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Testing the Balanced Growth Hypothesis in the Presence of Structural Breaks: Evidence from Developed and Developing Countries

Arjun, Bibhuti Ranjan Mishra

Department of Humanities and Social Sciences, Visvesvaraya National Institute of Technology, Nagpur, India, bibhutieco@gmail.com

Abstract

The balanced growth theory and the neoclassical growth model predict that certain macroeconomic variables such as output, consumption, and investment grow at a constant rate. Analytically, it indicates that the consumption-output ratio and the investment-output ratio (termed "great ratios") must be stationary. Moreover, consumption and investment must be cointegrated with output. This paper examines these implications with respect to developed (G7) and emerging (E7) countries using data for the period 1970–2019. The validity of the balanced growth hypothesis (BGH) is tested by using unit root tests (univariate analysis) and cointegration techniques (multivariate analysis) that permits endogenously determined structural breaks. The findings of our univariate analysis suggest limited evidence of the BGH in developed and developing countries. The multivariate analysis exhibits more supportive evidence of the BGH in five developed countries and limited evidence for two developing countries. The study also employs the Westerlund (2006) panel cointegration test with structural breaks to examine the validity of the BGH. Empirical findings validate the BGH for the G7 countries, while it is not validated for E7 countries. In sum, the study promulgates the use of structural breaks in a multivariate setup in testing the BGH to find robust evidence.

Keywords: balanced growth, great ratios, structural breaks, E7 and G7 countries

JEL codes: C32, C33, E13, E23

1. Introduction

Since their beginning, modern growth theories have focused on the balanced growth path (Harrod, 1939; Solow, 1956). On this path, the endogenous variables of an economy grow at a constant rate but not necessarily at an equal rate. Factor shares and the interest rate remain constant, as does the capital-output ratio. Due to the paucity of resources in the economy, the sum of investment and consumption is limited by output. It implies that consumption, investment, and output share the same steady growth rate. When these economic aggregates increase at the same rate, their ratios should be constant or stationarity over time. It deciphers that both consumption and investment must be cointegrated with the output[1].

Empirical tests on the validity of the BGH began a long time ago. Kuznets (1942) showed long-run constancy in the ratio of saving to income during the industrialization of the US economy. Klein and Kosobud (1961) often used the formal trend-fitting method on Kuznets's data and found mixed results with respect to the evidence of the BGH. In the same year, Kaldor (1961) presented stylized facts about economies in the growth process. As such, the balanced growth models may be exogenous or endogenous in nature. An empirical investigation of balanced growth has generally been presented as a test of the neoclassical exogenous growth model. Kunst and Neusser (1990) conducted a study on Austrian data by employing the cointegration method and strongly rejected the BGH. King et al. (1991) introduced a stochastic version of the balanced growth model. Their paper was the first to lend empirical support to the neo-classical balanced growth model for the USA. Various authors have proven the BGH for the US economy (Rotemberg and Woodford, 1996; Stock and Watson, 1988). However, using a cointegration test, Neusser (1991) could not find strong evidence of the BGH in Austria, Canada, West Germany, Japan and the UK. He found clear evidence in support of the BGH solely for the USA. Serletis (1994) did not find any supporting evidence for balanced growth in the Canadian economy. Serletis and Krichel (1995) tested the BGH for Canada, France, Germany, Italy, the Netherlands, Norway, Switzerland, Japan, the UK, and the USA, and the findings suggest mixed support for the BGH. Harvey et al. (2003) confirmed the findings of Serletis and Krichel (1995) for G7 countries. Using the Johnson cointegration approach and generalized impulse response function, Mills (2001) provided supportive evidence of the BGH for the UK during the post-war period. Furthermore, Hossain and Chung (1999) found little evidence in favour of the BGH for two developing nations: Taiwan and South Korea.

1 For a detailed illustration of great ratios, see Klein and Kosobud (1961).

The above-cited studies have tested the validity of the BGH without taking structural breaks into account and found non-stationarity of great ratios or got less supportive evidence for the BGH for many countries. The findings of these studies could be biased in the presence of structural breaks that emanate from economic shocks. It is evident that unfavourable economic events (such as oil price shocks, international crises, global financial crises, etc.) affect the economy's condition, growth process and the sovereignty of each economy (for details, see Caldara et al., 2016; Foellmi, 2005; Meckl, 2002). Recognising the importance of economic shocks, few other studies have found more supportive evidence of the BGH by estimating the neoclassical growth model with structural breaks. Clemente et al. (1999) analysed the validity of the BGH in 21 OECD countries by taking one or two structural breaks and discovered robust support for the BGH in 10 countries. Attfield and Temple (2006) validated the BGH for the USA and the UK, using cointegration analysis in the presence of structural breaks. Using the cointegration technique with a structural break in the late 1970s, Li and Daly (2009) found evidence of balanced growth in the pre-break period, but did not get supportive evidence of balanced growth in the post-break period, and for the whole period (1953–2004). Furthermore, Kemper et al. (2011) applied a cointegration test under structural breaks to explore the BGH and confirmed supportive evidence of the BGH for Germany. Lastly, Chang et al. (2016) examined the validity of the BGH for 21 OECD countries and found that relatively less open countries are more likely to show a balanced growth path equilibrium.

After going through the literature, it is observed that developed nations have remained prime research areas while testing the validity of the BGH, while developing countries have been ignored. Developing countries have come across a moderately long period in the development process. Therefore, the BGH hypothesis should also be tested for developing countries. To fill this gap, this paper empirically revisits the validity of the BGH by compiling country and panel-level data for G7 and E7 countries over 50 years[2]. Moreover, it will be interesting to analyse the behaviour of great ratios in G7 and E7 countries as participating nations of these groups are at the top in garnering high economic growth in recent decades.

To address the research objectives, the study uses the following approaches. Firstly, the study employs Perron and Vogelsang (1992; henceforth PV) and Clemente, Montañés and Reyes (1998; henceforth CMR) unit root tests as standard methods to test stationarity that are biased towards non-rejection of the null of non-stationarity in the presence of structural breaks.

2 G7 stands for a group of seven developed countries of the world constituting Canada, France, Germany, Italy, Japan, the United Kingdom (UK) and the United States (US), while E7 stands for seven emerging/developing countries of the world constituting Brazil, China, India, Indonesia, Mexico, Russia and Turkey. Russia is not included in the analysis due to lack of data.

These methods allow proper assessment of the time series properties in the presence of endogenously determined structural breaks. Secondly, the study utilizes the maximum likelihood cointegration approach of Johansen et al. (2000) as standard cointegration tests usually fail to reject the null of no cointegration, when breaks exist in the cointegrating vectors. Thirdly, the panel cointegration approach of Westerlund (2006) is employed to derive the cointegration properties in the presence of structural breaks for the panel of G7 and E7 countries. To the best of our knowledge, no study has tested the BGH for G7 and E7 countries using Westerlund's (2006) method. Thus, the main contributions of the study to the existing literature are the applications of Westerlund's (2006) panel co-integration and the inclusion of emerging economies in our sample.

The rest of the paper is organized as follows. Section 2 describes the theoretical framework of the study. Section 3 provides the econometric methodology used in the study. Section 4 demonstrates our findings, and Section 5 presents the conclusion of the study.

2. Theoretical Framework

There are several approaches to growth models to test the BGH. This section presents the theoretical setting for the discrete-time, deterministic trend and rational expectation models of neoclassical exogenous growth theory (Kemper et al., 2011; Li and Daly, 2009). The present study builds on the non-stochastic (exogenous) balanced growth model. This model offers a theoretical framework to understand the concept of worldwide output growth and the disparities in per capita output geographically. By choosing this model, we discuss relevant parameters that establish whether given parameters change over time. It also highlights the importance of "great ratios" in G7 and E7 countries in the presence of structural breaks.

To investigate the properties of balanced growth, restrictions are imposed on the popular basic neoclassical growth model for one-sector economy of Solow and Swan (1956), which followed the properties of constant returns to scale with diminishing marginal productivity of inputs. In this model, technology is assumed to be labour-augmenting, which grows at an exogenous fixed rate g. Fixed capital formation is channelized by a constant fraction, s, of unconsumed output. Labour force grows exogenously at a rate n. Production technology and consumer preferences are assumed in a way that it ensures the existence of the steady state. The steady-state per capita quantities (per capita capital k, per capita output y and per capita consumption c) grow at the same rate with technological progress. Their aggregate levels K, Y and C grow accordingly in the steady state at a common growth rate of $g + n$.

In the special case of Cobb and Douglas's (1928) production function, we have:

$$Y_t = K_t^{1-\rho}\left(A_t L_t\right)^{\rho} \tag{1}$$

where Y_t is output, K_t is capital stock, L_t is labour input and A_t is labour augmenting technological progress. The value of ρ is chosen in such a way that at the equilibrium level, the distribution between labour income and capital income is close to one.

The constant growth rate for the effectiveness of labour is described with a deterministic logarithmic trend as follows:

$$\log(A_t) = g + \log(A_{t-1}) \tag{2}$$

All the per capita variables grow at the exogenously given rate of technical progress: $\gamma_y = \gamma_k = \gamma_A = g\left(\gamma_x \equiv \log x_t - \log\left(x_{t-1}\right),\ x_t = {X_t}/{L_t}\right)$. This balanced growth of per capita aggregates suggests that the great ratios of consumption-output and investment-output are constant over time.

