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Investigating Structural Breaks in Selected Finance-Growth Variables in Nigeria. A Saikkonen and Lutkepohl (2002) Approach

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Abstract: The need to identify point of break in economic variables cannot be over emphasized and thus, the need for this study to investigate the point of structural break in some selected financial sector variables in Nigeria using the Saikkonen-Lutkepohl (2002) method. The study identifies years 2008 as point of break for private sector credit ratio to GDP and Broad money supply ratio, 1986 for GDP per capita, 2007 for Market capitalization ratio, 2006 for Liquidity ratio, 2001 for investment ratio and 2005 for openness ratio. The study recommends that structural breaks should be considered in any finance-growth modeling to avoid spurious results which may ultimately lead to wrong or inappropriate policy formulation and may be counterproductive to the objective of economic growth and financial development.
Key words: Financial Sector, Structural Breaks
JEL Classification:C18, G0, O4

1. Introduction

Having a good understanding of the movements in financial development indicators such as the ratio of the broad money supply to GDP (M2Y) and ratio of market capitalization to GDP (MCY) is important for the conduct of monetary policies. The behaviour of these indicators and other variables in relation to GDP may convey corroborative information about the current level of financial development in the economy and also provide to large extent information about future movements in these variables which are reflected in official statistics. Statistics show discernible instability in the growth movements of financial sector variables in Nigeria. For example, the ratio of market capitalization to GDP rose from 5per cent in 1981 steadily to about 50 per cent in 1992 but rose sharply to 170

percent in 1995, falling steadily to an average of 52 percent between that time and 2000. The ratio fell drastically from about 160 percent in 2006 to negative values in 2010. In the same spurious manner, the ratio of broad money supply (M2Y) experienced a slight decline of about 5 percent from 1970 to 1974 to 10 percent but rose sharply to about 22 percent from 1975 to 1980 and a further sharp rise from 22 percent to 33 percent between 1981 and 1985. Also, between 1991 and 1995, the ratio declined sharply from 26 percent to 13 percent. This variable also experienced a sharp rise between 2003 and 2010. The implication of these unstable movements is that any forecast on the relationship between financial sector variables and economic growth may be inaccurate if structural breaks in the variables are not taken into consideration. The knowledge of break point is very important for accurate evaluation of any program or policy that is aimed at bringing about structural changes; such as capital market reforms, the tax reforms, banking sector reforms and regime shifts etc. Information on the structural break in the time series is very important so as to avoid model misspecification as this may result into wrong/spurious results and ultimately, misguided policy formulation. The macroeconomic objective desired to be achieved in developing the financial sector and to enhance economic development and growth may therefore, not be achievable as a result of wrong model specification..

Previous studies on finance-growth nexus did not take this into consideration thereby, necessitating the need to determine the break points (dates) of each of the financial variables in the study. The objective of this study therefore is to determine the points of structural changes in financial sector variables and economic growth variables in Nigeria over the years.

2. Literature Review

Several studies have critically examined the relationship between financial development and economic growth. Majorly, substantial empirical evidences have been provided to lend credence to the existence of a robust finance-growth relationship. However, the validity of these empirical evidences in the face of structural break may not guarantee. Therefore, studies have begun to give keen attention to investigating the validity of finance-growth relationship in the face of structural break.

Study by Rioja & Valev (2004) investigated the relationship between financial development and economic growth based on level of financial development (Divided in three regions). The study also applied panel econometric technique of generalized method of moment to time series data from 74 countries to determine the validity of finance- growth relationship. The study reported strong evidences to support robust relationship between financial development and economic growth especially in intermediate region. Another study by Deidda & Fattouh (2002), finance- growth nexus within the framework of non-linear and possibly non-monotonic assumption. With the use of threshold regression method of estimation, the outcome suggests that the theoretical presumptions of financial depth - growth relationship is valid in the face of structural breaks. Similar study

by Huang & Lin (2009) also provided empirical evidence in this direction.

