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CONSUMPTION FUNCTION FOR INDIA: A STUDY THROUGH GROWTH, BREAK AND FLUCTUATION

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ABSTRACT

Majority of macroeconomic variables exhibit growth (or logarithmic trend), breaks in different policy regimes and fluctuations of various types around the growth path. One or more of these components make the variables non-stationary. If one such variable is linearly dependent on another, non-stationarity of the latter is transmitted to the former and the linear combination of them implied by the linear dependence mentioned above becomes stationary or at least less non-stationary and the variables are said to be cointegrated. After observing that consumption and income series for India for the period 1950-51 to 2009-10 are cointegrated with income as a significant Granger cause of consumption, this paper tries to examine how growth, break and fluctuation in income can explain those in consumption. For pursuing this objective, especially for evaluating growth, break and fluctuation in a macroeconomic variable, this paper uses a methodology obtained from the methodologies developed by Cuddy-Della Valle (1978), Della Valle (1979), Coppock (1962) and Bai-Perron (1998, 2003), and used in Mondal and Mondal Saha (2008). This study helps us having a fresh look on the nature of consumption function for India in the period 1950-51 to 2009-10.

KEYWORDS: *growth, production, income, expenditure, Consumption Expenditure*

1. INTRODUCTION

Growth (or logarithmic trend) and fluctuation are two common elements of time series data of almost all macroeconomic variables. These two elements make a series non-stationary. Growth in macroeconomic series of production, income or expenditure occurs mainly from the human propensity to save and invest for having increased production, income and expenditure in the future; it also occurs from the economic policies pursued by the government or by the planning authority. Fluctuation, on the other hand, is mainly the result of inherent cyclical behaviour of the individuals in a market-based economy. It also occurs due to disturbances of several types. Breaks in the growth path result from changes in policy regimes and thus break has also now been treated as a common element in long-run economic (especially macroeconomic) series. The methodology used in the existing literature for estimating the rate of growth in a time series is well established but the methodologies used in the estimation of fluctuation or of break in the growth path are not so well established and are needed to be modified and tuned. This article seeks to serve that purpose and to study the nature of growth, break and fluctuation in Private Final Consumption Expenditure (PFCE) and Net National Product (NNP) in India in the period from 1950-51 to 2009-10, and also to examine how growth, break and fluctuation in the latter can influence those in the former.

Final consumption expenditure plays a very crucial role in national income determination of developing countries like India having excess supply not only in labour market but also in product market. It spreads its role through the consumption function that takes an almost non-proportional linear form in the short run and an almost proportional linear form in the long run. In modern econometric literature the existence of a linear long run (consumption) function is verified and such a function is estimated through co-integration and error correction model. Consumption expenditure and national income are found to be co-integrated in almost all countries because of their common trends and/or common fluctuations. The present method of evaluating growth/ trend and fluctuation helps us evaluating to what extent growth/trend and/or fluctuation of national income are able to explain growth/trend and fluctuation of consumption expenditure or in what way these two variables are co-integrated.

Unit root test on PFCE, its first difference and 2nd difference through ADF test gives t-values as 6.41, -1.69 and -6.78 respectively indicating that the series is integrated of order 2. Almost similar results are found for PP test. Unit root test on NNP, its first difference and 2nd difference through ADF test gives t-values as 5.90, 0.09 and -7.08 respectively indicating that the series is also integrated of order 2. Almost similar results are found for PP test. Johansen's cointegration test indicates existence of cointegrating relation between them. Granger causality test indicates NNP as the cause for PFCE with 2.7% level of significance and fails to indicate PFCE as the cause for NNP even at 5% level of significance.

2. GROWTH, BREAK AND FLUCTUATION OF INDIA'S PRIVATE FINAL CONSUMPTION EXPENDITURE

In this section we shall try to examine the nature of trend/growth, breaks in the trend/growth and fluctuation around the growth path of India's Private Final Consumption Expenditure (PFCE) during the period 1950-51 to 2009-10. In Diagrams 5 and 6 log (natural) values of PFCE of India (at 1993-94 prices, and measured in Rs. crores) for the period 1950-51 to 2009-10 are presented. The data on PFCE are obtained from different volumes of National Accounts Statistics published by the Central Statistical Organisation, Government of India.

In diagram-5 we find that there exists a clear and almost linear trend in the log values of PFCE indicating an almost constant growth (the growth rate is estimated at 3.80% per annum, R-square = 0.9861, Adjusted R-square = 0.9859, t-value = 64.13 with P-value = 1.50E-55 and RSS = 0.3659). If we observe the diagram very closely we find that fluctuations are also there around the linear trend (constant growth) path. Extent of fluctuation as indicated by R-square is 1.39% of total variation (1 – R-square = 0.0139). To have a detailed idea about the nature and extent of fluctuation we use two other measures of fluctuation F_{RSS} [1] and [2]. The value of F_{RSS} is found to be 0.0059. This implies that average absolute fluctuation obtained from RSS is 0.59% of average lnPFCE (Please refer table-5). This average absolute fluctuation is 11.79% of average variation in lnPFCE. From the diagram we also find that fluctuations are mainly due to changes in growth rates over the period considered and very little due to cyclical (business or trade cycles), year-to-year or irregular fluctuations. Cycles are there, but they are long cycles created through changes in growth rates in different policy regimes. Thus, the actual path of lnPFCE cuts the linear trend path only twice – first in between 1965-66 and 1966-67, and then in between 1997-98 and 1998-99. Fluctuations created through year-to-year movements is calculated by the adjusted Coppock index $F_{COPPOCK}'$ This index also includes some parts of cyclical (business or trade cycles) and irregular fluctuations, and a small part of changes in growth rates (because changes in growth rates also create some year-to-year fluctuations). Most importantly, this index is comparable to the RSS based index. The value of $F_{COPPOCK}'$ in the present case is found to be 0.0009. This implies that average fluctuation due to this factor is 0.09% of average lnPFCE. This is only 15.87% of F_{RSS} so that the cycles created by the series are basically long cycles and the average length of a full cycle is estimated at about 79.46 years.