On the other hand, technological progress could be framed stochastically (Brock and Mirman, 1972; Donaldson and Mehra, 1983; King et al., 1991) as a logarithmic random walk with drift:

$$\log\left(A_t\right) = g + \log(A_{t-1}) + \varepsilon_t \tag{3}$$

Here, ε_t is a white noise process representing productivity shocks, that is deviations of the growth rate for labour effectiveness from its expected value g. Each ε_t contributes a lasting impact such that their cumulative effect at any point in time is their undiscounted sum up to and including that date, which is a "stochastic trend". In a log-linear version of the stochastic growth model, the stochastic trend is shared by logarithms of output, consumption and investment (King et al., 1988) along the solution path. The common stochastic trend is given by log $\frac{A_t}{\rho}$ and the growth rate is equal to $\frac{g+\varepsilon_t}{\rho}$. Therefore, these three aggregates are individually non-stationary in nature, being integrated of order one $I(I)$. As these aggregates have a common stochastic trend, it is possible to develop two different linear combinations of them that are stationary. Furthermore, the model solution suggests that these combinations are the logarithms of the consumption-output and investment-output "great ratios", i.e., there is the presence of balanced growth in a stochastic sense. Afterwards, the testable implications of the model include (1) a suitable cointegration rank, and (2) parametric restrictions to confirm that the cointegrating vectors imply stationarity of the "great ratios". The appropriate cointegration rank r in an error-correction model for ($\log c_t, \log i_t$ and $\log y_t$), that is the logarithms of per capita consumption, investment and output, is $r = 2$[3]. For the cointegrating vectors to indicate "balanced growth", one should find the following matrix in the presence of a trend in the cointegration space.

$$\beta' = \begin{bmatrix} 1 & 0 - 1 \\ 0 & 1 - 1 \end{bmatrix} \tag{4}$$

These restrictions can be used in the framework of Johansen et al. (2000) or by directly evaluating the stationarity of the "great ratios" when g is constant. However, there was a worldwide dip in productivity in the 1970s, indicating variability of productivity growth due to the possibility of structural breaks. Therefore, it would be wise to assume structural breaks in g. Possible factors for the decline in productivity could be: (a) the end of the post-war period of the 1950s and the 1960s, (b) the reduction in import tariffs after the 1970s, (c) the two oil shocks in 1973 and 1979, (d) the recessions in 1974–1975 and in 1980–1981, and (e) the inclination of governments towards increasing regulation in the early 1970s (Maddison, 1987). As per Kose et al. (2020), the suffering of the world economy continued with the global recessions of 1975, 1982, 1991 and 2009. Due to the 1979 oil shock, Latin American countries faced a debt crisis that contributed to the long-lasting slump in growth of emerging markets and developing economies. In the mid-1990s, world economies were affected by the international crisis, which resulted in a downturn of economic activity (Walsh, 1993). The above-mentioned global slowdown over the past seven decades has weakened the global per capita GDP and other key indicators of economic activity. Subsequently, due to loose regulation and supervision of financial markets and institutions, the Global Financial Crisis in mid-2007 occurred in major advanced economies. The 2009 global recession, triggered by the Global Financial Crisis, was the deepest and most synchronous of the four recessions (Ayhan et al., 2020).

As per the above analysis, various dates could be identified when an individual country is affected by a crisis. Thus, the accurate break date could not be inferred a priori. Therefore, this study models the average growth rate of productivity with a structural break at an unknown break date. Let $DTB_{\tau t}$ signify a dummy variable defined by:

$$DTB_{t\tau} = \begin{bmatrix} 1, if\ t \geq \tau \\ 0, if\ t < \tau \end{bmatrix} \tag{5}$$

Here, τ is an unknown parameter, and $\tau \in T$ represents the time at which the break occurs.

3 In the tri-variate system, two cointegrating equations should be identified for establishing the BGH.

3. Data Sources

For G7 and E7 countries, annual data are retrieved from the United Nations Conference on Trade and Development (UNCTAD) covering the period from 1970 to 2019, which constitutes 50 years of observation. Russia is not included in our analysis due to missing data. The variables of interest in this work are per capita consumption (c), per capita gross fixed capital formation (i) and per capita GDP (y). All the variables are measured in real terms at $2015 prices. Quarterly data series are not used due to lack of availability and uniformity of data. Moreover, the Johansen cointegration test provides effective results when series are available for a long span of time (Hakkio and Rush, 1991; Lahiri and Mamingi, 1995; Shiller and Perron, 1985). Therefore, this study chooses an annual observation for a longer span of time for the empirical analysis.

4. Empirical Setting

4.1 Univariate analysis

The two great ratios ($\log c_t - \log y_t$) and ($\log i_t - \log y_t$) considered in our analysis are plotted in Figures 1A and 1B, respectively, for G7 countries and in Figures 2A and 2B, respectively, for E7 countries. At first glance, these great ratios do not seem to be stationary. In most of the cases, these ratios seem to drift with time; in other cases, random walk behaviour could be inferred. To check the stationarity of these ratios more formally, the conventional unit root tests by Dickey and Fuller (1979; ADF) and by Phillips and Perron (1988; PP) are employed. The ADF and PP unit root test results suggest that ($\log c_t - \log y_t$) and ($\log i_t - \log y_t$) ratios are non-stationary for all the countries except France (G7) and Indonesia (E7), confirming our first impression that the great ratios are non-stationary, which negates the BGH.[4]