More recent study by Arcand, Berkes, & Panizza (2015) further investigated the existence of threshold effect in financial depth –growth nexus. The study was based on non-monotonic assumption and employed both parametric and non-parametric ordinary least square regression. The report from the study established vanishing effect of financial depth–growth nexus. This suggests that at a particular threshold the positive effect of financial development on growth will start diminishing. This is not new as previous study by Rousseau and wachtel, 2011; Rioja and Valev, 2004 & Huang & Lin, 2009 have given insight in this direction. However, the study employed a wide range of econometric methods and strictly worked under non-monotonic assumption to achieved their results.

Apart from these array of panel studies, empirical efforts at the country- specific level have been recognized. Towards this direction, study Mukhopadhyay & Pradhan (2011) examined causal relationship between financial development and economic growth in Indonesia using ARDL bound testing approach. The study identified structural breaks in the relationship and reported that finance doesn't matter for economic growth. Another study by Uddin, Sjö & Shahbaz (2013) investigated finance-growth nexus in Kenya based on ARDL bounds testing and Gregory and Hansen's structural break cointegration approaches. Contrary to the study Mukhopadhyay & Pradhan (2011), the study empirically established that there is positive relationship between financial development and economic growth in the presence of a structural break. In related study by Olowofeso, Adeleke & Udoji (2015) using Gregory and Hansen (1996) cointegration test that account for structural breaks and endogeneity inherent in most previous studies, the study examined the impacts of private sector credit on economic growth in Nigeria. The study reported positive effect of private sector credit on output in Nigeria.

Bist and Bista (2018) investigates the relationship between financial development and economic growth in Nepal using time series data between 1984 and 2014. The study also sought to determine the presence of structural breaks in the variables adopted using the Zivot and Andrews (ZA) unit root test method and found the presence of structural change in Private sector credit in 2007, real GDP and per capita growth in 2001. In the same vein, Medeiros et al. (2018) conducted structural break tests to determine the possibility of changes in the discharge of the Brazilian monetary policy during the inflation-targeting regime and the study concludes that structural break occurred in the third quarterin the parameters of monetary rule.

The current study is providing further evidences in respect of finance-growth nexus with emphasis on structural break in the relationship between the two variables.

3. Methodology

The model is based on the previous works of King and Levine (1993), Levine and Zervos (1998), Wachtel (2001), Christopoulos and Tsionas (2004), Seetanah et al. (2010). The

model primarily shows the relationship among GDP per capita (GDPK), ratio of private sector credit to GDP (PSCY), ratio of broad money supply to GDP (M2Y), market capitalization ratio (MCY), liquidity ratio (LRY), investment ratio (INVRY) and trade openness (OPNY). The study is a 35-year time series study from 1982-2016 with the data sourced from the Central Bank of Nigeria (CBN) statistical bulletin (various issues). These variables are specified in the model below;

The Saikkonen, and Lütkepohl (2002) test

$$GDPK_t = f(M2Y_t, PSCY_t, MCY_t, LRY_t, INVRY_t, OPNY_t) \quad (1)$$

The Saikkonen, and Lütkepohl (2002) test

Expressing the model in its explicit form is;

$$GDPK_t = M2Y_t^{\mu}\, PSCY_t^{\theta}\, MCY_t^{\gamma}\, LRY_t^{\omega} INVRY_t^{\Omega}\, OPNY_t^{\psi} \varepsilon_t \quad (2)$$

The Saikkonen, and Lütkepohl (2002) test

Linearizing and logging equation (2),

$$lnGDPK_t = \alpha_0 + \mu lnM2Y_t + \theta lnPSCY_t + \gamma lnMCY_t + \omega lnLRY_t + \Omega lnINVRY_t + \psi lnOPNY_t + \varepsilon_t \quad (3)$$

Where ε_t is white noise error term; α_0 is the constant parameter and $(\mu, \theta, \gamma, \omega, \Omega \text{ and } \psi)$, are the slope coefficients of each variable.

