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Does Causation hold for Panel Data in between SDP and NTR among Indian States?

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Fiscal health of Indian states is deteriorating in the recent past with serious implications on their developmental efforts. Inadequate revenue sources, uncontrolled growth of current expenditures and failure of central transfers to grow as fast as the states 'own revenues' have been the major causes of fiscal imbalance at state level. In fact, states' expenditures have been growing which has resulted as shrinking of capital expenditure. Other factors responsible for poor fiscal health of states are up-trend of non-developmental consumption expenditure, high cost of Government employees and implementation of the Sixth Central Pay Commission. From the revenue receipts side, poor tax collections, poorly targeted cost recovery policy and lack of appropriate tax reforms have adversely affected the income buoyancy of the states. The state budget in Indian federation is divided into revenue and capital account (Report on Currency and Finance 1980). Accordingly, states receive revenue from revenue account and capital account. Non-tax revenue of the states comprises interest receipts, receipts from general services like lotteries, fees received from providing various social and economic services etc. But the rates and fees charged for such services are insignificantly low.

In spite of this marked increase in the absolute level of collection of non-tax revenues, it has remained static at less than 1 per cent of GSDP. The state government during the 10-years period from 1995-96 to 2005-06 has surely enhanced its own revenue mobilisation by more than 200 per cent but as its revenue expenditure have gone up simultaneously, its capacity to finance revenue expenditure out of own revenue receipts has declined by more than 16 per cent during the same period. Non-tax revenues grew at a compound annual rate of 7.6 per cent in the 10 years ending 2009-10 (Economic survey 2012-13). Further, the states do not have the same ability to finance their growing fiscal imbalance as availed by the Central Government. The

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states do not have independent power to borrow from the open market, nor from Reserve Bank of India because of the regulation of the overdrafts.

Given these constraints on borrowing, the burden of adjusting the imbalance in state finance has tended to fall mainly on capital and maintenance of expenditures with adverse implications in terms of infrastructural constraints, declining productivity of state public sector enterprises and ultimately deceleration in long term growth of economy of the states. These issues have been brought out by several studies like Aiyar and Kurup (1992), Rao and Sen (1993), Srivastava *et al.* (1998), George (2002), Srivastava (2002), Gaur (2002).

It has been found that most of the studies in the field of public finance like Anderson *et al.* (1986), Artis and Buti (2000), Baghestani and McNown (1994), Chang *et al.* (2002), Garcia and Henin (1999), Hassan and Lincoln (1997), Hondroyiannis and Papapetrou (1996), Joulfaian and Mookerjee (1991), Kollias and Makrydakis (1995), Manage and Marlow (1986), Miller and Russek (1990), Owoye (1995), Gounder *et al.* (2007), Kollias and Paleologous (2007) and Pandey and Dixit (2009) have concentrated on revenue and expenditure of the government using cointegration and error correction mechanism.

The relationship between Non Tax Revenue (NTR) and State Domestic Production (SDP) has been an important issue of discussion among scholars and economists throughout the world. The existence of nexus in between NTR and SDP can be examined in several ways like growth rates relating to SDP and NTR, proportion of NTR to SDP, several policies relating to accelerate SDP and NTR, etc. So far as inter-state non-tax revenue and state domestic product in India is concerned, limited studies have been done. This is the one of the important study which tries to explore the stationarity and cointigration between Non Tax Revenue and State Domestic Product of West Bengal and other nineteen states of Indian federal system in time series and panel data structure for the period 1980-81 to 2011-12.

Objective of the Study:

I. To test the panel stationary of Domestic Production and Non Tax Revenue of the major states of the Indian federal system for the period 1980-81 to 2011-12 in terms of total and growth rate.
II. To test the panel cointegration in between SDP and NTR for the Indian federal system of twenty major states state for the period 1980-81 to 2011-12 in terms of total and growth rate.

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Hypothesis of the Study:

To test the first hypothesis we are considering a following AR (1) process for N states and T time periods

$$Y_{it} = \rho_i Y_{it-1} + \varepsilon_{it} \quad \ldots. \quad (1)$$

X_{it}, represents the exogenous variables, including any fixed effect or individual trend, ρ_i is the autoregressive coefficients, and the errors ε_{it} are assumed to be mutually IID. The null and alternative hypotheses are

Ho: If $|\rho_i| < 1$, Y_i is said to be trend-stationary

Ha: if $|\rho_i| = 1$ then Y_i contains a unit root

To test the second hypothesis between state domestic production and non tax revenue for the twenty major Indian states if the two variables are integrated of same order say I(1), estimated with OLS the long run equilibrium equation

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \omega_{it} \quad \ldots. \quad (2)$$

save the residuals ω_{it}, as are estimates of the equilibrium error, w_{it}.