4 To save space, the results of standard (ADF and PP) unit root tests are not shown here.

Figure 1A: G7 great ratios, log consumption-output

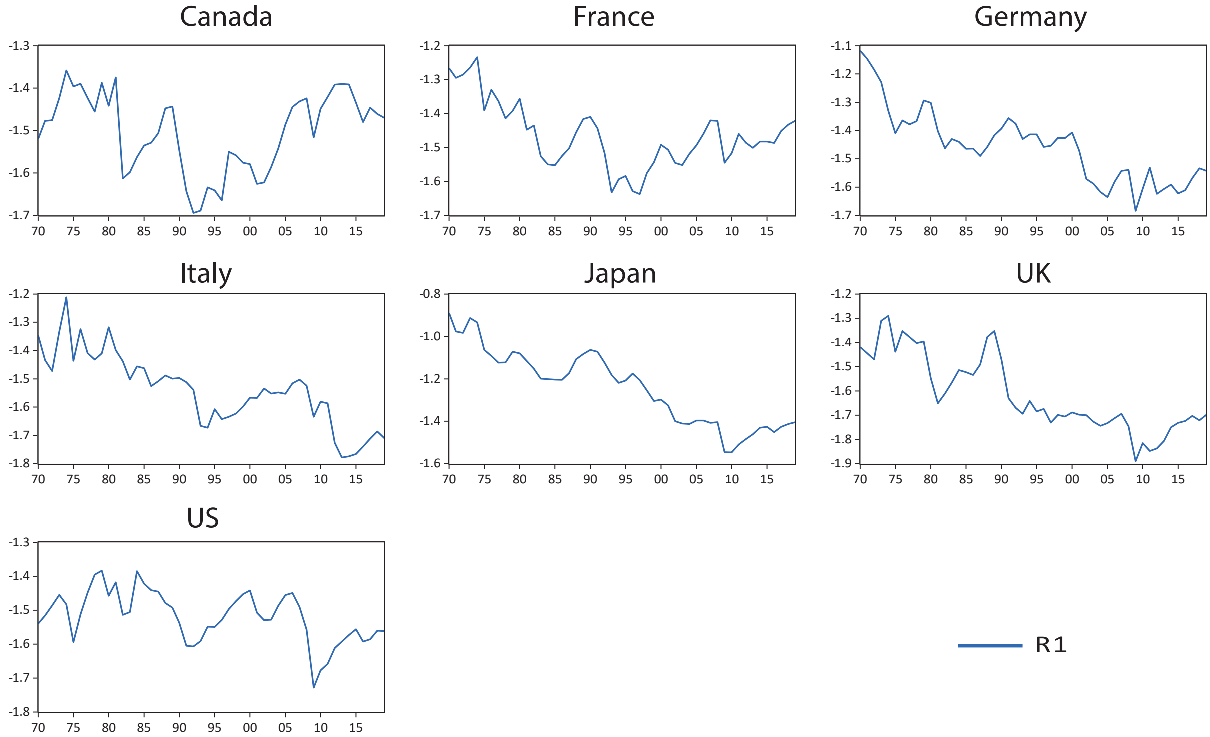


Figure 1B: G7 great ratios, log investment-output

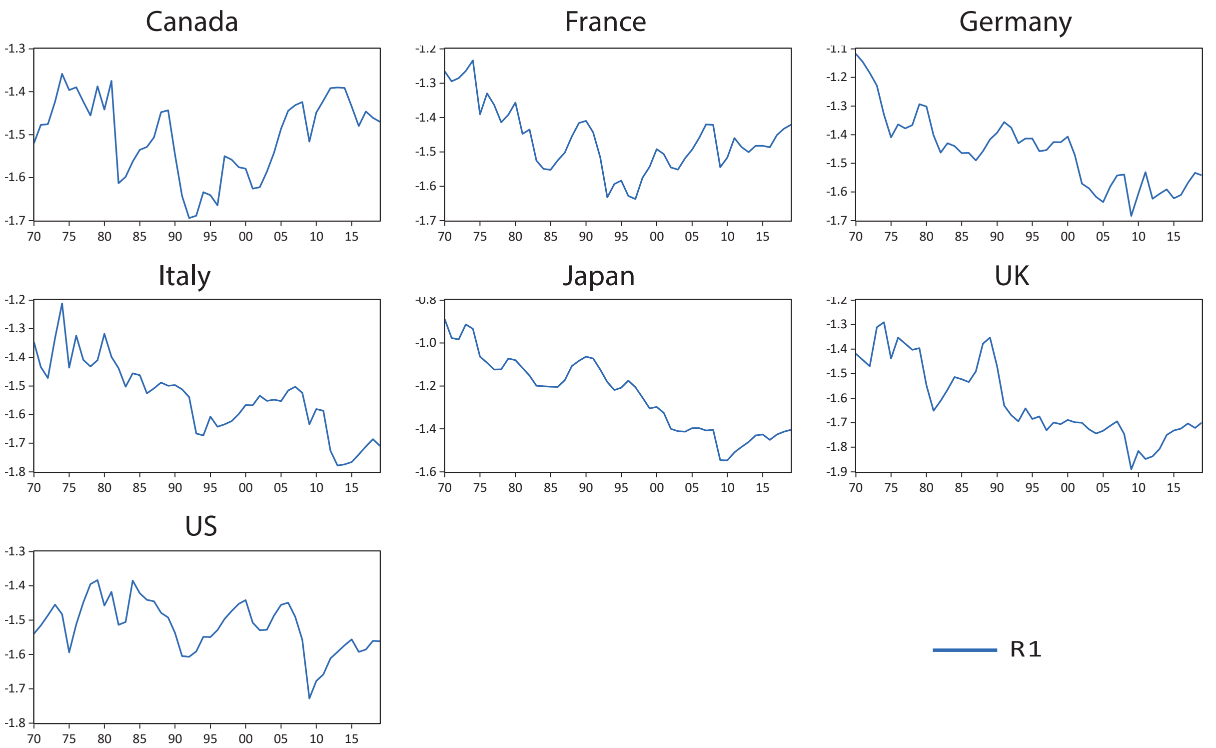


Figure 2A: E7 great ratios, log consumption-output

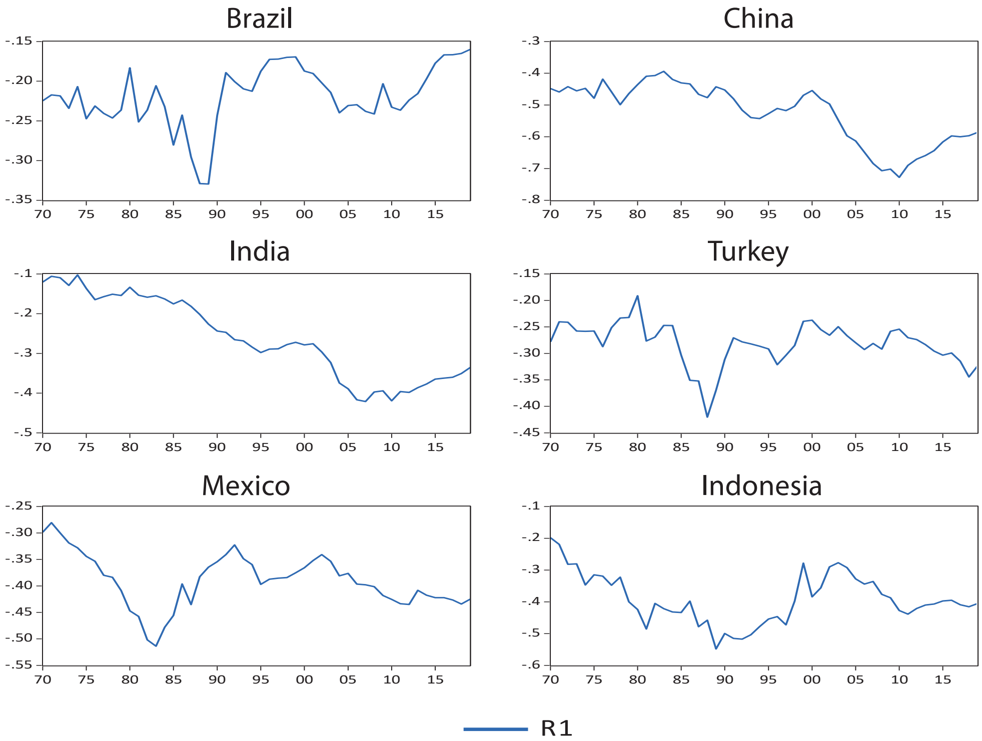
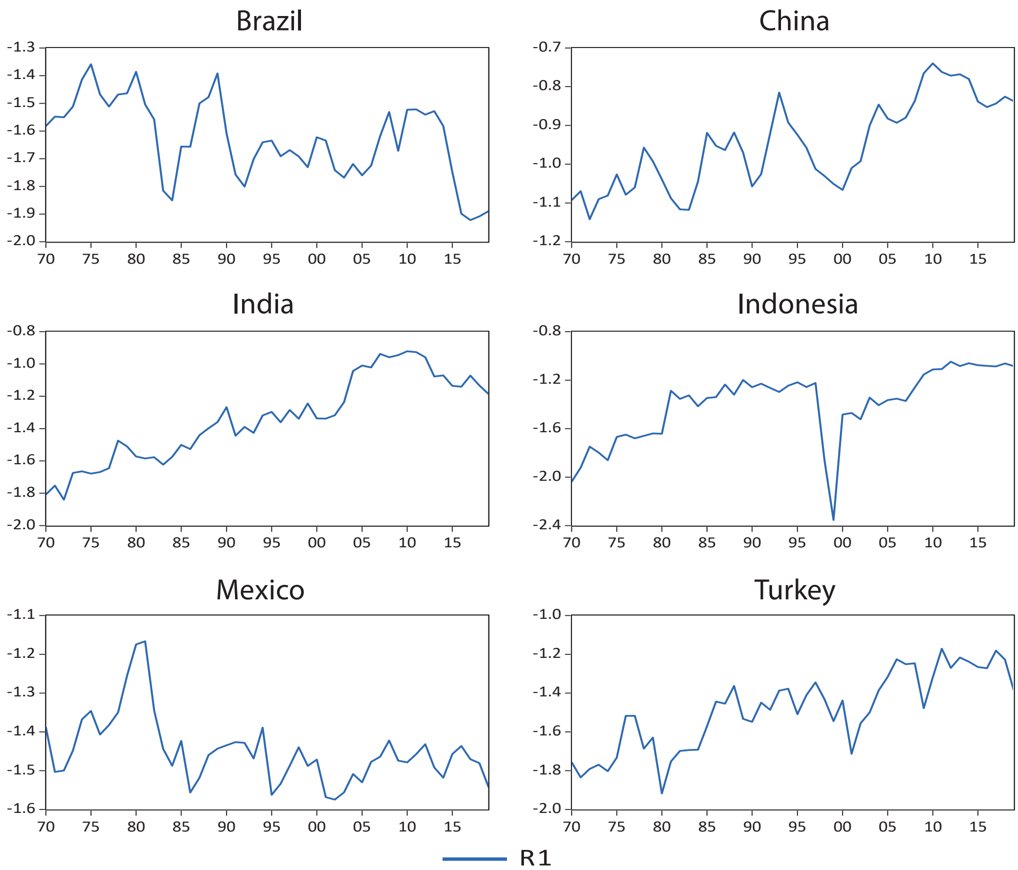


Figure 2B: E7 great ratios, log investment-output



Standard unit root tests are biased towards acceptance of the null hypothesis if the variable is influenced by a structural break (Perron, 1989; 1990). In fact, the plot of great ratios indicates fluctuations in the trend of great ratios, with some spikes indicating the presence of structural breaks in the series.

The seminal work of Perron (1990) considered the structural breaks in the series by changing the mean. The main assumption of this study is that the break date of the trend function is fixed exogenously, resulting in spurious rejection of the null hypothesis. To resolve this problem, PV endogenously drew the structural breaks and identified one change in the mean. However, some variables do not just show one break and may exhibit the presence of multiple breaks in the model. Considering this view, the CMR test is developed which exhibits a double change in the mean. In this study, the BGH is tested in the univariate analysis by employing mean shift structural break unit root tests proposed by PV and CMR, with one and two breaks, respectively.

Following Kemper et al. (2011), the study uses an innovational outlier model where the structural change occurs gradually rather than suddenly. The model is as follows:

$$\Delta z_t = \mu + \delta DTB_{t\tau} + dDU_t + \alpha z_{t-1} + \sum_{j=1}^{k} c_j \Delta z_{t-j} + \varepsilon_t \tag{6}$$

The study estimates Equation (6) for the PV unit root test, where z_t represents the great ratios ($z_t = \log c - \log y$ or $\log i - \log y$); $DTB_{t\tau}$ and DU_t are indicator dummy variables for the break at the time τ. $DTB_{t\tau}$ is a step dummy as explained in Section 2, whereas the value of the impulse dummy (DU_t) takes the value 1 if $t = \tau$ and 0 otherwise. Furthermore, the break date is ascertained by estimating the model for each possible break date in the dataset for each country individually. τ is selected as the value that minimizes the t-statistics for testing $\alpha = 0$: $Min(t_{\hat{\alpha}})(\tau, k)$.

Here, $t_{\hat{\alpha}}(\tau, k)$ is the t-statistic for testing the null H_0: $\alpha = 0$ against H_1: $\alpha < 0$ with a break date τ, and k is the lag truncation parameter. The lags of Δz_t are included in Equation (6) to eliminate the potential existence of autocorrelation in the residuals.

The associated t-statistics for testing the null of unit root against the alternative of stationarity with the identified break for various countries are shown in Table 1. When $t_{\hat{\alpha}}(\tau, k)$ surpasses in absolute terms the 5% critical value for Min $t_{\hat{\alpha}}(\tau, k)$, the null hypothesis of non-stationarity is rejected.

Table 1 provides evidence of the BGH in four G7 countries (Germany, Japan, UK, and USA) and three E7 countries (Brazil, Turkey and Mexico). To rule out the possibility of further regime shifts in the mean of the great ratios and determine the stability of the model, the CUSUM square test is employed (Farhani, 2012; Kemper et al., 2011; Turner, 2010). The CUSUM square model with a single break is estimated as follows:

$$\left(\log c_t - \log y_t\right) = \mu + \phi DTB + e_t, \text{ and } \left(\log i_t - \log y_t\right) = \mu + \phi DTB + e_t \tag{7}$$

where *DTB* is a step dummy for an identified break. The CUSUM square test with estimated PV break dates reveals instability of break dates for both E7 and G7 countries[5]. It is quite possible that the series could have been influenced by multiple structural breaks.

The above results motivated us to conduct the extended version of the PV unit root test, i.e., the CMR test with two structural breaks. The innovational outlier model of the CMR unit root test is as follows.

$$z_t = \mu + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + d_1 DU_{1t} + d_2 DU_{2t} + \beta z_{t-1} + \sum_{j=1}^{k} c_j \Delta z_{t-j} + \varepsilon_t \tag{8}$$

where $DTB_{j\tau}$ is a pulse variable which takes the value 1 if $t = TB_{jt} + 1 \; (j = 1, 2)$ and 0 otherwise. DU_{jt} takes the value 1, *if* $t > TB_j \; (j = 1, 2)$ and 0 otherwise. TB_1 and TB_2 are time periods when the mean is being changed. For simplicity, it is assumed that $TB_j = \gamma_j N$ (*N* is sample size, and $j = 1, 2$) with $0 < \gamma_j < 1$, and also that $\gamma_2 > \gamma_1$.