3.1 Unit Root Testing with Structural Breaks

The Saikkonen, and Lütkepohl (2002) test

The traditional view of the unit root test hypothesis held that current shocks only have a transitory/permanent effect and the long-run movement in the series is unaffected by such shocks. The most important consequence under the unit root hypothesis generated by Nelson and Plosser (1982) is that the random shocks have enduring/permanent effects on the long-run level of macroeconomics; meaning that the fluctuations are not transitory. A structural break occurs when there exists a sudden and unexpected shift/change in a macroeconomic time series. This could also result to a large error in forecasting and thereby rendering the model unreliable in general. Recent literature has stressed the need to move away from the traditional method of unit root testing to testing for structural breaks in unit root testing in typical economic data sets (Christiano, 1992; Banerjee et al., 1992; and Zivot and Andrews, 1992). The procedure for testing the unit root hypothesis, which allows for possible presence of structural break has its own advantages; firstly, it prevents generating a test result which is biased towards non-rejection (Perron, 1989) and secondly, because this procedure can identify when the possible presence of structural break occurred, then it would provide useful information for analyzing whether a structural break on a certain variable is associated with a particular government policy, economic crises, wars, regime shifts or other factors.

The importance of testing structural breaks was championed by the work of Perron (1989) when he criticized the seminal work of Nelson and Plosser (1982). He stated that Nelson and Plosser's strong evidence in favor of the unit root hypothesis for thirteen (13) of fourteen (14) economic and financial aggregate for United States of America is based on their failure to take into consideration, the structural change in the data. According to Perron, the date of

a potential break in the data is assumed to be known, which is now incorporated exogenously in the model and then unit root is tested for the variable. This is usually termed as unit root testing with exogenous structural breaks.

Perron uses a modified Dickey-Fuller (DF) unit root tests that includes dummy variables to account for one known, or exogenous structural break. The break point of the trend function is fixed (exogenous) and chosen independently of the data. Perron's (1989) unit root tests allows for a break under both the null and alternative hypothesis. (Glynn et al. 2007). This work of Perron did not come without its own criticisms. Christiano (1992), Banerjee et al. (1992), Zivot and Andrews (1992) amongst others argued that using a framework where there is a fixed break point is inappropriate as it is unreasonable to determine the choice independently of the data. In their opinion, they assert that it is only appropriate to determine the break date endogenously. Zivot and Andrews (1992) adopted an alternative method by using a data-dependent algorithm to determine the break point and finite-sample critical values, reject the unit root null at 5% significance level for only three out of thirteen Nelson-Plosser series; the real GNP, nominal GNP and industrial production.

To examine the statistical properties of the series, we use unit root tests, specifically, the augmented Dickey-Fuller (ADF) test and the Saikkonen and Lütkepohl (SL) test, which take into account the influences of unknown structural changes in the data. In addition, Saikkonen and Lütkepohl (2002; see also Lanne and Saikkonen, 2002) posit that a shift may spread over several periods rather than being restricted to a single period (Lütkepohl, 2004). The tests used enables to examine the null hypothesis of a unit root based on the following general specification:

$$X_t = \mu_0 + \mu_1 t + f_t(\theta)\,\gamma + z_t, \qquad (4)$$

where θ and γ are unknown parameters, t is the time trend, the error term *z* is generated by an AR(p) process, and $f_t(\theta)'\gamma$ is the shift function, which depends on θ and the regime shift date T_B. We therefore consider three shift functions:

1. A simple shift dummy,

$$f_t^1 = d_{1,t} = \begin{cases} 0, & t < T_B \\ 1, & t \geq T_B \end{cases}. \qquad (5)$$

2. The exponential distribution function, which allows for a nonlinear gradual shift to a new level, starting at time T_B

$$f_t^2(\theta) = \begin{cases} 0, & t < T_B \\ 1 - \exp[-\theta(t - T_B + 1)], & t \geq T_B \end{cases}. \qquad (6)$$

3. A rational function in the lag operator applied to a shift dummy,

$$f_t^3(\theta) = \left[\frac{d_{1,t}}{1 - \theta L} \quad \frac{d_{1,t-1}}{1 - \theta L} \right]. \qquad (7)$$

We first estimate the deterministic term with generalized least squares (GLS), then apply an ADF test to the adjusted data, which include the series obtained by subtracting them from the original series. Following the data observations,

we decide to retain or not a linear trend for the series.

4. Result of Unit Root Test with Structural Break

The result of the Saikkonen and Lütkepohl unit root test are presented in table 1. The break dates for the variables are endogenously determined within the model. The result suggests that we reject the null of unit root for MCY and LRY at 1 percent and 10 percent level of significance respectively while we fail to reject the unit root hypothesis for the remaining 5 series. It is very obvious from the table that there is a clear contrast between the results got from the unit root test with structural and the results got from the unit root test without structural breaks for the series.