For the state domestic production and non tax revenue for the twenty major Indian states to be cointegrated if the equilibrium errors must be stationary. Thus the equation

$$\Delta\omega_{it} = \delta\omega_{it-1} + \upsilon_{it} \quad \ldots. \quad (3)$$

And finally,

H_o: $\delta = 0$, for non-stationarity of ω_{it}, i.e. for non-cointegration, if $t_\delta > \tau$

H_a: $\delta < 0$, for stationarity of ω_{it}, i.e. for cointegration, if $t_\delta > \tau$

Econometric Methodology:

Two types of test can be distinguished based on the panel unit root test (Kappler 2006). First type of test considers a homogeneous alternative (Levin Lin and Chu 2002, Breitung 2000 and Hadri 2000) and the second type of test considers heterogeneous alternative (Im, Pesaran and Shin 2003, Maddala and Wu 1999 and Choi 2001). In the present study, LLC (2002) and IPS (2003) tests of stationarity have been used.

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Panel Unit Root Tests: Levin, Lin, and Chu (2002)

Levin Lin and Chu (LLC) consider the following basic ADF specification:

$$\Delta Y_{it} = \alpha Y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta Y_{it-j} + X'_{it}\delta + \varepsilon_{it} \quad \ldots. \quad (4)$$

Where we assume a common $\alpha = \rho - 1$, but allow the lag order for the difference terms, p_i to vary across cross-sections1.

For a given set of lag orders, we begin by estimating two additional sets of equations, regressing both ΔY_{it} and Y_{it-1} on the lag terms ΔY_{it-j} (for $j = 1, 2, 3, \ldots\ldots\ldots, p_i$) and the exogenous variables X_{it}. The estimated coefficients from these two regressions will be denoted $(\hat{\beta}, \hat{\delta})$ and (β, δ), respectively. We define $\Delta \bar{Y}_{it}$ and $\bar{Y}_{it-1}$ by removing the autocorrelations and deterministic components2 and proxies by standardizing both $\Delta \bar{Y}_{it}$ and $\bar{Y}_{it-1}$, dividing by the regression standard error3.

An estimate of the coefficient α may be obtained from the pooled proxy equation:

$$\Delta \bar{Y}_{it} = \alpha \bar{Y}_{it-1} + \eta_{it} \quad \ldots. \quad (5)$$

LLC show that under the null, a modified t-statistic for the resulting $\hat{\alpha}$ is asymptotically normally distributed

$$t^*_{\alpha it} = \frac{t_\alpha - (N\dot{T}) S_N \hat{\sigma}^{-2} se(\hat{\alpha}) \mu_{m\dot{T}^*}}{\sigma_{m\dot{T}^*}} \rightarrow N(0,1) \quad \ldots. \quad (6)$$

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[1] The hypotheses for the test; $H_0 : \alpha = 0$, i.e., there is a unit root against $H_a : \alpha < 0$, i.e. there is no unit root.

[2] $\Delta \bar{Y}_{it} = \Delta Y_{it-1} - \sum_{j=1}^{p_i} \hat{\beta}_{ij} \Delta Y_{it-j} - X'_{it}\delta$ and $\bar{Y}_{it-1} = Y_{it-1} - \sum_{j=1}^{p_i} \hat{\beta}_{ij} \Delta Y_{it-j} - X'_{it}\delta$

[3] $\Delta \bar{Y}_{it} = (\Delta \bar{Y}_{it} / s_i)$ and $\bar{Y}_{it-1} = (\bar{Y}_{it-1} / s_i)$

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Where t_α is the standard t-statistic for $\hat{\alpha}=0$, $\hat{\sigma}^2$ is the estimated variance of the error term η, $se(\hat{\alpha})$ is the standard error of $\hat{\alpha}$, and
$\bar{T}=T-(\sum_i p_i/N)-1$ .... (7)

The average standard deviation ratio, S_N, is defined as the mean of the ratios of the long-run standard deviation to the innovation standard deviation for each individual. Its estimate is derived using kernel-based techniques. The remaining two terms, $\mu_{m\dot{T}^*}$ and $\sigma_{m\dot{T}^*}$ are adjustment terms for the mean and standard deviation.
The LLC method requires a specification of the number of lags used in each cross-section ADF regression, p_i as well as kernel choices used in the computation of S_N.