When we try to find optimum breaks[3] in the series under the assumptions that the minimum duration of a regime is 10 years, that there may be single, double or triple kink in between two regimes and that the minimum duration of the truncated regimes at the two ends is 5 years we find that there are 8 breaks in the series in the years 1956-57, 1957-58, 1958-59, 1971-72, 1972-73, 1974-75, 1990-91 and 1992-93 leading to four main regimes from 1950-51 to 1956-57, 1958-59 to 1971-72, 1974-75 to 1990-91 and 1992-93 to 2009-10 of 7, 13, 16 and 17 years respectively.

Table-1
Sub-period growth rates of PFCE of India, 1950-51 to 2009-10

Periods	Growth rates	t-values	P-values
(1) 1950-51 to 1956-57	**3.94**	**13.52**	**2.50E-18**
(2) 1956-57 to 1957-58	-3.08	-1.65	1.06E-01
(3) 1957-58 to 1958-59	8.03	4.64	2.52E-05
(4) 1958-59 to 1971-72	**2.95**	**28.81**	**8.36E-33**
(5) 1971-72 to 1972-73	0.87	0.54	5.88E-01
(6) 1972-73 to 1974-75	1.60	1.98	5.32E-02
(7) 1974-75 to 1990-91	**4.20**	**56.80**	**4.40E-47**
(8) 1990-91 to 1992-93	2.44	4.90	1.06E-05
(9) 1992-93 to 2009-10	**5.23**	**75.97**	**2.52E-53**

Source: NAS (Different Issues), CSO, GOI.

There is a triple break of 1 and 1 years in between 1st and 2nd regimes, another triple break of 1 and 2 years in between 2nd and 3rd regimes and a double break of 2 years in between 3rd and 4th regimes. The fitted path is shown in diagram-6 and the growth rates in 9 sub-periods are shown in table-1. The path is best fitted to the data as is observed from minimum BIC at – 473.09, R-square = 0.9995, Adjusted R-square = 0.9995, F-value = 12273.90 with P-value = 2.21E-80 and RSS = 0.0119. Growth rates are positive and statistically significant at 1 percent level of significance in almost all sub-periods. In the second sub-period from 1956-57 to 1957-58 the growth rate is negative but statistically not significant at 1 percent level of significance. In the 5th and 6th sub-periods from 1971-72 to 1972-73 and from 1972-73 to 1974-75 the growth rate are positive but statistically not significant at 1 percent level of significance. However, all these three sub-periods are not true regimes, they are small sub-periods creating double or triple kinks in between two consecutive regimes. Growth rates in four regimes mentioned above are 3.94, 2.95, 4.20 and 5.23 respectively and all of them are statistically highly significant.

To estimate the growth differences between two consecutive sub-periods the growth difference from the previous sub-period model is used and the estimates are presented in table-2. Growth differences, as such, can be obtained directly from table-1. For example, the growth difference of sub-period-2 from sub-period-1 estimated by – 7.02 can be obtained from table-1 as – 3.08 – 3.94. However, this growth difference from the previous sub-period model helps us testing the statistical significance of these differences.

Table-2
Growth differences from previous sub-period of PFCE of India, 1950-51 to 2009-10

Periods	Growth differences	t-values	P-values
(1) 1950-51 to 1956-57	-	-	-
(2) 1956-57 to 1957-58	-7.02	-3.48	1.07E-03
(3) 1957-58 to 1958-59	11.11	3.31	1.72E-03
(4) 1958-59 to 1971-72	-5.09	-2.87	6.00E-03
(5) 1971-72 to 1972-73	-2.08	-1.27	2.10E-01
(6) 1972-73 to 1974-75	0.73	0.32	7.50E-01
(7) 1974-75 to 1990-91	2.60	3.08	3.32E-03
(8) 1990-91 to 1992-93	-1.75	-3.20	2.39E-03
(9) 1992-93 to 2009-10	2.79	5.13	4.69E-06

Source: NAS (Different Issues), CSO, GOI.

From the results of table-2 we find that 6 out of 8 such differences are statistically significant. The difference between the 4th and the 5th sub-periods and that between the 5th and the 6th sub-periods are not significant. As is clear from the table, this growth difference from the previous sub-period model fails to be helpful in comparing growth rates of two consecutive regimes if there exist double or triple breaks in between two regimes – we have to use galloping growth difference model or double galloping growth difference model. The results of galloping growth difference model are shown in table-3 and those of double galloping growth difference model are shown in table-4.