Also, the test endogenously identifies the point of the single most significant structural break (*TB*) in every time series examined in this study. The break-date for each series is reported in table 1. Generally, if the break-date were exogenously determined by the researcher, the year 1986 would have been the most appropriate date, because it is the year which Nigeria embarked on the restructuring of the economy through the Structural Adjustment Program (SAP), but this wasn't so, as the break-dates were endogenously determined by the model itself. For the GDP per capita (GDPK), the break date is 1986 and this could be adduced to the deregulation policy of the Structural Adjustment Program (SAP) policy of 1986 in Nigeria. This is similar to the work of Bist and Bista (2018). The break date in broad money supply ratio (M2Y) and private sector credit ratio to GDP (PSCY) in Nigeria was 2008 and this can be attributed to the impact of the global financial meltdown and also, the aftermath effect of the bank sector recapitalization that commenced in 2005. This is in conformity with the work of Olowofeso, Adeleke and Udoji (2016) which confirms the presence of structural break in the Private Sector Credit in Nigeria.. The break date of market capitalization ratio (MCY) is 2007 and this also can be ascribed to the effect of the 2005 financial sector recapitalization coupled with the immediate effect of the global financial crises of 2007. The break date of liquidity ratio (LRY) and investment ratio is 2001 and the break date of trade openness ratio (OPNY) was in 2005 and policy change and policy imbalance are possible reasons for the structural changes.Among the studies that established the presence of structural changes are the studies of, Mukhopadhyay & Pradhan (2011), Arcand, Berkes, & Panizza (2015),

From the knowledge of these break dates in the variables therefore, equation (3) can now be re-specified as;

$$lnY_t = \alpha_0 + \alpha_1 lnM2Y_t + \alpha_2 lnPSCY_t + \alpha_3 ln MCY_t + \alpha_4 lnLRY_t + \alpha_5 lnINVRY_t + \alpha_6 lnOPNY_t + \alpha_7 D_{lnIY_t} + \alpha_8 D_{lnMCY_t} + \alpha_9 D_{lnPSCY_t} + \alpha_{10} D_{lnMCY_t} + \alpha_{11} D_{lnLRY_t} + \alpha_{12} D_{lnINVRY_t} + \alpha_{13} D_{lnOPNY_t} + \varepsilon_t \quad (8)$$

The dummy variable *Di* in the above equation represents the structural breaks in each of the variables and they take a value of 0 until the particular break date for each variable and a value of 1 onwards.

Table 1 Result of Saikkonen and Lutkepohl (S-L) one-break unit root test with trend

Variables	ADF test statistic (unit root without structural break) Without trend	S-L test statistic (Unit root with structural break) With trend	Break Period	Number of Lags	
GDPK	1.2419	2.5239	-1.4078	1986	I(1)
M2Y	-1.5108	-0.0847	-2.1350	2008	I(1)
PSCY	-0.00241	-0.3303	-0.9746	2008	I(1)
MCY	-1.1606	-0.6152	-4.2918[a]	2007	I(1)
LRY	-2.0054	-0.3303	-2.7616[c]	2006	I(1)
INVRY	-2.8678	2.8230	-1.1392	2001	I(1)
OPNY	-1.2000	1.7040	-1.0845	2005	I(1)

Note: a, b and c shows show level of significance at 1%, 5% and 10% respectively. (a)For the ADF test, the lags are determined by the Schwartz criterion. Critical values extracted from Davidson and MacKinnon (1993) for the 1%, 5%, and 10% levels are, respectively, -3.96, -3.41, and -3.13 for the model with trend and -3.43, -2.86, and -2.57 for the model without trend. (b) Critical values from Lanne et al. (2002) for the 1%, 5%, and 10% levels are -3.48, -2.88 and -2.58, respectively,
Source: Author

5. Conclusion and Recommendations

The study sought to investigate the existence of structural breaks and identify the point of break (if any) in selected financial sector variables in Nigeria using the Saikkonen and Lutkepohl (2002) method. The study established the presence of a single breakpoint in all of the selected financial sector and economic growth variables and therefore, recommends that to avoid wrong forecast and misspecification of financial sector models, the point(s) of break should be taken into consideration before running the regression model.