Panel Unit Root Tests: Im, Pesaran, and Shin (2003)

Im, Pesaran, and Shin (IPS) begin by specifying a separate ADF regression for each cross section:

$$\Delta Y_{it}=\alpha Y_{it-1}+\sum_{j=1}^{p_i}\beta_{ij}\Delta Y_{it-j}+X'_{it}\delta+\varepsilon_{it} \quad \ldots. \quad (8)$$

After estimating the separate ADF regressions[1], the average of the *t*-statistics for α_i from the individual ADF regressions, $t_{iT_1}(p_i)$:

$$\bar{t}_{NT}=\left(\sum_{i=1}^{N}t_{iT_1}(p_i)\right)\Big/N \quad \ldots. \quad (9)$$

1 The null hypothesis and alternative hypothesis may be written as, $H_0:\alpha_i=0,\ for\ all\ i$ and $H_a:\begin{cases}\alpha_i=0 & for\ i=1,2,3.....N_1\\ \alpha_i<0 & for\ i=N+1,N+2,N+3.....N\end{cases}$;(Where i may be reordered as necessary) which may be interpreted as a non-zero fraction of the individual processes is stationary.

The lag order is always zero ($p_i = 0 \; for \; all \; i$), simulated critical values for $\bar{t}_{NT}$ are provided for different numbers of *N* and *T* (equation containing either intercepts, or intercepts and linear trends).

$$W_{\bar{t}_{NT}} = \frac{\sqrt{N}\left\{\bar{t}_{NT} - N^{-1}\sum_{i=1}^{N} E(\tilde{t}_{iT}(p_i))\right\}}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(\tilde{t}_{iT}(p_i))}} \rightarrow N(0,1) \qquad \ldots. \qquad (10)$$

The expressions for the expected mean and variance of the ADF regression *t*-statistics, $E(\tilde{t}_{iT}(p_i))$ and $Var(\tilde{t}_{iT}(p_i))$, are given by Im, Pesaran, and Shin (IPS) for various values of *T* and *p* and differing test equation assumptions.

Panel Cointegration Tests:

A Panel Residual-based test has been performed for panel cointegration (Kao1999) between state domestic production and non tax revenue for the twenty major Indian states for the period 1980-81 to 2011-12.

Kao (1999) test specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors in the panel cointegration. In the bivariate case for panel SDP & panel NTR the model is of the form

$$Y_{it} = \alpha_i + \beta X_{it} + e_{it} \qquad \ldots. \qquad (11)$$

Where

$Y_{it} = Y_{it-1} + \varepsilon_{it}$ and $X_{it} = X_{it-1} + \xi_{it}$.

The estimated residuals are

$$e_{it} = Y_{it} - \alpha_i - \beta X_{it} \qquad \ldots. \qquad (12)$$

i.e. e_{it} Containing a unit root. For this residual we run an ADF test. The Kao test used the null hypothesis of no cointegration for the panel.

Data for the Study:

In the present study data has been taken from Handbook of Statistics on Indian Economy and State Finance for twenty major states; Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura and Uttar Pradesh (Handbook of Statistics on Indian Economy 2012-13). For a

proper comparison of stationarity over time for the state, the revised series of SDP should be extended backwards. For this purpose, first we computed the price correction factor[1]. In the present study, panel stationarity has been tested for State Domestic Product (SDP) and Non Tax Revenue (NTR) in panel data (in terms of level and growth rate). The stationarity in panel data for SDP and NTR, Levin Lin and Chu (LLC) test and Im, Pesaran, and Shin (IPS) test have been applied. A Panel Residual-based test has been performed for panel cointegration (Kao1999) between state domestic production and non tax revenue for the twenty major Indian states.

Results and Discussion:

In the present study, Levin Lin and Chu (LLC 2002) and Im, Pesaran and Shin (IPS 2003) tests of stationarity have been used. In table 1, LLC panel unit root test presented for the SDP and NTR for the period 1980-81 to 2011-12. LLC test suggests presence of unit root at level, first difference and second difference in trend and intercept model. For both the series at no constant and no trend LLC test suggest that the series are stationary at first difference. Table 2 presents LLC test for panel SDP and NTR in terms of growth rate. Result suggests that both the series are stationary at no constant and no trend