Diagram-5

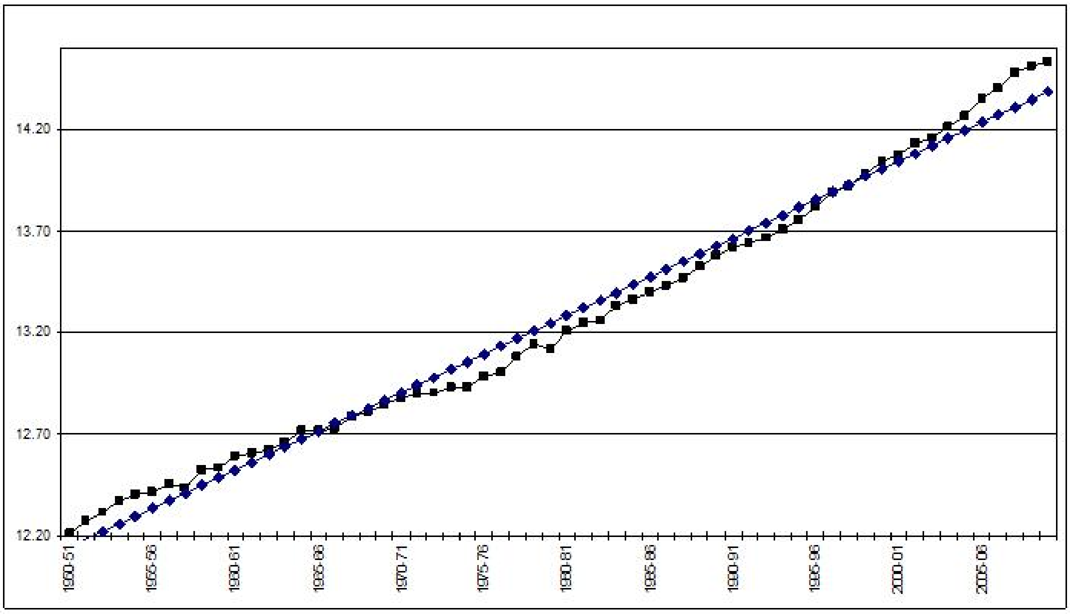

Diagram-6

Breaks in Log (natural) values of PFCE of India in the period 1950-51 to 2009-10

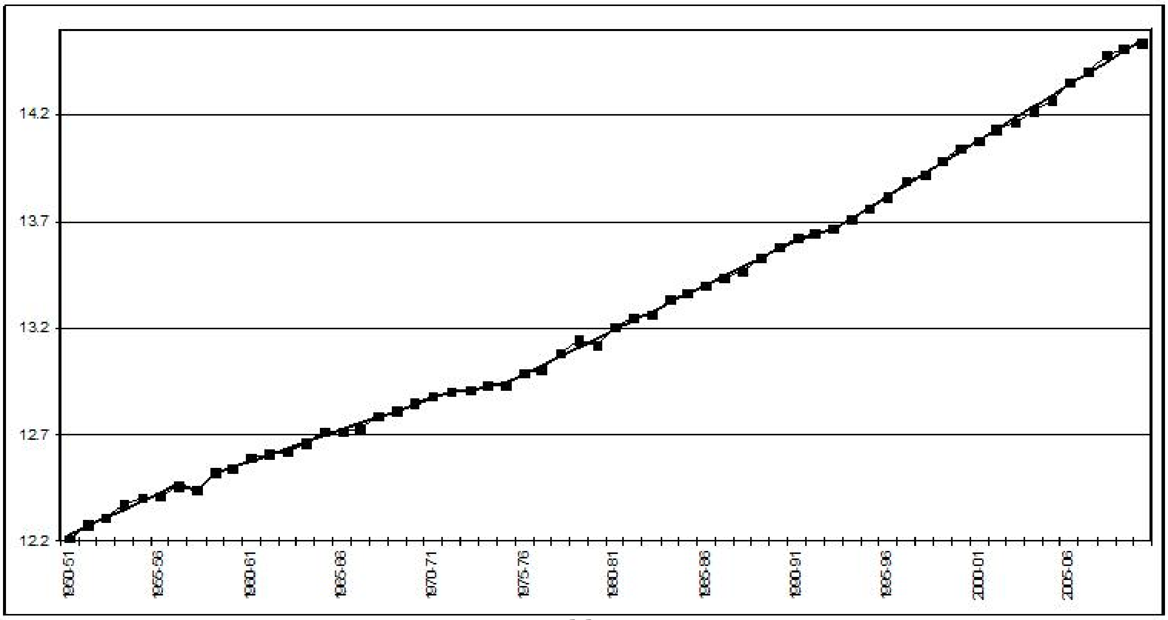

Table-3

Galloping growth differences of PFCE of India, 1950-51 to 2009-10

Periods	Growth differences	t-values	P-values
(1) 1950-51 to 1956-57	-	-	-
(2) 1956-57 to 1957-58	-	-	-
(3) 1957-58 to 1958-59	4.09	2.33	2.38E-02
(4) 1958-59 to 1971-72	6.02	3.22	2.24E-03
(5) 1971-72 to 1972-73	-7.17	-3.21	2.33E-03
(6) 1972-73 to 1974-75	-1.35	-1.66	1.04E-01
(7) 1974-75 to 1990-91	3.33	2.10	4.12E-02
(8) 1990-91 to 1992-93	0.84	0.96	3.39E-01
(9) 1992-93 to 2009-10	**1.04**	**10.46**	**3.49E-14**

Source: NAS (Different Issues), CSO, GOI.

In table-3 estimates from the galloping growth difference model are shown. These results help us comparing growth rates of 3rd and 4th regimes (i.e., of 7th and 9th sub-periods) because there exists a double break in between these two regimes. The results show that growth rate in the 4th regime has increased by 1.04 percentage points over that in the third regime and the difference is statistically significant.

On the other hand, results of table-4 help us comparing growth rates of 1st and 2nd regimes (i.e., of 1st and 4th sub-periods) and of 2nd and 3rd regimes (i.e., of 4th and 7th sub-periods) because there exist triple break in between 1st and 2nd regimes and also in between 2nd and 3rd regimes. The results show that growth rate in the 2nd regime (4th sub-period) has decreased by 1.00 percentage points over that in the 1st regime (1st sub-period) and that in the 3rd regime (7th sub-period) has increased by 1.25 percentage points over that in the 2nd regime (4th sub-period), and that both the differences are statistically significant, the second one is more significant than the first.