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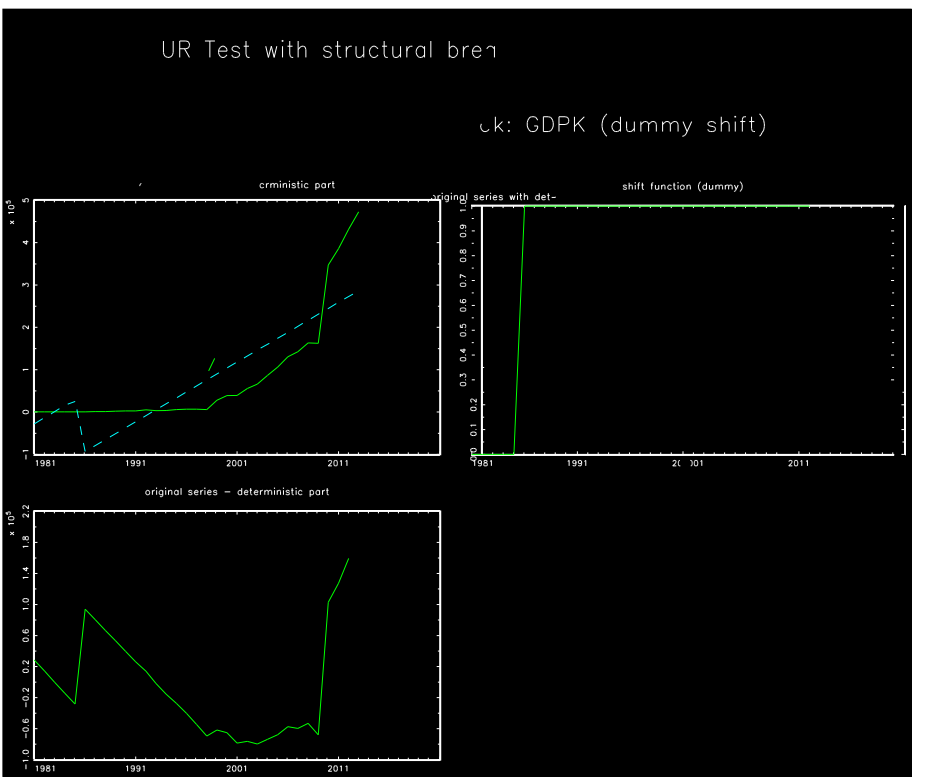