Table 3 shows that IPS test on panel SDP and NTR for twenty major states in India for the period 1980-81 to 2011-12. Panel SDP for twenty states in India are stationary at first difference for intercept and trend while for Panel NTR stationary at first difference for constant and also for intercept and trend. In table 4 IPS test presented panel SDP and NTR in terms of growth rate. Table shows that SDP and NTR are stationary at level for constant and also for constant and trend.
From the above we came to know that both the series are stationary at same order hence panel based cointegration test developed by Kao (1999) can be applied. Kao (1999) test specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors in the panel cointegration. In the bivariate case for panel SDP & panel NTR the model is of the form

$$SDP_{it} = \alpha_i + \beta NTR_{it} + e1_{it}$$
$$NTR_{it} = \alpha_i + \beta SDP_{it} + e2_{it}$$
$$SDPG_{it} = \alpha_i + \beta NTRG_{it} + e3_{it}$$
$$NTRG_{it} = \alpha_i + \beta SDPG_{it} + e4_{it}$$

[11] Defined as the ratio of implicit deflator for 2004-05 series to 1999-2000 series for the year 2004-05, 1999-2000 series to the 1993-94 series for the year 1999-2000 similarly for 1993-94 series to 1980-81 series for the year 1994.

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The estimated residuals are

$e1_{it} = SDP_{it} - \alpha_i - \beta NTR_{it}$

$e2_{it} = NTR_{it} - \alpha_i - \beta SDP_{it}$

$e3_{it} = SDPG_{it} - \alpha_i - \beta NTRG_{it}$

$e4_{it} = NTRG_{it} - \alpha_i - \beta SDPG_{it}$

For this residual we run Dickey Fuller test. The Kao test used the null hypothesis of no cointegration for the panel. The Kao test for panel data of SDP and NTR rejects the null hypothesis of no cointegration.

Table 1: Panel Unit Root -LLC test for SDP and NTR for the period 1980-81 to 2011-12.

Model	At Level	Coefficient	t-value	t-star	P>t
	No constant and no trend	0.079	12.754	12.296	1.00
State Domestic Product	With constant	0.082	9.356	15.056	1.00
	With constant and trend	0.000	0.009	6.632	1.00
	At First Difference				
	No constant and no trend	-0.142*	-2.838	-2.779	0.00
	With constant	-0.564	-7.742	2.560	0.99
	With constant and trend	-1.333	-14.654	2.173	0.99
	At Second Difference				
	No constant and no trend	-2.726*	-21.342	-20.752	0.00
	With constant	-2.797	-22.004	3.396	1.00
	With constant and trend	-2.857	-22.291	9.569	1.00
Non Tax Revenue	**At Level**				
	No constant and no trend	0.157	6.725	6.448	1.00
	With constant	0.137	4.781	15.755	1.00
	With constant and trend	0.010	0.230	14.058	1.00
	At First Difference				
	No constant and no trend	-0.497*	-5.874	-5.752	0.00
	With constant	-0.784	-8.429	8.457	1.00
	With constant and trend	-1.235	-12.177	10.446	1.00
	At Second Difference				
	No constant and no trend	-2.865*	-21.157	-20.620	0.00
	With constant	-2.919	-21.569	13.657	1.00
	With constant and trend	-3.010	-22.254	20.207	1.00

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Note: Data has been taken from RBI Handbook of Statistics on Indian Economy 2012-13 and State Finance 12-13. Statistical estimate on the basis of equations 4, 5, 6 and7given in section Econometrics Methodology * Significant at 1 percent level, STATA11.0 used for LLC test

Table 2: Panel Unit Root -LLC test for growth in SDP and growth in NTR for the period 1980-81 to 2011-12.

Model	At Level	Coefficient	t-value	t-star	P>t
	No constant and no trend	-1.079*	-13.814	-13.415	0.00
Growth in State Domestic Product	With constant	-1.380*	-16.736	-2.638	0.00
	With constant and trend	-1.458	-17.310	0.683	0.75
	At First Difference				
	No constant and no trend	-2.730*	-24.711	-24.010	0.00
	With constant	-2.745	-24.820	0.567	0.71
	With constant and trend	-2.779	-25.080	6.370	1.00
	At Second Difference				
	No constant and no trend	-3.740*	-31.417	-30.555	0.00
	With constant	-3.739	-31.419	6.893	1.00
	With constant and trend	-3.743	-31.456	15.482	1.00
Growth in Non Tax Revenue	**At Level**				
	No constant and no trend	-1.269*	-15.080	-14.644	0.00
	With constant	-1.373	-15.929	-1.784	0.04
	With constant and trend	-1.432	-16.380	1.213	0.89
	At First Difference				
	No constant and no trend	-2.752*	-24.488	-23.787	0.00
	With constant	-2.753	-24.508	-0.819	0.21
	With constant and trend	-2.760	-24.571	4.681	1.00
	At Second Difference				
	No constant and no trend	-3.665*	-30.227	-29.378	0.00
	With constant	-3.665	-30.212	2.632	1.00
	With constant and trend	-3.664	-30.225	9.748	1.00