After estimating Equation (8), the pseudo *t*-ratio, $t_{\hat{\beta}}$, could be obtained, which minimizes the value of the *t*-ratio under the hypothesis that $\beta = 1$ among potential break points. Under the null hypothesis of non-stationarity, $\beta = 1$ and, likewise, $\delta_j = 0$, $\delta_j \neq 0$, $(\forall j = 1, 2)$. On the contrary, under the alternative hypothesis of stationarity, it is anticipated that $|\beta| < 1$ and $\delta_j \neq 0$, $(\forall j = 1, 2)$. The main parameter of interest β also measures the persistence of z_t. The lag order of the above AR process, β, is determined by the AIC for each country.

5 To save space, the results of the CUSUM square test for the PV test with a single break are not shown.

Table 1: Unit root test of Perron and Vogelsang (1992)

	Min $t_{\hat{\alpha}}$	*TB*	Min $t_{\hat{\alpha}}$	*TB*
	Log ratio of consumption-output		Log ratio of investment-output	
G7 countries				
Canada	−2.79	1981	−2.89	1981
France	−3.97	1979	−3.59	1974
Germany	−4.48*	1987	−4.92*	2000
Italy	−3.16	1978	−3.04	1980
Japan	−4.29*	1991	−4.50*	1997
UK	−6.68*	1994	−4.27*	1989
USA	−4.56*	1999	−4.28*	2007
E7 countries				
Brazil	−4.28*	1989	−4.29*	1980
China	−3.1	2002	−3.65	2002
India	−2.62	1986	−3.05	2002
Turkey	−4.45*	1988	−4.60*	1984
Mexico	−4.94*	1998	−4.43*	1999
Indonesia	−4.22	1997	−4.54*	1999

Notes: * denotes the rejection of non-stationarity at the 5% level of significance (C.V. at 5%: −4.27). This table reports the unit root tests of Perron and Vogelsang (1992), Min $t_{\hat{\alpha}}$,where *TB* presents the number of breaks. Null hypothesis: series has unit roots with one break.
Source: authors' calculations

The associated *t*-statistics for testing the unit root null against the alternative of stationarity with the identified breaks for all the countries considered in our analysis are shown in Table 2 with two structural breaks. When the critical value exceeds in absolute terms the 5% critical value of Min ($t_{\hat{\beta}}$), the null hypothesis of non-stationarity is rejected. The CMR unit root test findings support the BGH for five G7 countries (Canada, Italy, Germany, the UK, and the USA) and three E7 countries (Brazil, India, and Indonesia). The identified break dates from both PV and CMR tests are linked with several international or national economic turbulences which occurred from 1970 to 2019 (including the first oil crisis in 1973, second oil crisis in 1979, international financial crisis in 1991, global financial crisis in 2008, etc.) In addition, some countries also faced an economic recession/crisis at the domestic level. Turkey experienced financial crisis in 2001 (Koch et al., 2001) and Canada experienced an internal level economic downturn in 2001–2003 (Cross, 2010). Table A1 in the Appendix section provides the detail description of economic events for each great ratio of countries analyzed in the study.

Table 2: Unit root test of Clemente et al. (1998)

	Min ($t_{\hat{\beta}}$)	TB_1	TB_2	Min ($t_{\hat{\beta}}$)	TB_1	TB_2
	Consumption-output			Investment-output		
G7 countries						
Canada	–5.99*	1989	1996	–5.54*	1989	2004
France	–4.83	1974	1979	–3.83	1974	1980
Germany	–5.97*	1974	1988	–5.92*	1980	2000
Italy	–6.83*	1979	2008	–6.09*	1985	2011
Japan	–2.95	1973	1998	–4.45	1973	1997
UK	–6.95*	1994	2001	–5.84*	1979	1989
USA	–5.89*	1981	2000	–5.95*	1987	2007
E7 countries						
Brazil	–5.55*	1987	1989	–5.64*	1980	1989
China	–2.98	1990	2002	–6.92	1983	2002
India	–5.56*	1987	2002	–5.76*	1984	2002
Turkey	–5.58*	1984	1988	–4.32	1984	2004
Mexico	–4.17	2005	1987	–6.17*	1978	1981
Indonesia	–5.91*	1978	1997	–5.54*	1980	1999

Notes: * denotes the rejection of non-stationarity at the 5% level of significance (*C. V.* at 5% : –5.49). This table reports the unit root tests of Clemente Lopez et al. (1998) Min $t_{\hat{\beta}}$, where TB_1 and TB_2 present one and two breaks, respectively. Null hypothesis: series has a unit root with two breaks.

Source: authors' calculations

As discussed earlier, the stability of the model is important while identifying break dates. Thus, the CUSUM square test is conducted to check the stability diagnostic of the CMR test with two breaks. The CUSUM square model with two breaks is as follows:

$$\left(\log c_t - \log y_t\right) = \mu + \phi_1 TB_1 + \phi_2 TB_2 + \varepsilon_t, \text{ and } \left(\log i_t - \log y_t\right) = \mu + \phi_1 TB_1 + \phi_2 TB_2 + \varepsilon_t \tag{9}$$

where TB_1 and TB_2 are step dummies for estimated one break date and two break dates, respectively.[6] The CUSUM square test results are shown in the Appendix (Figure A1A for G7 and Figure A1B for E7 countries). Out of the two breaks identified by the CMR test for each great ratio, one break turns out to be stable. The identified single break date for each individual country with favourable statistical properties is shown in Table 3[7]. If break dates of the two ratios differ, two break dates would be taken in the multivariate analysis.

Table 3: Selected break dates for multivariate analysis

	Consumption-output ratio	Investment-output ratio
	G7 countries	
Canada	2004	1996
France	1980	1979
Germany	2000	1988
Italy	1985	1978
Japan	1997	1998
UK	1989	2001
USA	2007	2007
	E7 countries	
Brazil	1989	1989
China	2002	2002
India	2002	2002
Turkey	2004	1988
Mexico	1989	1987
Indonesia	1999	1999

Notes: break dates are obtained from the CUSUM square test.

6 Break dates estimated by the CMR statistics are provided in Table-2.

7 Break dates for distinct countries may vary due to differences in their economic, political, and geographic structure.

4.2 Multivariate analysis

After determining the break dates, a multivariate analysis with a cointegration technique is done to find further support of the BGH. Prior to the estimation of the cointegration relationship, the integration order of the variables of interest ($\log c_t$ $\log i_t$ $\log y_t$) is identified using the ADF and PP unit root tests. The results of the standard unit root test reveal that all the variables are non-stationary or I(1) processes[8].

The popular methodology to estimate the cointegration rank in the long-run time series is the Johansen (1988; 1995) procedure, which estimates the cointegration rank within the model without considering structural breaks. However, we noted structural breaks in the considered series of each G7 and E7 countries (see sub-section 4.1). Therefore, the maximum likelihood procedure of Johansen et al. (2000) is applied to estimate the number of cointegrating vectors considering the presence of structural breaks. This method is based on reformulating an n-dimensional and k^{th} order of vector x_t to a vector error correction model (VECM). Based on Kamper et al. (2011), the following equation is estimated for each country separately to test the BGH.

$$\Delta x_t = \mu + \alpha\left(\beta' x_{t-1} - \gamma DBT_{t-1}\right) + \sum_{i=1}^{k-1}\Gamma_i \Delta x_{t-i} + \sum_{i=0}^{k-1}\omega_i DBT_{t-i} + \varepsilon_t \tag{10}$$

Here, x_t represents the $n \times 1$ vector of endogenous variables: ($x_t =$ $(\log c_t, \log i_t, \log y_t)'$, $n = 3$) the term DBT is an impulse dummy for the selected break date, α and β are $n \times r$ matrices, where n rows signify error correction coefficients, and r columns denote cointegration vectors among the variables in x_t. Γ_i is a matrix of order $n \times r$ denoting short-run coefficients, and ω_i signifies a $n \times r$ matrix of coefficients on DBT_{t-i}. The trace test is utilized in order to examine the cointegration relationship among the variables, which estimates the rank r of the $n \times n$ product matrix $\alpha\beta'$ such that the reduced rank, $0 < r \times n$, suggests cointegration. The matching critical values can be computed using the response surface estimates of Trenkler (2008).

The lag length of VECM is determined by the modified Akaike information criterion (MAIC) and the trace statistics is adjusted according to the small-sample correction factor given by Reinsel and Ahn (1992)[9]. Following Kemper et al. (2011), a structural break is imposed based on the CUSUM square test results for each individual country (refer to Table 3). When the break dates of ($\log c_t - \log y_t$) and ($\log i_t - \log y_t$) coincide, the common single year break is taken. However, when they differ, two breaks are imposed while estimating cointegration.

8 Results are not shown here to save space.

9 The formula for adjusted trace statistics is $\frac{T - n \times r_t}{T}$.

Panel cointegration test

The study further applies Westerlund's (2006) panel cointegration test to check the robustness of the cointegration relationship in the panel of G7 and E7 countries. The specification of this test is based on the LM test, which allows multiple structural breaks in both intercept and trend.

$$I_{it} = \delta_{ij} + \beta_i S_{it} + \mu_{it} \ \ j = 1, \ldots\ldots\ldots M_{i+1}, \ \mu_{it} = r_{it} + \mu_{it}, \ r_{it} = r_{it} + \alpha_i \mu_{it} \tag{11}$$

Here, j shows the structural breaks over the period T_{1i}, ... $T_i\ M_i$ when $T_{1i} = 0$ and $T_i\ M_i + 1 = 1$. The null hypothesis assuming the existence of cointegration between variables is H_0: $\alpha_i = 0$, $i = 1, ..., N$. The alternative hypothesis is H_1: $\alpha_i \neq 0$, $i = 1, ..., N_1 \vdots \alpha_i i = 0, N_1 + 1 ..., N$. In the case of cross-dependence, bootstrap critical values are utilised. The panel LM test statistics are computed using Equation (12).

$$\mathrm{Z}(\mathrm{M}) \equiv \sum_{i=1}^{N} \sum_{j=!}^{M_i} \sum_{t=T_{ij-1}+1}^{T_{ij}} \left(T_{ij} - T_{ij-1}\right)^{-2} \hat{\omega}_{i1.2}^{-2} S_{it}^{2} \tag{12}$$

In Equation (12), $\hat{\omega}_{i1.2}^{-2} = \hat{\omega}_{i1.1}^{'} - \hat{\omega}_{i21}^{'} \hat{\Omega}_{i22}^{-1} \hat{\omega}_{i21}^{'}$ and $S_{it} = \sum_{k}^{t} = T_{ij-1} + 1\hat{e}_{ik}^{*}$ · Besides, $\hat{e}_{it}^{*}$ signifies the error correction term estimated from any cointegration vector.