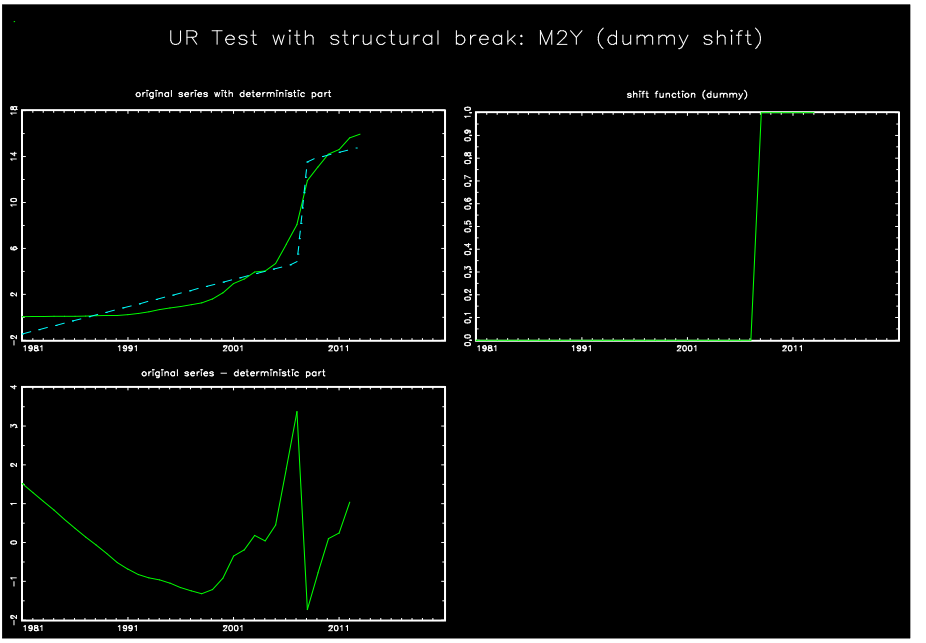
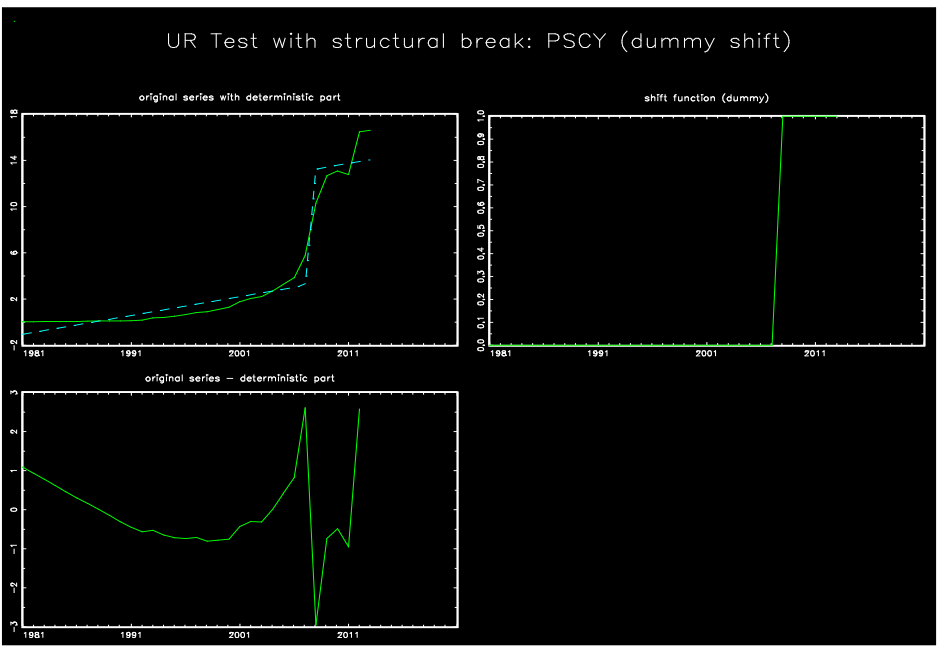
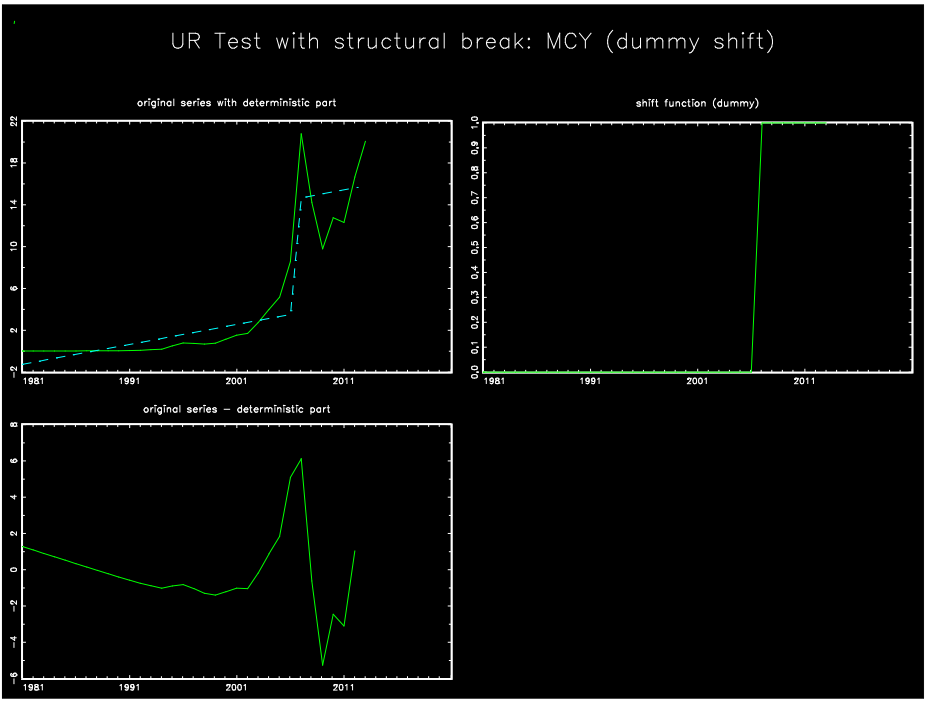
APPENDIX

