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IS REAL GDP PER CAPITA STATIONARY FOR BANGLADESH? EMPIRICAL EVIDENCE FROM STRUCTURAL BREAK

In this paper we examine the stationarity property with structural break for real GDP per capita of Bangladesh from 1971 to 2009. The structural break of 1990 representing political regime change in Bangladesh is found to be significant. The unit root test results, both ADF and Phillips-Perron, indicate that real GDP per capita is trend stationary process. This implies that the long-run path for per capita income is not influenced by temporary fluctuations.

Keywords: *unit root tests; structural break; real GDP per capita; stationary.*

JEL code: C22.

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ЧИ Є РЕАЛЬНИЙ ВВП НА ДУШУ НАСЕЛЕННЯ У БАНГЛАДЕШІ ПОСТІЙНОЮ ВЕЛИЧИНОЮ?

У статті оцінено сталість та структурні розриви у реальному ВВП на душу населення у Бангладеші з 1971 по 2009 роки. Суттєвий структурний розрив 1990 р. пов'язано зі зміною політичного режиму в країні. Результати моделювання, як за Діккі-Фуллером, так і за Філліпсом-Перроном, вказують на стаціонарність реального ВВП на душу населення відносно тренда. Це доводить, що на довготривалу перспективу дохід на душу населення не залежить від тимчасових коливань.

Ключові слова: *тестування на одиничні корені; структурний розрив; реальний ВВП на душу населення; стаціонарність.*

Форм. 1. Рис. 2. Табл. 4. Літ. 35.

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ЯВЛЯЕТСЯ ЛИ РЕАЛЬНЫЙ ВВП НА ДУШУ НАСЕЛЕНИЯ В БАНГЛАДЕШЕ ПОСТОЯННОЙ ВЕЛИЧИНОЙ?

В статье оценены постоянство и структурные разрывы в реальном ВВП на душу населения в Бангладеше с 1971 по 2009 годы. Существенный структурный разрыв 1990 г. обозначает смену политического режима в стране. Результаты моделирования, как по Дикки-Фуллеру, так и по Филлипсу-Перрону, указывают на стационарность реального ВВП на душу населения относительно тренда. Это доказывает, что в долгосрочной перспективе доход на душу населения не зависит от временных колебаний.

Ключевые слова: *тестирование на единичные корни; структурный разрыв; реальный ВВП на душу населения; стационарность.*

1. Introduction. Macroeconomic time series data are considered non-stationary i.e. they contain a unit root. The seminal article by Nelson and Plosser (1982) led to a large volume of literature investigating possible non-stationarity of macroeconomic time series data. The question whether real GDP can be characterized by unit roots or not, has been an issue of particular interest (Wasserfallen, 1986; Ben-David &

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Papell, 1995; Cheung & Chinn, 1996; Rapach, 2002). Non-stationarity in real output implies that shocks have permanent effects, is inconsistent with the view that business cycles are stationary fluctuations around a deterministic trend; instead, it suggests that shocks to real output have permanent effects (Nelson and Plosser, 1982). It can be argued that non-stationarity has important implications for the effectiveness of government policies. If real output contains a unit root, the logical implication is that government-initiated structural reform is of limited value, because the impact of such reform on the long-run growth path will be offset by other shocks. However, if real output is trend stationary, this implies that only large shocks such as government policies aimed at changing the fundamentals will have at least semi-permanent effects on the growth path (Li, 2000; Smyth and Inder, 2004:1-2).

The preceding discussion has important implications for small emerging economies like Bangladesh. Bangladesh's economy underwent the structural adjustment policies in the early 1980s, which included institutional as well as policy level alterations. The financial and external sectors underwent substantial reforms in the mid-1980s and early 1990s influencing the real output. The real output is also likely to have structural breaks as a consequence to these reforms. In the past decade or so, Bangladesh economy's growth was around 5-6% per annum (Figure 1).
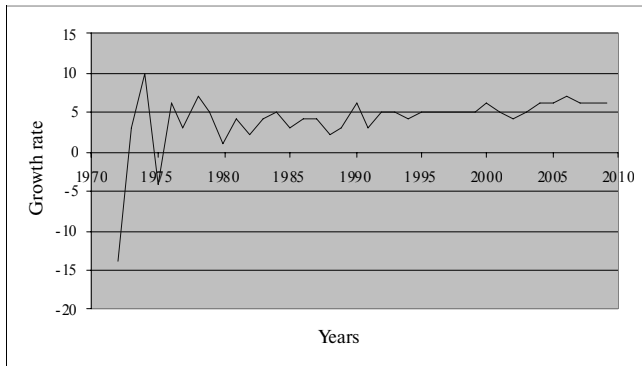