Table-4
Double galloping growth differences of PFCE of India, 1950-51 to 2009-10

Periods	Growth differences	t-values	P-values
(1) 1950-51 to 1956-57	-	-	-
(2) 1956-57 to 1957-58	-	-	-
(3) 1957-58 to 1958-59	-	-	-
(4) 1958-59 to 1971-72	**-1.00**	**-3.22**	**2.24E-03**
(5) 1971-72 to 1972-73	3.94	1.61	1.14E-01
(6) 1972-73 to 1974-75	-6.43	-3.37	1.45E-03
(7) 1974-75 to 1990-91	**1.25**	**9.90**	**2.24E-13**
(8) 1990-91 to 1992-93	1.58	0.94	3.53E-01
(9) 1992-93 to 2009-10	3.64	4.48	4.29E-05

Source: NAS (Different Issues), CSO, GOI.

As mentioned earlier, fluctuations calculated through the RSS based fluctuation index F_{RSS} is found to be 0.0059. This implies that average absolute fluctuation is 0.59% of average lnPFCE (Please refer table-5). This average absolute fluctuation is 11.79% of average variation in lnPFCE. From the diagram we also find that fluctuations are mainly due to changes in growth rates over the period considered and very little due to cyclical (business or trade cycles), year-to-year or irregular fluctuations. Cycles are there, but they are long cycles created through changes in growth rates in different policy regimes. Thus, the actual path of lnPFCE cuts the linear trend path only twice – first in between 1965-66 and 1966-67, and then in between 1997-98 and 1998-99. As mentioned earlier, fluctuations created through year-to-year movements can be calculated by the adjusted Coppock index $F'_{COPPOCK}$. This index also includes some parts of cyclical (business or trade cycles) and irregular fluctuations, and a small part of changes in growth rates (because changes in growth rates also create some year-to-year fluctuations). Most importantly, this index is comparable to the RSS based index. The value of $F'_{COPPOCK}$ in the present case is found to be 0.0009. This implies that average fluctuation due to this factor is 0.09% of average lnPFCE. This is only 15.87% F_{RSS} of so that the cycle created by the series is a long cycle and the average length of a full cycle is estimated at about 79.46 years.

Table-5
Fluctuation in PFCE of India, 1950-51 to 2009-10

Periods	Growth rates	Variation (%)	Fluctuation (%)	Yr-to-yr Fluctuation (%)	Average Length of cycle (year)
1950-51 to 2009-10	3.80	4.99	0.59 (11.79)	0.09 (15.87)	79.46
1950-51 to 1956-57	3.94	0.65	0.12 (17.93)	0.07 (60.30)	5.50
1958-59 to 1971-72	2.95	0.94	0.09 (9.61)	0.07 (78.45)	3.25
1974-75 to 1990-91	4.20	1.55	0.12 (7.78)	0.10 (82.65)	2.93
1992-93 to 2009-10	5.23	1.93	0.11 (5.59)	0.06 (59.82)	5.59

Note: (1) Variation, fluctuation and year-to year fluctuation are measured as percentage to average value of lnY_t for the relevant period.

(2) Figures in the parentheses of fluctuation refer to percentage share in variation.

(3) Figures in the parentheses of year-to-year fluctuation refer to percentage share in fluctuation.

For individual regimes we have only growth, year-to-year fluctuations, cyclical fluctuations and small irregular fluctuations. For the first regime (1950-51 to 1956-57) variation in lnPFCE is 0.65% of mean lnPFCE of that period of which 0.12% is due to fluctuations of all types and 0.09% is due to year-to-year fluctuations. Thus fluctuations of all types constitute 17.93% of total variation and year-to-year fluctuations constitutes 60.30% of fluctuations of all types. This means that the contribution of cyclical fluctuations in fluctuations of all types is about 40% and the length of cycles estimated for this period is about 5.50 years. Almost similar results are seen for the fourth regime. For other two regimes contributions of cyclical fluctuations in fluctuations of all types are further low and average lengths of cycles are also further small. For example, for the third regime (1974-75 to 1990-91) year-to-year fluctuations constitute 82.65% of fluctuations of all types. Automatically, length of cycles estimated for this period is 2.93 years, only a bit greater than 2.

3. TO WHAT EXTENT INDIA'S NNP RESPONSIBLE FOR GROWTH, BREAK AND FLUCTUATION OF PFCE?

To examine whether the above mentioned growth, break and fluctuation in PFCE can be explained by growth, break and fluctuation in Net National Product (NNP), or to test the existence of common trend and/or common fluctuation in the two variables, or to test the existence of a valid consumption function for India in her post-independence period we regress lnPFCE on lnNNP and we find the results presented in table-6.

Table-6
Results from regression of Ln-PFCE on Ln-NNP for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	R Square	Adjusted R Square	F	Significance F
Intercept	1.61	24.57	2.41E-32	0.9982	0.9981	31758.76	3.81E-81
Ln-NNP	0.8698	178.21	3.81E-81				

Table-6 shows that trend and fluctuation (non-stationarity) in Ln-PFCE can be explained to the extent of 99.82% by those (non-stationarity) in Ln-NNP. The coefficient of lnNNP is 0.8698 which is highly significant. Thus, we become sure of the existence of a strong common trend and/or fluctuation or common movement between the two variables.