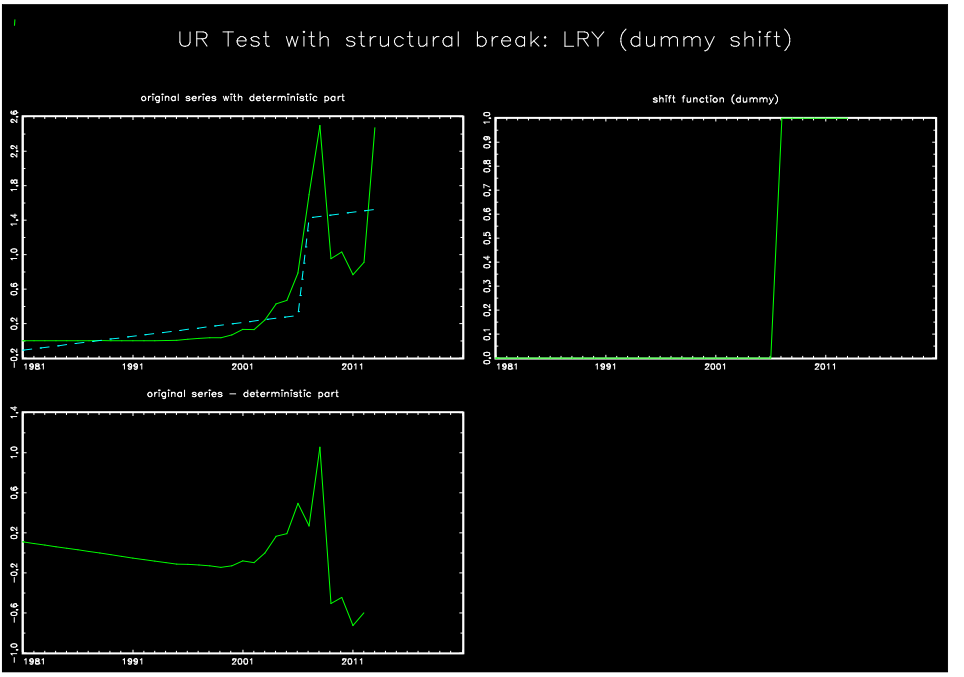
Plots of Unit Root Test with Structural Breaks and the Break Determination (Saikkonen and Lutkopehl, 2002)