Figure 1. **Real GDP growth rates for Bangladesh (1971-2009)**

With the restoration of parliamentary democracy in the 1990 and onwards, we can observe the periodic growth averages are much higher than in the previous two decades (Table 1). GDP growth has been much more volatile till 1990, which became much more stable and increasing in the subsequent years (Figure 1). Hence, it is important to assess the validity of the unit root hypothesis for real income as an empirical fact for Bangladesh.

Table 1. **Average growth rates for Bangladesh (%)**

Period	1972-1980	1981-1990	1991-2000	2000-2009
Average	1.88	3.7	4.8	5.6

The remainder of the paper is organized as follows: Section 2 reviews the literature, Section 3 presents the data and the analytical methodology, Section 4 shows the empirical results and finally Section 5 concludes the paper.

2. Literature review. The relevance of macroeconomic stabilization programs can be critically dependent on the fact that GDP follows a stochastic or deterministic path. A transitory fluctuation around a deterministic path supports the role for temporary monetary and/or fiscal shocks. The effect of these policy shocks then are evaluated for duration above or below the trend, and long-run uncertainty is also limited by the expected duration of the business cycle around the trend. On the other hand, if real GDP follows a stochastic trend, real shocks such as productivity or labor/leisure trade-offs have lasting effect, and the long-run path of GDP is unrestrained (Fleissig and Strauss, 1999).

Since Nelson and Plosser (1982) seminal work on unit roots for US macroeconomic variables, a large literature has emerged using different data sets, sample periods and testing procedures that initially corroborate to their finding that real GDP has unit root (Campbell and Mankiw, 1987; Schwert,1987; Perron, 1988). Subsequently, Perron (1989) concluded that GDP follows a trend stationary process allowing for structural break during Great Depression or 1973 oil shock. The trend stationarity model led to another stream of discussion that asserts that if a break is significant then conventional unit root tests will often fail to reject the null, hence leading to fallacious conclusions. Zivot and Andrews (1992) show evidence against a unit root for many macroeconomic variables that are less conclusive when allowing for an endogenous structural break. It transpires from the empirical literature that real GDP levels are non-stationary by using either univariate unit root statistics (Cheung and Chinn, 1996) or panel unit root tests (Rapach, 2002; Ozturk and Kalyoncu, 2007) along the lines of the Augmented Dickey-Fuller (ADF) statistics. The tests conjecture that a symmetric adjustment process exists for the real GDP series. However, there is an increasing trend in empirical literature that allows for non-linear dynamics for unit root testing procedures, e.g. Caner and Hansen (2001), and Kapetanios et al. (2003).

Conventional univariate tests support the null of a unit root in GDP for OECD economies (Stulz and Wasserfallen, 1985; Kormendi and Meguire, 1990; Cogley, 1990). Banerjee et al. (1992) perform recursive structural breaks on 7 OECD economies and find little evidence against a unit root for U.S. GDP or in most other countries in the postwar period. Zelhorst and De Hann (1994) show that the results are less clear cut if one allows for an exogenous change in the mean and/or growth rate in GDP. Ben-David and Papell (1995) detect structural breaks in real per capita GDP for many OECD economies using a dataset of Maddison (1991) from 1870-1979. Hence, evidence of a structural break may be sensitive to the sample period considered. Studies used panel unit root tests when the failure to reject the null hypothesis is attributed to the lack of power intrinsic in univariate unit root tests. Fleissig and Strauss (1999) find evidence in favor trend stationarity for OECD per capita income using the bootstrap estimation. Ben-David et al. (2003) use two structural breaks for testing the stationarity for the G-7 countries. Narayan (2007) using Lagrange multiplier test that allows for two structural breaks finds G-7 per capita income is stationary except for Germany and Italy. Chang et al. (2008) use the newly developed and refined panel stationary test with structural breaks to investigate the time-series properties of per capita real GDP for 20 Latin American countries during the 1960-2000 period. The empirical results from numerous earlier panel-based unit

root tests which do not take structural breaks into account indicate that the per capita real GDP for all the countries are non-stationary; but panel stationary test with structural breaks find the null hypothesis of stationarity in per capita real GDP can not be rejected for any of the 20 countries. Therefore, the issue of stationarity for real GDP with structural breaks is a crucial one. Till date the literature investigating the stationarity property of real GDP per capita for LDC economies like Bangladesh do not exist and this paper intends to fill this gap.