Existence of a strong common trend and/or fluctuation or common movement between the two variables can also be ensured from the analysis of trend and fluctuation of lnNNP. Like lnPFCE there exists a clear and almost linear trend in the log values of NNP indicating an almost constant growth at the rate of 4.35% per annum (R-square = 0.9801, Adjusted R-square = 0.9798, t-value = 53.44 with P-value = 4.91E-51 and RSS = 0.6909). Amount of fluctuation as indicated by r-square is 1.99% of total variation (1 – r-square = 0.0199). Fluctuations calculated through the RSS based fluctuation index F_{RSS} is found to be 0.0080. This implies that average absolute fluctuation is 0.80% of average lnNNP. This average absolute fluctuation is 14.11% of average variation in lnNNP. These fluctuations are mainly due to changes in growth rates over the period considered and very little due to cyclical (business or trade cycles), year-to-year or irregular fluctuations. Cycles are there, but they are long cycles created through changes in growth rates in different policy regimes. As mentioned earlier, fluctuations created through year-to-year movements can be calculated by the adjusted Coppock index $F_{COPPOCK}'$. This index also includes some parts of cyclical (business or trade cycles) and irregular fluctuations, and a small part of changes in growth rates (because changes in growth rates also create some year-to-year fluctuations). Most importantly, this index is comparable to the RSS based index. The value of $F_{COPPOCK}'$ in the present case is found to be 0.0012. This implies that average fluctuation due to this factor is 0.12% of average lnNNP. This is only 15.03% of F_{RSS} so that the cycle created by the series is a long cycle and the average length of a full cycle is estimated at about 88.55 years.

When we try to find optimum breaks in the series under the assumptions that the minimum duration of a regime is 10 years, that there may be single, double or triple kink in between two regimes and that the minimum duration of the truncated regimes at the two ends is 5 years we find that there are 8 breaks in the series in the years 1964-65, 1966-67, 1967-68, 1977-78, 1978-79, 1979-80, 1992-93 and 2003-04 leading to five main regimes from 1950-51 to 1964-65, 1967-68 to 1977-78, 1979-80 to 1992-93, 1992-93 to 2003-04 and 2003-04 to 2009-10 of 15, 10, 13, 11 and 6 years respectively. There is a triple break of 2 and 1 years in between 1st and 2nd regimes, another triple break of 1 and 1 years in between 2nd and 3rd regimes and all other breaks are single breaks.

Growth rates in 9 sub-periods are shown in table-7. The path is well fitted to the data as is observed from minimum BIC at – 445.59, R-square = 0.9995, Adjusted R-square = 0.9994, F-value = 10226.01 with P-value = 2.12E-78 and RSS = 0.0189. Growth rates are positive and statistically significant at 1 percent level of significance in almost all sub-periods. Growth rates in five regimes mentioned above are 4.05, 3.24, 4.83, 5.80 and 8.06 respectively and all of them are statistically highly significant.

Table-7

Sub-period growth rates of NNP of India, 1950-51 to 2009-10

Periods	Growth rates	t-values	P-values
(1) 1950-51 to 1964-65	**4.05**	**35.56**	**3.68E-37**
(2) 1964-65 to 1966-67	-1.14	-1.11	2.74E-01
(3) 1966-67 to 1967-68	8.93	4.33	7.12E-05
(4) 1967-68 to 1977-78	**3.24**	**17.50**	**5.85E-23**
(5) 1977-78 to 1978-79	12.77	5.72	5.97E-07
(6) 1978-79 to 1979-80	-8.11	-3.75	4.57E-04
(7) 1979-80 to 1992-93	**4.83**	**44.44**	**7.40E-42**
(8) 1992-93 to 2003-04	**5.80**	**48.09**	**1.56E-43**
(9) 2003-04 to 2009-10	**8.06**	**28.04**	**3.02E-32**

Source: NAS (Different Issues), CSO, GOI.

As mentioned earlier, Fluctuations calculated through the RSS based fluctuation index F_{RSS} is found to be 0.0080. This implies that average absolute fluctuation is 0.80% of average lnNNP (Please refer table-8). This average absolute fluctuation is 14.11% of average variation in lnNNP. The value of $F_{COPPOCK}'$ is found to be 0.0012. This implies that average fluctuation due to this factor is 0.12% of average lnNNP. This is only 15.03% of F_{RSS} so that the cycle created by the series is a long cycle and the average length of a full cycle is estimated at about 88.55 years.

Table-8

Fluctuation in NNP of India, 1950-51 to 2009-10

Periods	Growth rates (%)	Variation (%)	Fluctuation (%)	Yr-to-yr Fluctuation (%)	Length of cycle (year)
1950-51 to 2009-10	4.35	5.68	0.80(14.11)	0.12(15.03)	88.55
1950-51 to 1964-65	4.05	1.41	0.14(9.80)	0.10(74.56)	3.60
1967-68 to 1977-78	3.24	0.81	0.19(23.11)	0.12(63.79)	4.91
1979-80 to 1992-93	4.83	1.46	0.13(8.97)	0.08(64.77)	4.77
1992-93 to 2003-04	5.80	1.41	0.10(7.30)	0.05(51.87)	7.43
2003-04 to 2009-10	8.06	1.10	0.07(6.65)	0.04(57.91)	5.96

Note: (1) Variation, fluctuation and year-to year fluctuation are measured as percentage to average value of lnY_t for the relevant period.

(2) Figures in the parentheses of fluctuation refer to percentage share in variation.

(3) Figures in the parentheses of year-to-year fluctuation refer to percentage share in fluctuation.