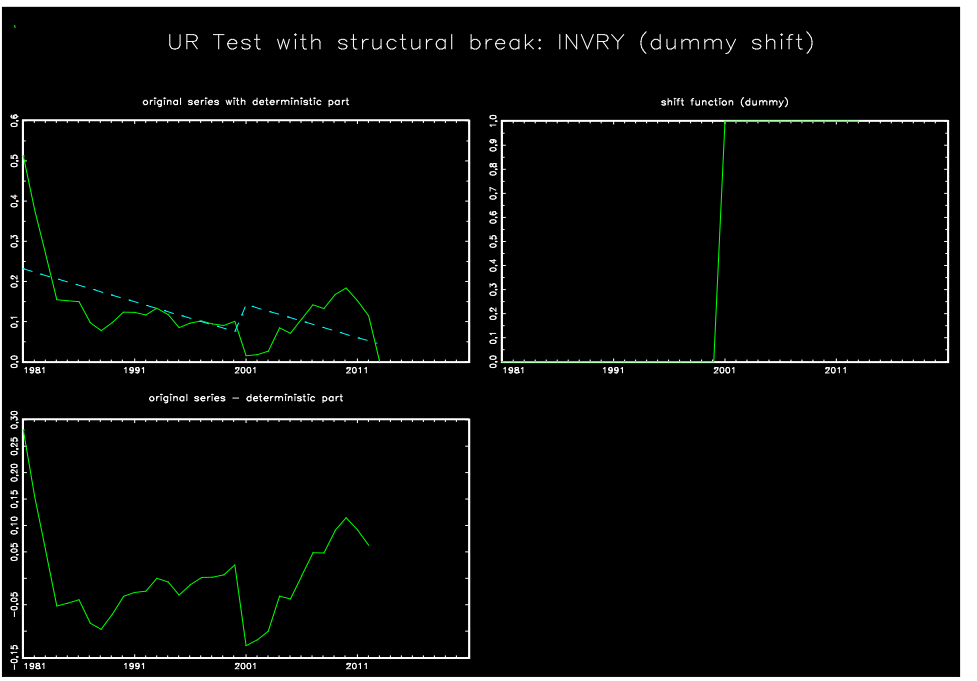


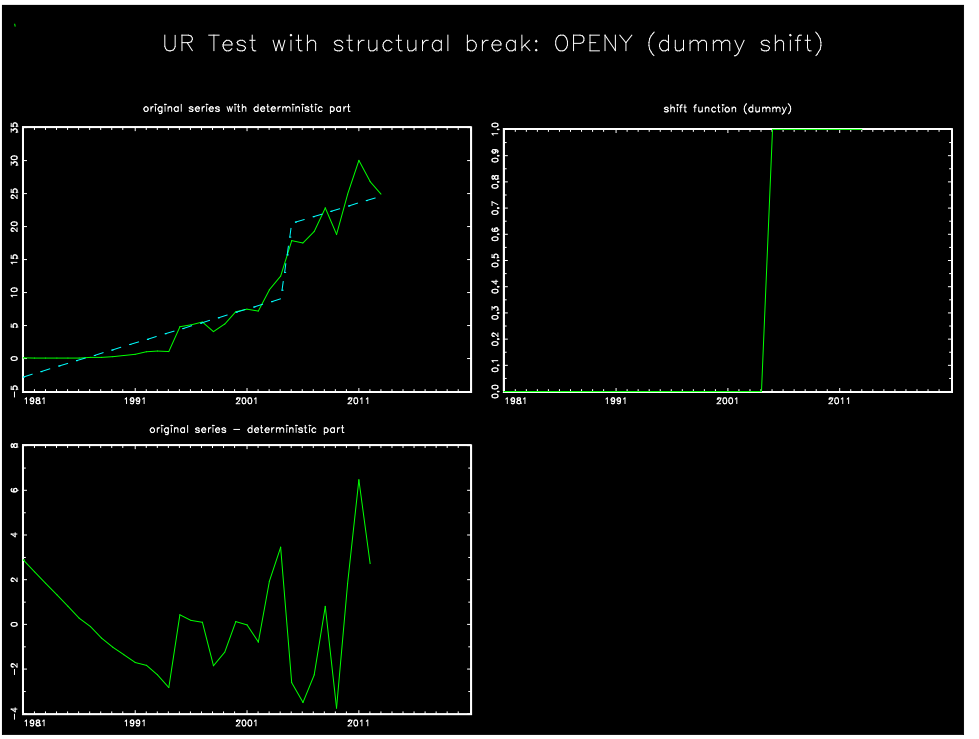

UR Test with structural break: M2Y (dummy shift)
original series with deterministic part
shift function (dummy)
original series – deterministic part
1981
1991
2001
2011


UR Test with structural break: PSCY (dummy shift)
original series with deterministic part
shift function (dummy)
original series – deterministic part
1981
1991
2001
2011


UR Test with structural break: MCY (dummy shift)
original series with deterministic part
shift function (dummy)
original series – deterministic part
1981
1991
2001
2011


UR Test with structural break: LRY (dummy shift)
original series with deterministic part
shift function (dummy)
original series – deterministic part


UR Test with structural break: INVRY (dummy shift)
original series with deterministic part
shift function (dummy)
original series – deterministic part


UR Test with structural break: OPENY (dummy shift)
original series with deterministic part
shift function (dummy)
original series – deterministic part
1981
1991
2001
2011