5. Results of Multivariate Analysis

The results of the cointegration analysis for G7 countries are reported in Table 4. The order of cointegration is determined by successively conducting Johansen's test of the null of at most r cointegrating vectors against the alternative of more than r cointegrating vectors, for $r = 0, 1, 2$. Trace statistics reveal two co-integrating vectors for each G7 country except France. It suggests sufficient support for the *BGH* for Germany, the UK, the USA, Canada, Italy, and Japan. Moreover, the adjusted trace statistics confirm these findings[10].

10 Adjusted trace statistics embody a small sample modification as suggested by Reimers (1992). Critical values are obtained from Osterwald-Lenum (1992).

Table 4: Johansen et al. (2000) approach for G7 countries

Country	Hypothesized no. of CEs	Trace statistics	Adjusted trace statistics	Lag	No. of cointegrating equations
Canada	r = 0 r ≤ 1 r ≤ 2	100.18* 66.29* 39.79	96.09* 63.88* 38.16	1	2
France	r = 0 r ≤ 1 r ≤ 2	62.26 33.21 17.62	62.1 31.85 16.88	1	1
Germany	r = 0 r ≤ 1 r ≤ 2	95.68* 66.61* 38.76	91.78* 63.88* 37.17	1	2
Italy	r = 0 r ≤ 1 r ≤ 2	99.50* 67.31* 36.19	95.44* 64.56* 34.72	2	2
Japan	r = 0 r ≤ 1 r ≤ 2	74.24* 42.92* 14.38	71.21* 43.16* 13.79	1	2
UK	r = 0 r ≤ 1 r ≤ 2	100.48* 67.96* 41.93	96.38* 65.18* 40.22	1	2
USA	r = 0 r ≤ 1 r ≤ 2	89.14* 44.88* 23.7	85.51* 43.05* 22.73	3	2

Notes: * denotes rejection of the null at the 5% level of significance. Null hypothesis: no cointegration.
Source: authors' calculations

These findings are consistent with the theoretical implication of the BGH as two cointegrating vectors in the three-variable space indicate one common long-run stochastic trend among the variables. The essence of this multivariate analysis can now be undertaken to determine whether the data support cointegrating relations that define the properties of great ratios. Now the likelihood ratio (LR) test is undertaken by imposing a parametric restriction, which signifies the stationarity property of the great ratios: $(\beta_1 = [1 \quad 0 \quad -1, \quad \theta_1]')$ and $(\beta_2 = [0 \quad 1 \quad -1, \quad \theta_2]')$. These restrictions are applied in the presence of two cointegrating vectors in the VECM by using the methodology described in Johansen and Juselius (1990). As evident from Table 5, for the USA, the UK, Japan, Germany, and Canada, the point estimates are close to parametric restrictions, and the dummy variables are highly significant, suggesting the presence of structural breaks. In the last column, the results of the LR test are reported for the hypothesis that the parameters on γ are (–)1. It could be observed that these restrictions are not rejected at the 5% level of significance for all the G7 countries except Italy and France. Therefore, no substantive evidence of cointegration is found for Italy and France, implying rejection of the BGH for these two countries. The BGH doctrine suggests that developed countries can effectively follow a balanced growth path as they possess sufficient resources, technology, and entrepreneurs. However, despite being developed countries, Italy and France might have failed in implementing important economic policy to maintain the saving-investment gap, giving rise to more dependence on FDI and rise in trade deficit. Since the 1980s, the Italian economy (Giavazzi et al., 1989; Malpede, 2011) and the French economy (Cette et al., 2017) have faced several domestic and external imbalances causing a decline in total factor productivity, increase in public debt and collapse in the industrial sector, resulting in unsatisfactory growth. It disturbs the balanced growth path by affecting the consumption, investment, and income pattern of these two economies.

Table 5: Estimated cointegration vectors and LR test for G7 countries

Country	Variable	$\hat{\beta}_1$	$\hat{\beta}_2$	Likelihood ratio statistics
Canada	γ d_1 d_2	−0.51* 2.42* −2.36*	−1.41* −2.11* 4.71*	5.91*
France	γ d_1 d_2	−1.10* −0.53* –	−0.70* −0.36* –	N/A
Germany	γ d_1 d_2	−1.00* −0.60* 0.89*	−0.68* 4.20* −11.20*	5.63*
Italy	γ d_1 d_2	−1.10* −0.20* −0.22*	−0.93* 0.54* 0.25*	N/A
Japan	γ d_1 d_2	−1.20* 3.32* –	−0.63* −7.90* –	11.29*
UK	γ d_1 d_2	−1.00* −0.30* 0.19*	−0.75* −1.27* −0.22*	6.47*
USA	γ d_1 d_2	−1.00* −0.1 –	−1.26* −0.24* –	5.18*

Notes: * denotes rejection of the null at the 5% level of significance. d_1 and d_2 are break dates.
Source: authors' calculations

The cointegration relationship for E7 countries is presented in Table 6. The findings for trace statistics reveal two co-integrating vectors for each E7 country except Brazil, China, and India. It provides sufficient support for the BGH for Turkey, Indonesia and Mexico. Moreover, the adjusted trace statistics confirm these findings[11]. Subsequently, the results of the LR test with a parametric restriction for E7 countries are reported in Table 7. The results indicate that the point estimates are close to the parametric restrictions for Turkey and Indonesia and the dummy variable is highly significant, suggesting the presence of structural breaks. In the last column, the results of the LR test are reported for the hypothesis that the parameters on γ are (–)1. It could be observed that these restrictions are not rejected for Turkey and Indonesia at the 5% significance level and are rejected for the rest of the E7 countries. Therefore, no substantive evidence of cointegration is found for Brazil, China, India, and Mexico with restriction on the great ratios, implying rejection of the BGH for these countries.

In this study, out of six emerging countries, the BGH is only found for Turkey and Indonesia, which supports the fact that developing countries are on the back foot in achieving balanced growth. The reason could be that, unlike its counterparts, Turkey might have implemented more liberal economic policies to access the international market which provide economies of scale, leading to a convergence path. Indonesia undertook industrialization and increased competitiveness on the global market, leading to social and economic development which might have helped it achieve a balanced growth path (Elias and Noone, 2011; World Bank, 2022).

For a long time, Brazil has suffered from inadequate infrastructural development and an imbalance in demand, leading to a decline in productivity and economic growth (Cardoso and Teles, 2009; Kaufman and García-Escribano, 2013). Due to economic shocks, the Chinese economy has faced extreme macroeconomic imbalances over the past few decades (Knight and Wang, 2011; Huang, 2013). For many decades, Indian economy has been facing sectoral imbalances, regional disparities across states (Bandyopadhyay, 2012; Ghate and Wright, 2012), issues with remoteness and absolute divergence across districts (Das et al., 2015). The Mexican economy has also not proliferated since liberalizing its economy in the 1980s (Forbes, 2021; Moreno-Brid et al., 2005). These unfavourable conditions might have hindered these countries in achieving a balanced growth path.

11 Adjusted trace statistics embody a small sample modification as suggested by Reimers (1992). Critical values are obtained from Osterwald-Lenum (1992).

Table 6: Johansen et al. (2000) approach for E7 countries

Country	Hypothesized no. of CEs	Trace statistics	Adjusted trace statistics	Lag	No. of cointegrating equations
Brazil	r = 0 r ≤ 1 r ≤ 2	73.29* 33.84 19.07	70.3* 32.46 18.29	1	1
China	r = 0 r ≤ 1 r ≤ 2	84.02* 39.37 23.07	70.30* 32.46 18.29	1	1
India	r = 0 r ≤ 1 r ≤ 2	66.79* 29.83 11.50	64.06 28.61 11.03	1	1
Turkey	r = 0 r ≤ 1 r ≤ 2	117.53* 73.45* 40.92	112.73* 70.45* 39.25	2	2
Mexico	r = 0 r ≤ 1 r ≤ 2	98.33* 49.01* 18.08	94.32* 47.07* 17.34	2	2
Indonesia	r = 0 r ≤ 1 r ≤ 2	91.70* 44.46* 21.16	87.96* 42.64* 20.3	2	2

Notes: * denotes rejection of the null at the 5% level of significance. Null hypothesis: no cointegration.
Source: authors' calculations

The PV unit root test supports the BGH for four G7 and three E7 countries. Furthermore, the CMR unit root test supports the BGH for five G7 and three E7 countries. The findings of the CMR test are considered in the analysis because of its advantage over the PV test. Overall, the univariate analysis supports the BGH for eight out of thirteen countries. The multivariate cointegration analysis suggests sufficient support for balanced growth for nine out of thirteen countries in our analysis. The LR test with a parametric restriction suggests supportive evidence of the BGH for five G7 countries and two E7 countries.