For individual regimes we have only growth, year-to-year fluctuations, cyclical fluctuations and small irregular fluctuations. For the first regime (1950-51 to 1964-65) variation in lnNNP is 1.41% of mean lnNNP of that period of which 0.14% is due to fluctuations of all types and 0.10% is due to year-to-year fluctuations. Thus fluctuations of all types constitute 9.80% of total variation and year-to-year fluctuations constitutes 74.56% of fluctuations of all types. Thus, about 25.44% of fluctuations are cyclical in nature and the length of cycles estimated for this period is about 3.60 years. Almost similar results are seen for other four regimes. For the fourth regime (1992-93 to 2003-04) year-to-year fluctuations constitute about 50% of fluctuations of all types. Automatically, length of cycles estimated for this period is maximum at 7.43 years.

Table-9
Results from regression of Ln-PFCE on T and Ln-NNP for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	3.66	11.44	2.14E-16		0.9990	0.9989	27152.51	1.22E-85
T	0.0075	6.49	2.25E-08	0.4248				
Ln-NNP	0.6998	26.44	1.10E-33	0.9246				

As higher order non-stationarity arises mainly from fluctuation and not so much from trend, stationarity in the residuals from the regression between the two variables depend mainly on their common fluctuation, not simply on their common trend. To examine the existence of common fluctuation, we regress lnPFCE on T and lnNNP, and we find the results presented in table-9. With the inclusion of a new variable, T, R-square increases from 0.9982 to 0.9990 and adjusted R-square from 0.9981 to 0.9989. The coefficient of lnNNP reduces from 0.8698 to 0.6998 but it remains statistically significant. This implies that for one unit increase in lnNNP we find a significant 0.8698 unit increase in lnPFCE and for one unit increase in fluctuation in lnNNP we find again a significant but 0.6998 unit increase in fluctuation in the same way in lnPFCE. This ensures the existence of significant common fluctuation.

Table-10
Results from regression of Ln-PFCE on Predicted Ln-NNP(T)and Residual Ln-NNP(T) for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	1.56	30.88	2.81E-37		0.9990	0.9989	27152.51	1.22E-85
Predicted Ln-NNP(T)	0.8732	231.53	1.86E-86	0.9989				
Residual Ln-NNP(T)	0.6998	26.44	1.10E-33	0.9246				

The coefficient of T has now reduced remarkably to 0.0075 from 0.0380 in the simple growth model but it is still statistically significant. This is mainly due to the existence of multicollinearity between lnNNP and T. This also implies that a small but significant portion of trend of lnPFCE is not explained by lnNNP (actually by trend of lnNNP) but is explained exclusively by other trend factors.

On the other hand, to examine the existence of common trend vis-à-vis common fluctuation, we regress lnPFCE on Predicted lnNNP(T) (Predicted lnNNP in the regression of lnNNP on T) and Residual lnNNP(T), and we find the results presented in table-10. These two regressors are linearly independent and there is no question of common explanation. They together are able to explain 99.90% of the variability of lnPFCE, an amount same as that obtained in table-9. The coefficient of Predicted lnNNP(T) and the corresponding t-value, P-value and the partial correlation show the extent and strength of common trend and those with reference to Residual lnNNP(T) show those of common fluctuation (same as those obtained with reference to lnNNP in table-9). Results show that both of them are significant, but common trend is slightly more significant than common fluctuation.

The coefficient of Predicted lnNNP(T) or the coefficient of common trend is 0.8732, slightly greater than the coefficient of lnNNP in table-6 or the coefficient involving both common trend and common fluctuation (0.8698). On the other hand, the coefficient of Residual lnNNP(T) or the coefficient of common fluctuation is 0.6998, and this is less than 0.8698.

If breaks for policy changes including short term fluctuations in between two regimes are included in trend then fluctuations consist of year-to-year and cyclical fluctuations in different regimes and all sorts of irregular fluctuations. In this case, the coefficient of common trend and also the partial correlation of the variable reduce from the respective values in the previous model (common linear trend model). This is probably due to the fact that the coefficient of common break is less and less significant than that of common linear trend model. The coefficient of this newly defined fluctuation is also less than that in the common linear trend model and the partial correlation is significantly less than that of common linear trend model. However, this coefficient of this common fluctuation is still statistically significant.

Table-11
Results from regression of Ln-PFCE on Predicted Ln-NNP(M)and Residual Ln-NNP(M) for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	1.61	24.50	6.00E-32		0.9982	0.9981	15830.48	5.69E-79
Predicted Ln-NNP(M)	0.8699	177.90	6.05E-80	0.9982				
Residuals Ln-NNP(M)	0.6844	3.34	1.48E-3	0.1638				

A complete decomposition among linear trend, breaks in linear trend and fluctuation is shown in table-12. It is observed from the table that common movement arising from common linear trend is most significant followed by common movement created by common breaks. Common movement created by common fluctuation is least significant of the three. However, all of them are statistically significant.

Table-12
Results from regression of Ln-PFCE on Predicted Ln-NNP(T), Breaks and Residual Ln-NNP(M) for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	1.56	30.61	1.19E-36		0.9990	0.9989	17787.21	2.27E-83
Predicted Ln-NNP(T)	0.8732	229.51	5.72E-85	0.9989				
Breaks	0.7002	25.85	8.27E-33	0.9227				
Residuals Ln-NNP(M)	0.6844	4.34	6.09E-05	0.2514				

To examine whether the relation is other way round or whether growth, break and fluctuation in Net National Product (NNP) is more reasonably explained by growth, break and fluctuation in PFCE, or to test whether a dynamic income determination function is more identified than a dynamic consumption function for India in her post-independence period through the existence of common trend and/or common fluctuation in the two variables, we regress lnNNP on lnPFCE and we find the results presented in table-13. As correlation is a symmetric measure all the results except the regression coefficient are same as those in table-6. The coefficient of lnPFCE in this regression is 1.1476.