3. Data and analytical framework. The yearly data on Bangladesh's real GDP per capita have been collected from the World Development Indicators (WDI) of the World Bank (2010). The data constructed at 2000 constant prices from 1971 to 2009 and the data are in natural logarithm. Table 2 shows the descriptive statistics for real GDP per capita and its growth rates over the sample period.

Table 2. **Descriptive statistics of real GDP per capita and growth rates: 1971-2009**

	Adjusted Observations	Mean	Maximum	Minimum	Std. Dev.
LGDP	38	5.633	6.178	5.349	0.244
DLGDP	38	0.017	0.064	-0.177	0.039

Notes:
1. LGDP is the log of real GDP per capita in Bangladesh.
2. Growth rates are derived by taking the first difference.

As discussed earlier, Nelson and Plosser (1982) find that most macroeconomic variables have unit roots, and hence they are difference stationary processes (DSP). Perron (1989) challenging Nelson and Plosser shows that most macrovariables are trend stationary processes (TSP), and have deterministic trends often with structural breaks in intercept, slope, or in both. If structural breaks are not properly accounted for along with the trend, most macro series are likely to erroneously exhibit unit roots. Perron finds that 11 out of 14 series that appeared being difference stationary in Nelson and Plosser (1982) are actually trend stationary. Thus, once the structural breaks are accounted for, fluctuations in macrovariables are stationary around respective deterministic trends. Perron suggested plotting the data, and looking for any deterministic trend along with structural breaks around the time of big domestic or global events, such as oil shocks or the Great Depression. Perron's arguments has further merit, if we mistakenly de-trend a series that otherwise has unit roots; the residuals will still exhibit unit roots. Hence, we follow Perron's procedures to examine the possibilities of trends and structural breaks in the real per capita GDP series. Thus, our methodology engages two steps: i) detection of a break and detrending the variable; ii) finding stationarity of the detrended variable.

In Figure 2 a clear upward trend is evident in the natural log of per capita income series. In addition, we observe an increased slope of the trend ever since 1990, an important year of political and economic regime change in Bangladesh. The year of 1990 is viewed as the beginning of a new democratic era in Bangladesh. The mass political upsurge of 1990 marked the end of the authoritarian governance. All the governments after 1990 embraced deregulation and the market economy more extensively than ever before, registering an increased economic growth since then. Hence,

1990 can be regarded as a structural break in Bangladesh's macrovariables (See Maniruzzaman, 1992; Molla, 2000 for details).
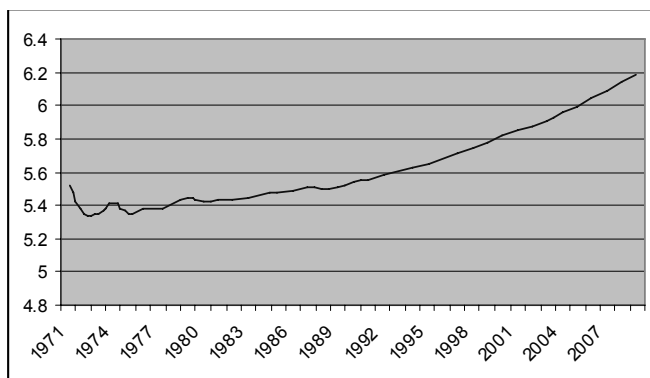

Figure 2. **Natural log of real GDP per capita income**

This case of a structural break in the slope of the trend fits the Model-B in Perron (1989), as shown below:

$$y_t = \alpha + \beta_1 Trend + \phi DT_t + \varepsilon_t$$
$$DT_t = t - T_B \text{ if } t > T_B \text{ or } 0 \text{ otherwise}$$

In the model y_t is a stationary series around a deterministic linear trend with a structural break in the slope of the trend. Intercept is α, β_1 is the coefficient on the trend term and ϕ is the value of the increased slope after the break point T_B, which is 1990. DT signifies the difference in the trend function. This dummy variable is constructed by taking the value 0 prior to and at 1990 and the value (t-20) after 1990, because 1990 is the 20th observation in the sample and ε_t is the error term.

