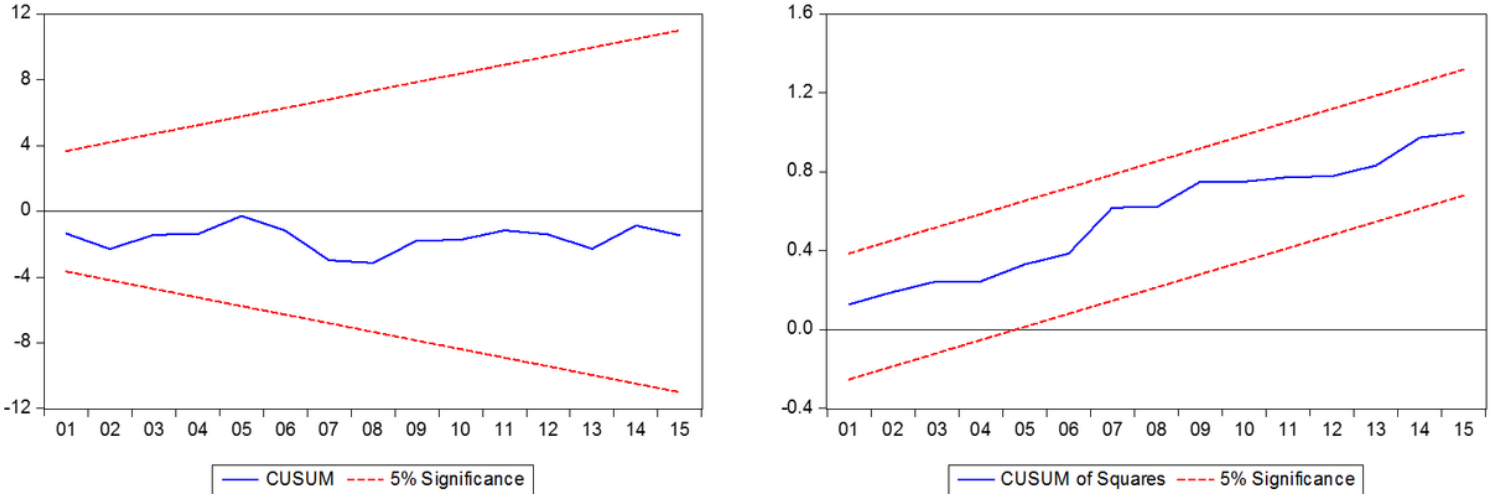
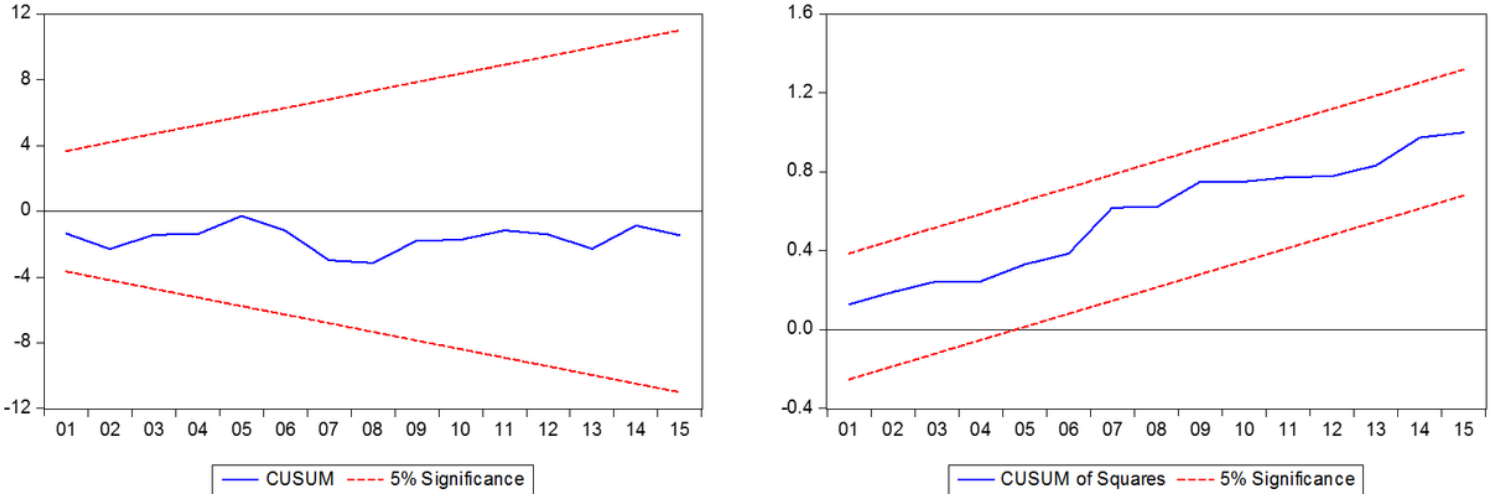


Figure 4

CUSUM and CUSUMsq stability test



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