To examine the existence of common fluctuation, we regress lnNNP on T and lnPFCE, and we find the results presented in table-14. With the inclusion of a new variable r-square increases from 0.9982 to 0.9985 and adjusted r-square from 0.9981 to 0.9984. The coefficient of lnPFCE increases from 1.1476 to 1.3213 and it remains statistically significant. This implies that for one unit increase in lnPFCE we find a significant 1.1476 unit increase in lnNNP and for one unit increase in fluctuation in lnPFCE we find again a significant 1.3213 unit increase in fluctuation in lnNNP. This ensures the existence of significant common fluctuation.

Table-13
Results from regression of Ln-NNP on Ln-PFCE for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	R Square	Adjusted R Square	F	Significance F
Intercept	-1.82	-21.31	4.10E-29	0.9982	0.9981	31758.76	3.81E-81
Ln-PFCE	1.1476	178.21	3.81E-81				

The coefficient of T has now reduced remarkably to a significant negative value of -0.0067 from 0.0380 in the simple growth model. As said earlier this is mainly due to the existence of multicollinearity between lnPFCE and T. This may also imply that a small but significant portion of trend of lnNNP is not explained by lnPFCE (trend of lnPFCE) but is explained exclusively by other trend factors in excess of joint contribution of them along with lnPFCE.

Table-14
Results from regression of Ln-NNP on T and Ln-PFCE for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	-3.92	-6.48	2.31E-08		0.9985	0.9984	18965.15	3.33E-81
T	-0.0067	-3.50	9.11E-04	0.1795				
Ln-PFCE	1.3213	26.44	1.19E-33	0.9258				

On the other hand, to examine the existence of common trend vis-à-vis common fluctuation, we regress lnNNP on Predicted lnPFCE(T) (Predicted lnPFCE in the regression on T) and Residual lnPFCE(T), and we find the results presented in table-15. These two regressors are linearly independent and there is no question of common explanation. They together are able to explain 99.85% of the variability of lnNNP, an amount same as that obtained in table-14. The coefficient of Predicted lnPFCE(T) and the corresponding t-value, P-value and the partial correlation show the extent and strength of common trend and those with reference to Residual lnPFCE(T) show those of common fluctuation. Results show that both of them are significant, but common trend is more significant than common fluctuation.

The coefficient of Predicted lnPFCE(T) that involves common trend only is 1.1452, slightly less than the coefficient of lnPFCE in table-13 that involves both common trend and common fluctuation (1.1476). On the other hand, the coefficient of Residual lnNNP(T) is 1.3213, a bit greater than 1.1476.

Table-15
Results from regression of Ln-NNP on Predicted Ln-PFCE(T)and Residual Ln-PFCE(T) for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	-1.79	-22.709	3.06E-30		0.9985	0.9984	18965.15	3.33E-81
Predicted Ln-PFCE(T)	1.1452	192.954	5.96E-82	0.9985				
Residuals Ln-PFCE(T)	1.3213	26.4394	1.1E-33	0.9258				

If breaks for policy changes including short term fluctuations in between two regimes are included in trend then fluctuations consist of year-to-year and cyclical fluctuations in different regimes and all sorts of irregular fluctuations. In this case, the coefficient of common trend and also the partial correlation of the variable reduce from the respective values in the previous model (common linear trend model). This is probably due to the fact that the coefficient of common break is less and less significant than that of common linear trend. The coefficient of this newly defined fluctuation is also less than that in the common linear trend model. However, this coefficient of this common fluctuation is still statistically significant.

Table-16
Results from regression of Ln-NNP on Predicted Ln-PFCE(M)and Residual Ln-PFCE(M) for India, 1950-51 to 2009-10

	Coefficients	*t-values*	*P-values*	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	-1.82263	-21.1245	1.23E-28		0.9982	0.9981	15609.61	8.49E-79
Predicted Ln-PFCE(M)	1.1476	176.6522	9.05E-80	0.9982				
Residuals Ln-PFCE(M)	1.1107	3.637267	5.94E-04	0.1911				

A complete decomposition among linear trend, breaks in linear trend and fluctuation is shown in table-17. It is observed from the table that common movement arising from common linear trend is most significant followed by common movement created by common breaks. Common movement created by common fluctuation is least significant of the three. However, as before all of them are statistically significant.

Table-17

Results from regression of Ln-NNP on Predicted Ln-PFCE(T), Breaks and Residual Ln-PFCE(M) for India, 1950-51 to 2009-10

	Coefficients	t-values	P-values	Partial Correlations	R Square	Adjusted R Square	F	Significance F
Intercept	-1.7899	-22.63	7.5E-30		0.9985	0.9984	12553.35	3.87E-79
Predicted Ln-PFCE(T)	1.1452	192.26	1.14E-80	0.9985				
Break	1.3284	26.05	5.51E-33	0.9238				
Residuals Ln-PFCE(M)	1.1107	3.99	1.91E-04	0.2217				

If we compare the results of tables 13 to 17 with those of table 6 and tables 9 to 12, we find following similarities and dissimilarities. As correlation is a symmetric concept, whether we regress lnPFCE on lnNNP (table-6) or lnNNP on lnPFCE (table-13), the value of R-square is found to be the same at 0.9982. These regressions fail to determine the direction of the relation between lnPFCE and lnNNP. But when lnPFCE is regressed on T and lnNNP (table-9), or on Predicted lnNNP(T) and Residual lnNNP(T) (table-10), or on Predicted lnNNP(T), Breaks and Residual lnNNP(M) (table-12) the value of R-square is found to increase to 0.9990. On the other hand, when lnNNP is regressed on T and lnPFCE (table-14), or on Predicted lnPFCE(T) and Residual lnPFCE(T) (table-15), or on Predicted lnPFCE(T), Breaks and Residual lnPFCE(M) (table-17) the value of R-square is found to increase from 0.9982 to 0.9985 only. This difference has a clear implication that growth and fluctuation in PFCE is better explained by those in NNP than the other way round.