4. Empirical results. Table 3 presents the estimation output for the detrending process. We can see that all the regressors are statistically significant. The dummy for 'break 1990' is due to the reinstatement of parliamentary democracy in 1990. This democratic regime change is considered as a significant change in the history of Bangladesh.

Table 3. **Detrending real GDP per capita with a structural break**

LHS Variables	Regressors		
	Constant	Trend	Break 1990
LGDP	5.379** (0.014)	0.006** (0.001)	0.027** (0.001)

Notes:
1. *, ** and *** indicate the significance at the 10%, 5% and 1% levels, respectively.
2. Standard errors are in the parentheses.
3. The dummy "Break 1990" considers a structural break in the slope of the series from 1990.
4. See the text for the construction of the dummy, and the model A of Perron for details.

We run unit root tests (results are in Table 4) to verify our hypothesis. The ADF test is widely used in this regard (Dickey and Fuller 1979, 1981). Phillips and Perron

(1988), however, proposed a modification of this DF test and have developed a more comprehensive theory of unit root non-stationarity. The Phillips-Perron (PP) test has introduced a t-statistic on the unit-root coefficient in a DF regression that is corrected for autocorrelation and heteroskedasticity. Formally, the power of a test is equal to the probability of rejecting a false null hypothesis. Monte Carlo simulations have shown that the power of various DF tests can be very low (Enders, 2004:207). Maddala and Kim (1998:107) comment that the DF test is less powerful than the PP test. Choi and Chung (1995) assert that for low frequency data, the PP test appears to be more powerful than the ADF test. Though we run both tests, we will regard the PP tests as final if the results contradict. There can be 3 specifications with unit root tests: the first type includes neither an intercept, nor a trend. The second type includes only an intercept, and the third type considers both an intercept and a trend. Since the series are already detrended, we will test only the first two possibilities.

Table 4. **Unit root tests with detrended real GDP per capita**

	LGDP_R_1990	P-values	Lag	Unit Root
ADF (μ)	-7.103**	0.000	0	I(0)
ADF (τ)	7.123**	0.000	0	I(0)
PP (μ)	-6.059**	0.000	4	I(0)
PP (τ)	-6.539**	0.000	4	I(0)

Notes:
1. The variables LGDP_R represents for the Real GDP residuals and derived after the trend and structural break equation, as described in Table 1.
2. The tests will not include any trend since they are already detrended. They will be tested without intercept, which is called 'none' and with intercept.
3. ADF (μ) and PP (μ) represent the most general model without intercept which is called 'none', and ADF (τ) and PP(τ) is the model with a drift and without trend of the variables.
4. The null hypothesis states that the variable has a unit root. P-values are used to decide on the unit root at the 1, 5 and 10% significance level.
5. The critical values and details of the tests are presented in Dickey and Fuller (1979, 1981) and Phillips and Perron (1988). The AIC determines the lag length (P) in the ADF tests (see Stock and Watson , 2007:561 for details), MacKinnon (1996) one-sided p-values in the ADF Tests.
6. PP test with automatic lag selection based on Newey-West (1994)

As Table 4 shows, the results of the ADF and PP tests strongly indicate the absence of unit roots in detrended real GDP per capita (LGDP_R_1990). Thus, detrended series is trend stationary processes (TSP), supporting Perron's (1989) findings that LGDP_R_1990 variable have stationary fluctuations around the trend function with an inclusion of structural breaks in 1990. Thus, temporary fluctuations do not have a lasting effect on long-run path for per capita real GDP in Bangladesh economy over 1971-2009 periods.

5. Conclusion. The aim of the paper is to investigate the stationarity of the real GDP per capita for Bangladesh with trend and structural break from 1971-2009, which is the largest data set till date. The ADF and Phillips-Perron (PP) tests indicate that real GDP per capita for Bangladesh is a Trend Stationary Process (TSP). This result is consistent with Perron (1989) and implies that temporary fluctuations do not have a lasting effect on long-run path for per capita GDP in Bangladesh economy.

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