Table 7: Estimated cointegration vectors and LR test for E7 countries

Country	Variable	$\hat{\beta}_1$	$\hat{\beta}_2$	Likelihood ratio statistics
Brazil	γ	−0.96*	−1.23*	N/A
	d_1	0.65*	0.29*	
	d_2	–	–	
China	γ	−1.00*	−1.23*	N/A
	d_1	0.65*	0.29*	
	d_2	–	–	
India	γ	−1.21*	−0.66*	N/A
	d_1	−1.94*	4.98*	
	d_2	–	–	
Turkey	γ	−0.70*	−1.32*	10.56*
	d_1	−1.54*	4.63*	
	d_2	–	–	
Mexico	γ	−1.20*	−0.66*	N/A
	d_1	2.23*	−3.16*	
	d_2	–	–	
Indonesia	γ	−1.00*	−0.68*	5.79*
	d_1	−0.60*	4.21*	
	d_2	0.89*	−11.21*	

Notes: * denotes rejection of the null at 5% level of significance. d_1 and d_2 are break dates. Null hypothesis: no cointegration.

Source: authors' calculations

5.1 Empirical results of panel cointegration test

The results of Westerlund's (2006) panel cointegration test allowing for multiple structural shifts are presented in Table 8 for G7 countries. In the empirical test, a maximum of four breaks are allowed. In both tables, Panel A reports the test results that allow for structural shifts in constant, while Panel B demonstrates the results where structural shifts are allowed in both constant and trend of the regression. For G7 countries, the test results do not differ significantly in Panel A and Panel B. The test detects four breaks for Germany, Japan, and the USA, three for France, two for Italy and the UK, and one for Canada. The location of breakpoints is linked with the 1980s, which could have been due to the impact of the oil price shock and energy shock. Another part of the breaks is connected with the beginning of the 1990s and the end of the 2000s, which coincided with the international economic crisis of 1990 and the Asian financial crisis of 1997, when all the countries were gravely affected. Moreover, another break is associated with the event of 2007–2008, which is connected with the global financial crisis, where France, Japan, the UK and the USA were affected. When breaks are allowed in constant, the statistics of the LM panel test fail to reject the null hypothesis of cointegration. However, the LM statistics reject the null hypothesis when a break is permitted in constant and trend, giving no support for cointegration.

Table 8: Westerlund (2006) approach for G7 countries

	Break in constant		Break in constant and trend	
Countries	**Break date**	**Number of breaks**	**Break date**	**Number of breaks**
Canada	2005	1	1976, 1983, 1991, 2011	4
France	1980, 1987, 1997	3	1980, 1987, 1997, 2008	4
Germany	1980, 1992, 1999, 2012	4	1979, 1992, 2005	3
Italy	1985, 1996	2	1980, 1992, 1999, 2011	4
Japan	1976, 1985, 1992, 2004	4	1977, 1985, 1995, 2012	4
UK	1979, 1996	2	1979, 1987, 1995, 2007	4
USA	1980, 1997, 2004, 2012	4	1977, 1984, 2008	3
	LM statistics: 2.174		LM statistics: 9.973*	

Notes: * rejects the null hypothesis of cointegration based on the bootstrap *p* values at the 5% level of significance. Null hypothesis: cointegration.

Source: authors' calculations

Likewise, Panel A of Table 9 demonstrates the breakpoints generated through Westerlund's (2006) panel cointegration test for E7 countries. The results indicate four breaks for Brazil and India, three for China and Indonesia, and two for Mexico and Turkey. Panel B exhibits four breaks for all the individual countries. The identified breaks from both panels (A and B) are significantly different. In sum, the location of breakpoints is concentrated around the beginning of the 1980s to 1990s, which could have been the repercussion of the oil price shock, energy shock (1980s) and international economic crisis (1990). Another part of the breaks is located around the beginning of the 2000s to 2010s, which coincided with the event of Asian financial crisis in 1997 and the global financial crisis (2008), when all the countries were severely affected. The LM statistics for both the models (with level −3.55; with level and trend −11.77) reject the null hypothesis of cointegration, refuting the BGH for E7 countries. In general, the panel cointegration results support the validity of the BGH for G7 (developed) countries but negate its validity for E7 (developing) countries. Moreover, the identified breakpoints for each country are coherent with the range of breaks found in the univariate analysis. It is an observed fact that developed economies are more open compared to developing economies. Perhaps due to this factor, the BGH is observed for G7 (developed) countries, which is contrary to the findings of Chang et al. (2016).

The unbalanced growth doctrine favours "partial or selective" government policies that target specific sectors intentionally, while the balanced growth doctrine favours "general" government policies, wherein equal importance is given to all sectors coherently. Unbalanced growth picks the winners, whereas balanced growth helps the losers achieve higher economic growth. Although Jiang et al. (2020) remarked that the balanced growth hypothesis may be more appropriate for developing countries to achieve higher economic development, they could not find robust evidence of the BGH in lower-income countries. It could be because achieving a balanced growth path is difficult for developing countries due to several economic and sociological issues (i.e., political structure, regional disparities, poverty, population size, higher investment and lower consumption (Ghate and Robertson, 2014; Kaufman and García-Escribano, 2013; Mayer Pelicice, 2019; Moreno-Brid et al., 2005). This fact is supported by the conservative view of economic development, which criticized the balanced growth strategy for developing countries (Hirschman, 1958; Kurihara, 1959; Singer, 1958). Singer stated that "*balanced growth can neither solve the problem of underdeveloped countries nor do they have sufficient resources to achieve balanced growth based on several assumptions*" (Singer, 1958). From this debate, it could be stated that depending on the level of economic development, a country can adopt either a balanced or an unbalanced growth strategy to achieve long-run equilibrium.

Despite being the fastest-growing economies in the world (PwC, 2017; Vu, 2020), E7 countries are facing several economic and social issues. Labour absorption in low-productivity sectors, varying income and demand elasticity and labour market imbalances could be some factors that impair the appropriate growth process in E7 countries.

Table 9: Westerlund (2006) approach for E7 countries

	Break in constant		Break in constant and trend	
Countries	**Break date**	**Number of breaks**	**Break date**	**Number of breaks**
Brazil	1983, 1990, 2002, 2012	4	1979, 1989, 1997, 2012	4
China	1981, 2002, 2009	3	1978, 1991, 1999, 2007	4
India	1980, 1991, 1999, 2007	4	1979, 1990, 2001, 2011	4
Turkey	1985, 2004	2	1979, 1989, 1994, 2001	4
Mexico	1990, 2008	2	1979, 1987, 1994, 2000	4
Indonesia	1976, 2002, 2010	3	1980, 1987, 1997, 2012	4
	LM statistics: 3.553*		LM statistics: 11.774*	

Notes: * rejects the null hypothesis of cointegration based on the bootstrap *p* values at the 5% level of significance. Null hypothesis: cointegration

Source: authors' calculations

A summary of the results with respect to the BGH test using various methods is provided in Table 10. It could be inferred from Table 10 that the balanced growth path is evident for more countries when the multivariate cointegration analysis of Johansen (2000) is used compared to the univariate analysis (PV and CMR). The differences in results arise because of the statistical properties of univariate and multivariate analysis. The multivariate approach is preferred over the univariate approaches as it is a superior method in validating the BGH. The former approach identifies two cointegrating vectors in the three-variable space considering structural breaks. It also validates the stationarity properties of the great ratios by imposing appropriate cointegrating restriction (see the methodology section for details).

Table 10: Summary of results

<table>
<tr><th>G7 countries</th><th>Perron and Vogelsang (1992)</th><th>Clemente et al. (1998)</th><th>Johansen et al. (2000)</th><th>Westerlund (2006)</th></tr>
<tr><td>Canada</td><td>–</td><td>BGH</td><td>BGH</td><td rowspan="7">BGH</td></tr>
<tr><td>France</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Germany</td><td>BGH</td><td>BGH</td><td>BGH</td></tr>
<tr><td>Italy</td><td>–</td><td>BGH</td><td>–</td></tr>
<tr><td>Japan</td><td>BGH</td><td>–</td><td>BGH</td></tr>
<tr><td>UK</td><td>BGH</td><td>BGH</td><td>BGH</td></tr>
<tr><td>USA</td><td>BGH</td><td>BGH</td><td>BGH</td></tr>
<tr><td colspan="5">E7 countries</td></tr>
<tr><td>Brazil</td><td>BGH</td><td>BGH</td><td>–</td><td rowspan="6">–</td></tr>
<tr><td>China</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>India</td><td>–</td><td>BGH</td><td>–</td></tr>
<tr><td>Turkey</td><td>BGH</td><td>–</td><td>BGH</td></tr>
<tr><td>Mexico</td><td>BGH</td><td>–</td><td>BGH</td></tr>
<tr><td>Indonesia</td><td>–</td><td>BGH</td><td>–</td></tr>
</table>

Notes: BGH implies that the concerned country or panel of countries are following a balanced growth path.

6. Summary and Conclusion

The study sought evidence of the balanced growth hypothesis in G7 and E7 countries using annual data for the period 1970–2019. The main variables of interest were per capita consumption, investment and output, with two great ratios: consumption-output and investment-output. Both univariate and multivariate techniques were used. A balanced growth path requires the presence of a common stochastic trend in the macroeconomic aggregates and stationarity of the "great ratios". This study employed both traditional unit root tests without considering structural breaks: Dickey and Fuller (1979) and Phillips and Perron (1988) tests, and modern unit root tests with structural breaks: Perron and Vogelsang (1992) with one break and Clemente et al. (1998) with two breaks, in the univariate analysis. The modern unit root tests incorporate break dates from around 1970 to 2019 (including the first oil crisis in 1973, second oil crisis in 1979, international financial crisis in 1991 and global financial crisis in 2008) in the selected dataset.

With the traditional unit root test, we could not find robust evidence of the BGH in G7 and E7 countries. When the PV test was conducted with a single break, the study found stationarity of the great ratios for four G7 and three E7 countries. However, when the CMR test was conducted with two structural breaks, the study obtained stationarity of the great ratios for five G7 and three E7 countries. The combined results suggest mixed evidence of stationarity of the "great ratios". The results are in conformity with those of Clemente et al. (1999) and Chang et al. (2016), who found mixed evidence of balanced growth for important OECD and G20 countries, respectively.