Thus for the Indian economy there exists a sensible long run relationship between consumption and income in its post independence period and variation inincome acts as a sensible cause for variation in consumption in the above said period. As growth is the main source of variation of income and so consumption, a log-linear line well estimates the long run relation between consumption and income. The overall elasticity of consumption with respect to income is estimated at 0.8698 (table-6). However, the said elasticity in the long run, arising from common growth, is estimated at 0.8732; that in the medium run, arising from common breaks in the growth paths is estimated at 0.7002 and that in the short run, arising from short run fluctuations, is estimated at 0.6844 (table-12).

4. CONCLUDING REMARKS

Major macroeconomic series in majority of the countries follow a growth (or trend) path and in majority of the cases the path is not stable. Instability is due mainly to cyclical or business fluctuation inherent in any market based economy. Cycles may be of short duration of two years leading to year to year fluctuations. They may be also of medium duration of more than two but generally not more than ten years. In long series instability is also created through breaks created by policy changes. This article proposes a unified methodology for evaluating growth, break and fluctuation, and applies that methodology on India's NNP and PFCE data in the post-independence period. This evaluation helps explaining in what way consumption is determined by income in India.

FootNote

[1] Growth in a time series Y_t is usually estimated by the semi-log-linear trend regression $\ln Y_t = a + bt$ with b as the assumed constant exponential rate of growth ('ln' stands for natural logarithm). Automatically, fluctuation around this growth path is usually viewed as the average absolute deviation of observed values from the estimated values in the regression mentioned above. A relative average measure of absolute fluctuation (relative to average log value of Y_t) is normally obtained by F_{RSS} = $\sqrt{\frac{1}{T}\sum_{t=1}^{T} e_t^2} \Big/ \overline{\ln Y_t}$. For interpretational convenience it is expressed in percentage term. It can be easily verified that this index is also equal to CV(lnY) multiplied by $\sqrt{(1-R^2)}$. A measure of fluctuation in the form $CV(\ln Y_t)\sqrt{(1-\bar{R}^2)}$ is used by Cuddy-Della Valle (Cuddy-Della Valle [1978] and Della Valle [1979]) with the argument that CV(lnY) measures the amount of variation in lnY a part of which (given by $\bar{R}^2$) is due to trend and so the rest is due to fluctuation. However, in our methodology we shall use the measure given by F_{RSS} above.

[2] Coppock (Coppock [1962]) has introduced an important way of measuring fluctuation around the growth path of an economic time series. He has argued that if the series Y_t experiences a constant growth path then the ratios between Y_{t+1} and Y_t or the differences between $\ln Y_{t+1}$ and $\ln Y_t$ become constant and the standard deviation (S.D.) of these differences becomes zero, or the antilog of the standard deviation becomes one. Any fluctuation from the constant growth path makes the standard deviation greater than zero or its antilog greater than 1. Coppock has used this latter (i.e., antilog of the standard deviation) as the measure of fluctuation. We denote this fluctuation measure by $F_{COPPOCK}$. Thus, $F_{COPPOCK} = Exp\,(S.D.(\ln(\frac{Y_{t+1}}{Y_t})))$. As is clear from the expression or from the conception about it, the measure is based on year to year fluctuation of Y_t. Ray (1983) uses this measure for explaining fluctuation in Indian agriculture in the post independence period. F_{RSS} and $F_{COPPOCK}$ give different views of fluctuation. $F_{COPPOCK}$ is based on year to year fluctuations in $\ln Y_t$. On the other hand, F_{RSS} is based on the extent of fluctuations of $\ln Y_t$ from the long run growth path. Thus, F_{RSS} incorporates both short cycles of year to year fluctuation given by $F_{COPPOCK}$ and long cycles generated through business cycles or breaks in growth path. However, these two measures are not directly comparable. To make them comparable we propose some adjustment in the Coppock's measure through rationalisation of $S.D.(\ln(\frac{Y_{t+1}}{Y_t}))$ by $2\overline{\ln Y_t}$.

The adjusted Coppock measure of fluctuation is thus given by $F_{COPPOCK}' = (SD(\ln(\frac{Y_{t+1}}{Y_t})))/(2(\overline{\ln Y_t}))$. Now the two measures are comparable and the average length of a full cycle of long cycles can be estimated by $2(F_{RSS} \big/ F_{COPPOCK}')^2$. A detail theoretical discussion on this comparison is found in Mondal and Mondal Saha (2008).

[3] Bai and Perron (Bai-Perron [1998, 2003]) develop an algorithm for evaluating optimum break points in a macro time series under the assumption of a minimum length of a policy regime. In this paper we use a modified Bai-Perron method that incorporates short breaks in between two policy regimes and truncated regimes at the two ends. A detailed discussion on this modification and the corresponding algorithm is given in Mondal and Mondal Saha (2008). The algorithm is based on maximisation of adjusted R-square. However, Bai and Perron observe that the optimum decision is best obtained when it is judged in terms of minimisation of Bayesian Information Criterion (BIC). In the present paper optimum breaks are identified on the basis of minimisation of BIC.

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