A multivariate analysis using the maximum likelihood test of Johansen et al. (2000) was undertaken in the analysis to gather further support for the BGH considering the importance of structural breaks. The results suggest two cointegrating equations for six G7 countries and three E7 countries. The LR test did not reject parametric restrictions at the 5% level of significance for five G7 countries (the UK, the USA, Japan, Germany, and Canada) and two E7 countries (Turkey and Indonesia). The study found support of the BGH for all the G7 countries except France and Italy. On the other hand, only two out of six E7 countries (Turkey and Indonesia) show compatibility with the BGH. This finding can be interpreted as lack of presence of a common average growth rate of output, consumption, and investment due to the worldwide slowdown/productivity changes/ structural breaks from the early 1970s to 2008s for the four E7 countries. The results for the G7 countries support the findings of Harvey et al. (2003). It is evident that multivariate analysis is better at tracing the balanced growth property for both G7 and E7 countries as compared to the univariate analysis. Therefore, multivariate analysis should be conducted in examining supportive evidence on the BGH. Lastly, the findings of Westerlund's (2006) panel cointegration suggest a cointegration relationship (balanced growth) in the G7 countries, while there is no cointegration relationship (unbalanced growth) in the E7 countries. It could be because developing countries are relatively closed economies compared to developed countries. Due to the lack of access to international markets, their consumption might grow at a different rate than their output and investments even in the long term, which distorts a sustained long-term equilibrium path. Moreover, they are constrained by the growth of their own resources. Therefore, it may be recommended that the governments of developing countries restructure their policy towards trade liberalization to access international markets and follow a balanced growth strategy to remove the socio-economic and political bottlenecks in their economies and achieve a balanced growth equilibrium path. Countries that are not following a balanced growth path should try to strike macroeconomic balance by using appropriate policies to reduce the unfavourable impacts of economic upheavals.

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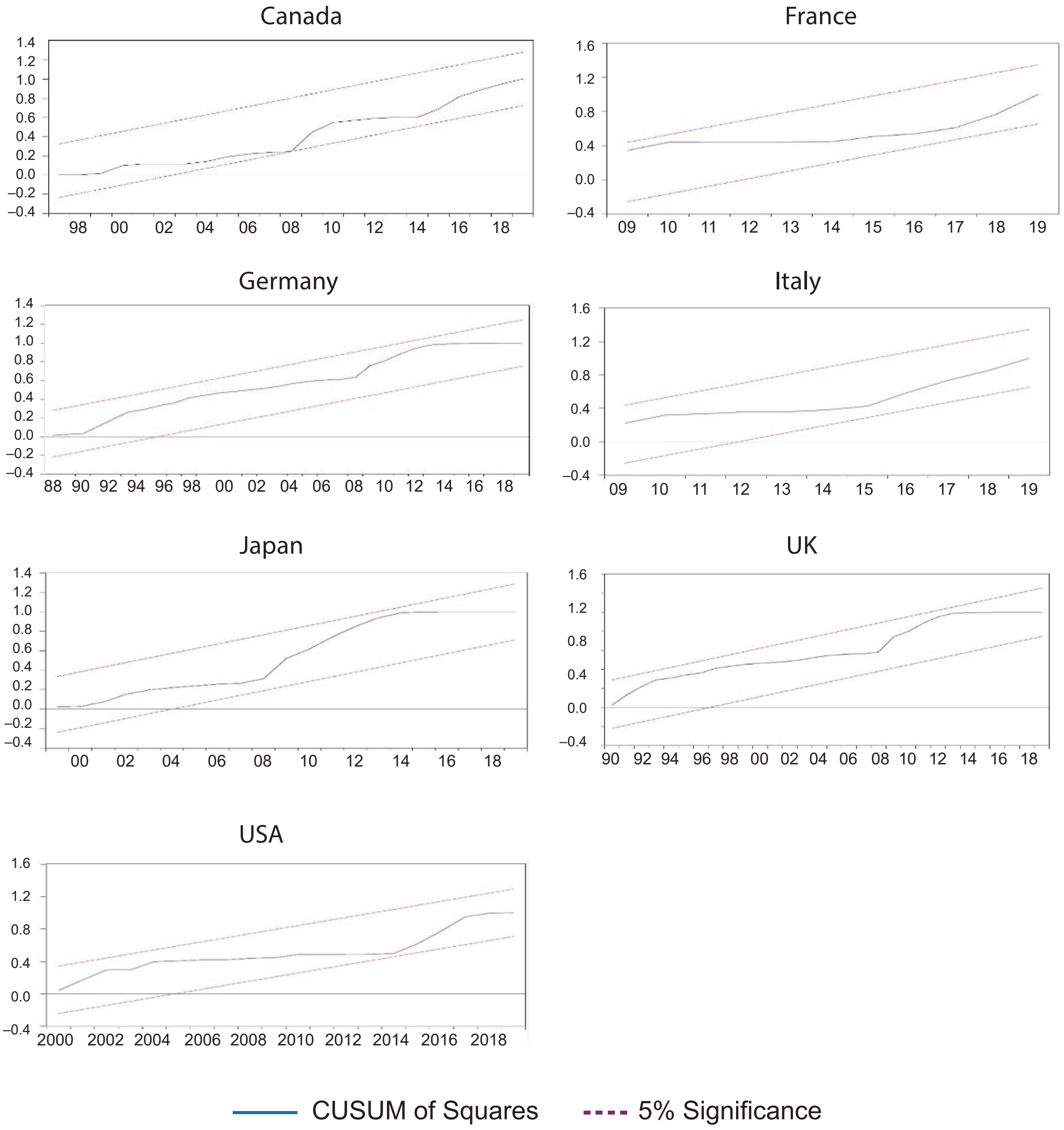
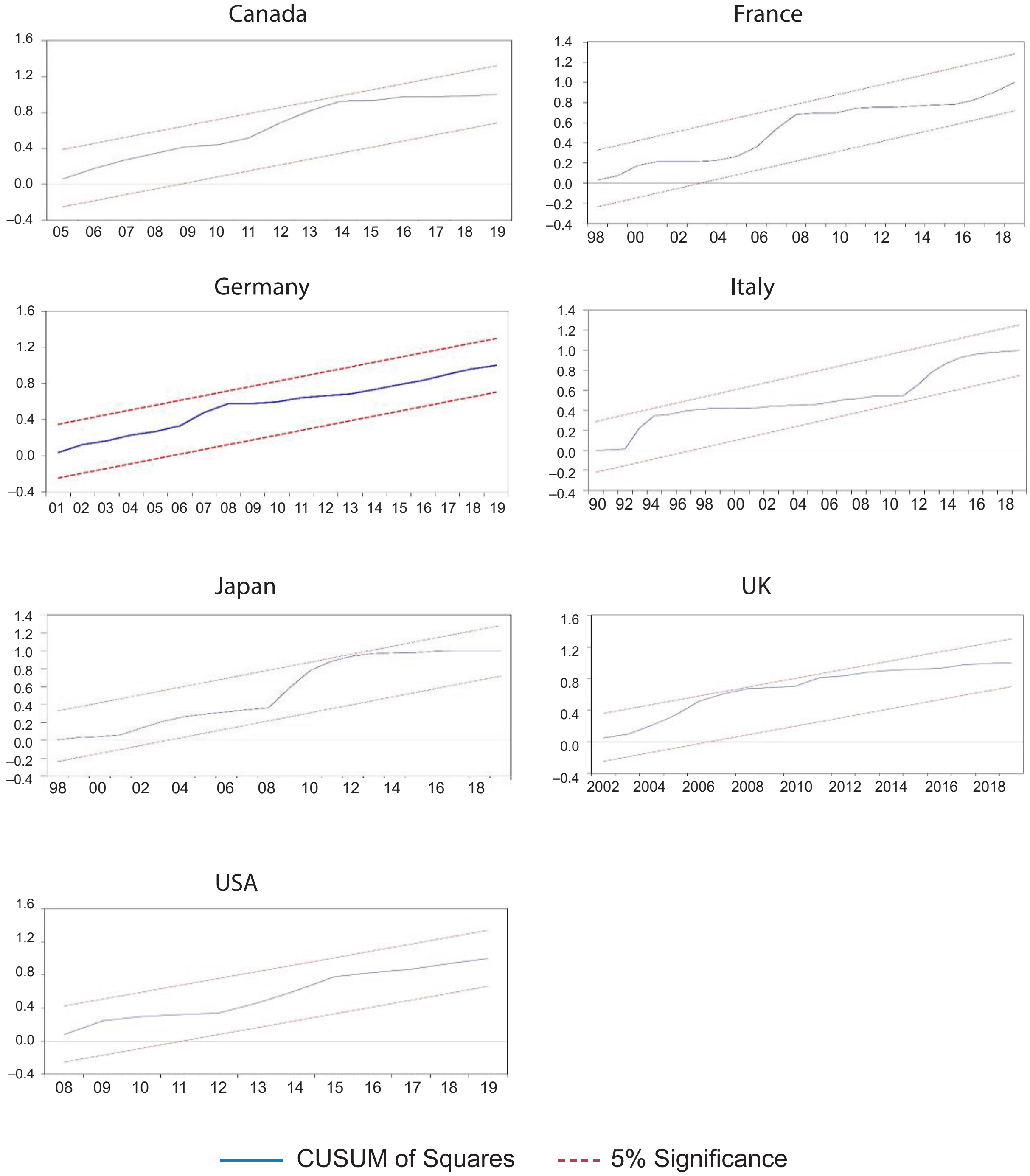
Appendix

Figure A1A: Plot of cumulative sums of squares of recursive residuals of consumption-output ratio in G7 countries



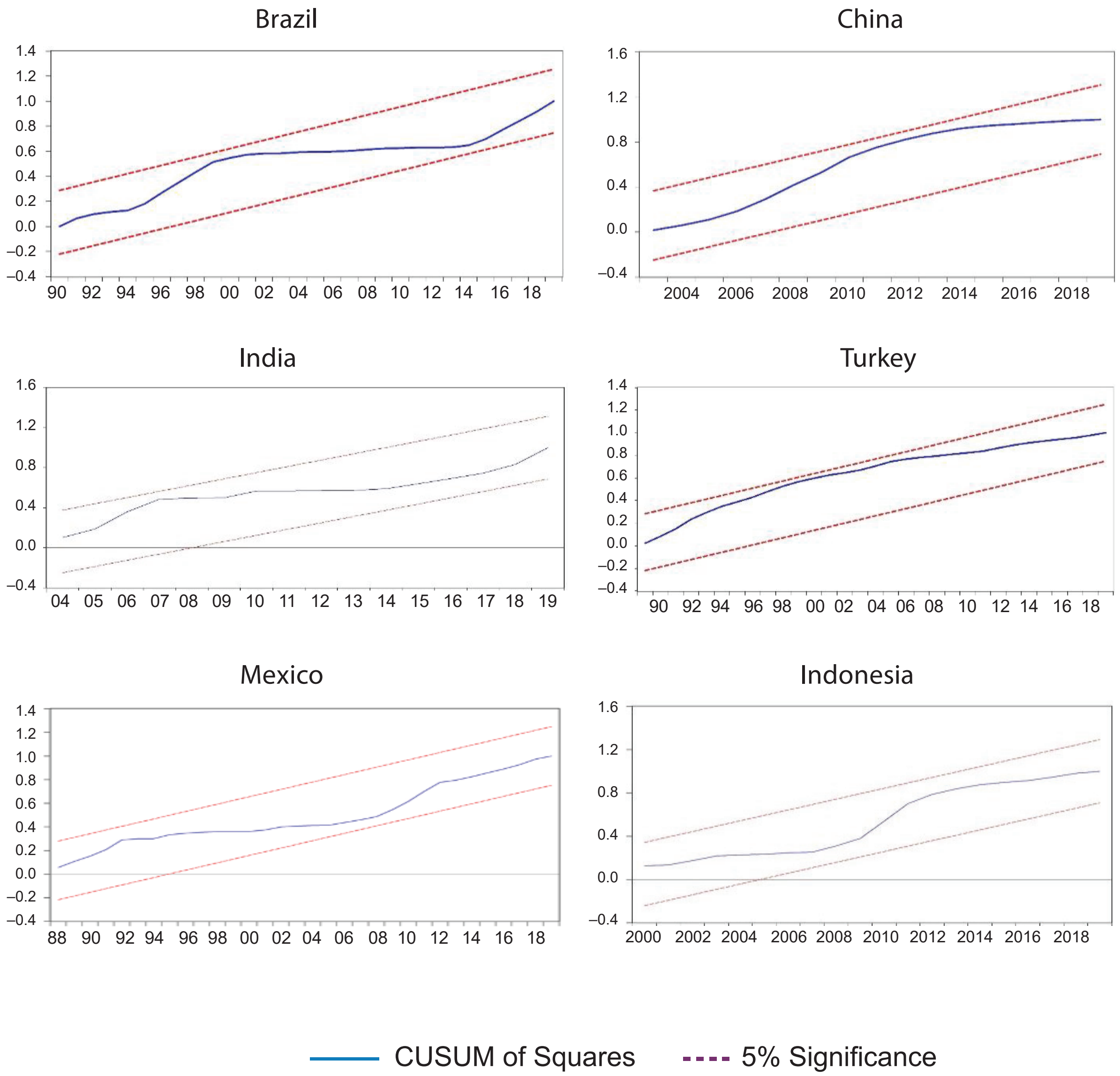
Notes: the straight lines represent critical bounds at the % significance level.

Figure A1B: Plot of cumulative sums of squares of recursive residuals of investment-output ratio in G7 countries



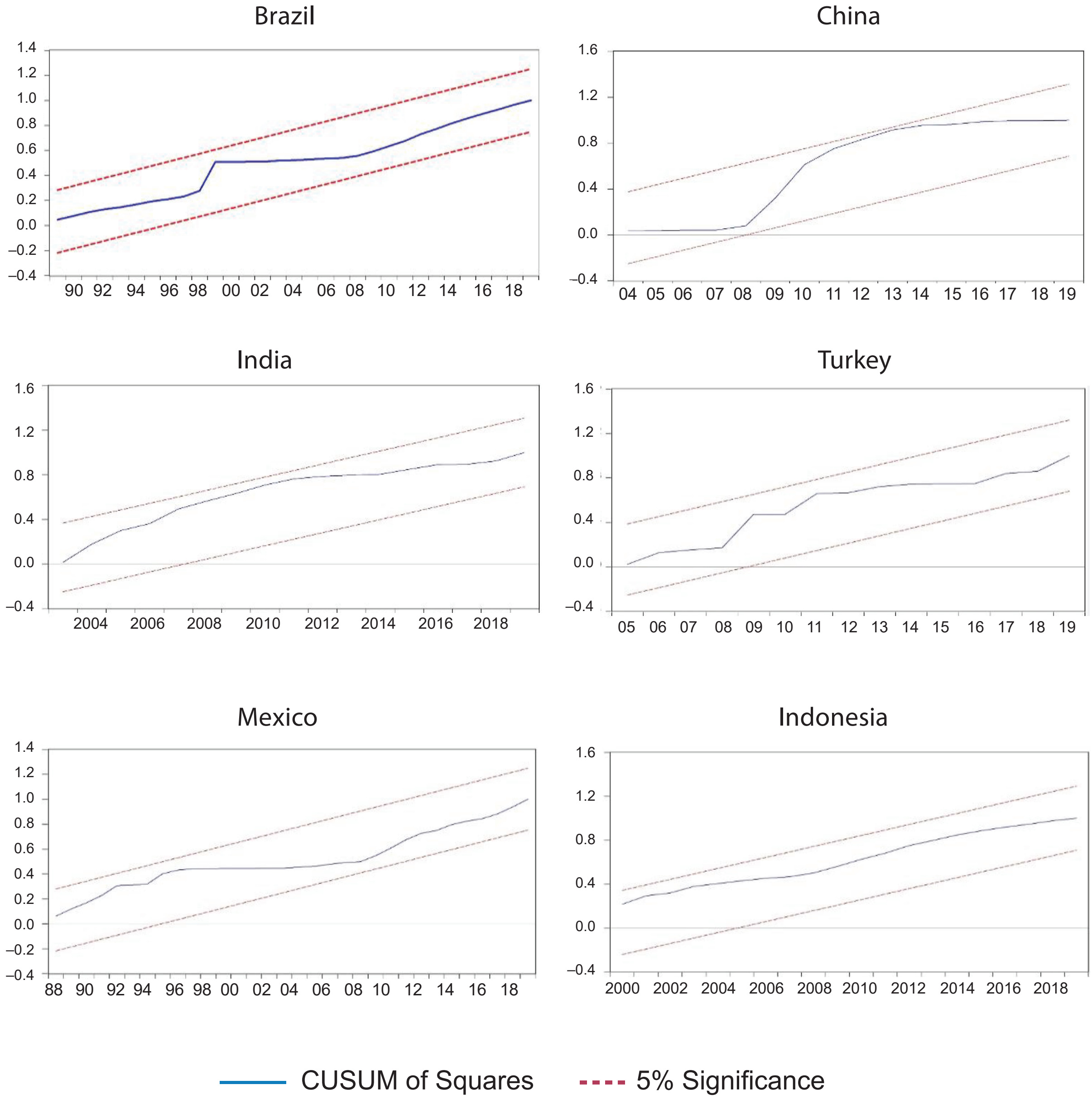
Notes: the straight lines represent critical bounds at the 5% significance level.

Figure A2A: Plot of cumulative sums of squares of recursive residuals of consumption-output ratio in E7 countries



Notes: the straight lines represent critical bounds at the 5% significance level.

Figure A2B: Plot of cumulative sums of squares of recursive residuals of investment-output ratio in E7 countries



Notes: the straight lines represent critical bounds at the 5% significance level.

Table A1: Summary of economic events

G7 countries				Consumption-output
	PV	CMR (1)	CMR (2)	Linked crises
Canada	1981	1989	1996	Recession and IC
France	1979	1974	1979	Oil price shock/energy crisis
Germany	1987	1974	1988	Oil price shock and recession
Italy	1978	1979	2008	Oil price shock and GFC
Japan	1991	1973	1998	IC, oil price shock and AFC
UK	1994	1994	2001	IC and AFC
USA	1999	1981	2000	Recession and AFC
E7 countries				**Consumption-output**
Brazil	1989	1987	1989	Recession and IC
China	2002	1990	2002	AFC, recession and IC
India	1986	1987	2002	AFC and recession
Turkey	1988	1984	1988	recession
Mexico	1998	2005	1987	AFC and recession
Indonesia	1997	1978	1997	AFC and oil price shock
G7 countries				**Investment-output ratio**
Canada	1981	1989	2004	Recession, IC and domestic slowdown
France	1974	1974	1980	Oil price shock and recession
Germany	2000	1980	2000	AFC and recession
Italy	1980	1985	2011	Recession and GFC
Japan	1997	1973	1997	AFC and oil price shock
UK	1989	1979	1989	IC and recession
USA	2007	1987	2007	GFC and recession
E7 countries				**Investment-output ratio**
Brazil	1980	1980	1989	Recession and IC
China	2002	1983	2002	AFC and recession
India	2002	1984	2002	AFC and recession
Turkey	1984	1984	2004	Turkish financial crisis (2001) and recession
Mexico	1999	1978	1981	AFC, oil price shock and recission
Indonesia	1999	1980	1999	AFC and recession

Notes: PV: Perron and Vogelsang (1992) with one break; CMR (1) and (2): Clemente et al. (1998) with two breaks. Break periods: 1970s to 1980s: first and second oil price crisis/energy crisis, 1980s to 1990s: early 1980s recession, 1990s international crisis (IC), 1990s to 2000s: Indian economic crisis, Early 1990s Recession, Asian financial crisis (AFC); 2000s to 2010: global financial crisis (GFC), subprime mortgage crisis; 2010 to 2019: European sovereign debt crisis.

Source: Calamitsis et al. (1998)