Note: Data has been taken from RBI Handbook of Statistics on Indian Economy 2012-13 and State Finance 12-13 Statistical estimate on the basis of equations 4, 5, 6 and 7 given in section Econometrics Methodology * Significant at 1 percent level, STATA11.0 used for LLC test

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Table 3: Panel Unit Root -IPS test for SDP and NTR for the period 1980-81 to 2011-12.

Model	At Level	t-bar	W[t-bar]	P-value
State Domestic Product	With constant	1.330	13.776	1.00
	With constant and trend	-0.541	8.430	1.00
	First Difference			
	With constant	-1.875	-1.957	0.03
	With constant and trend	-3.055*	-4.991	0.00
	Second Difference			
	With constant	-4.553*	-14.872	0.00
	With constant and trend	-4.523*	-12.488	0.00
Non Tax Revenue	**At Level**			
	With constant	0.366	9.044	1.00
	With constant and trend	-0.378	9.298	1.00
	First Difference			
	With constant	-2.269*	-3.893	0.00
	With constant and trend	-2.772*	-3.479	0.00
	Second Difference			
	With constant	-4.513*	-14.678	0.00
	With constant and trend	-4.558*	-12.666	0.00

Note: Data has been taken from RBI Handbook of Statistics on Indian Economy 2012-13 and State Finance 2012-13. Statistical estimate on the basis of equations 8, 9 and 10 given in section Econometrics Methodology * Significant at 1 percent level, STATA11.0 used for IPS test

Conclusion

The present study focuses on the nexus of the non tax revenue and state domestic product of twenty major Indian states for the period 1980-81 to 2011-12. The study is based on the panel data. For twenty states in Indian federal system, panel unit root test applied on SDP and NTR in the present study. The LLC and IPS tests show stationary of the series at first difference for trend and intercept. Kao test of panel cointegration shows that the SDP and NTR and NTR and SDP for the twenty states for the period under study are cointegrable. The results of the study suggest that state domestic product of the states are causing the non tax revenue of the states and the non tax revenue of the states are also causing state domestic product of the states for Indian federal system.

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Table 4: Panel Unit Root -IPS test for growth in SDP and growth in NTR for the period 1980-81 to 2011-12.

Model	At Level	t-bar	W[t-bar]	P-value
Growth in State Domestic Product	With constant	-3.454*	-9.709	0.00
	With constant and trend	-3.487*	-7.298	0.00
	First Difference			
	With constant	-5.217*	-18.067	0.00
	With constant and trend	-5.165*	-15.788	0.00
	Second Difference			
	With constant	-6.605*	-24.741	0.00
	With constant and trend	-6.462*	-22.464	0.00
Growth in Non Tax Revenue	**At Level**			
	With constant	-3.408*	-9.484	0.00
	With constant and trend	-3.432*	-7.002	0.00
	First Difference			
	With constant	-5.103*	-17.519	0.00
	With constant and trend	-5.002*	-14.954	0.00
	Second Difference			
	With constant	-6.213*	-22.854	0.00
	With constant and trend	-6.072*	-20.457	0.00

Note: Data has been taken from RBI Handbook of Statistics on Indian Economy 2012-13 and State Finance 2012-13.

Statistical estimate on the basis of equations 8, 9 and10 given in section Econometrics Methodology

* Significant at 1 percent level, STATA11.0 used for IPS test

Table 5 : Kao test for panel cointegration for the period 1980-81 to 2011-12: Regression results for SDP and NTR

Model	Constant	Variable	R square	ADJ_ R square	Root MSE	F statistics
$SDP_{it} = \alpha_i + \beta NTR_{it} + e1_{it}$	37543.92 (11.04)	0.135 (22.22)	0.4362	0.4353	68549	493.66
$NTR_{it} = \alpha_i + \beta SDP_{it} + e2_{it}$	69364.57 (3.87)	3.224 (22.22)	0.4362	0.4353	330000	493.66

$SDPG_{it} = \alpha_i + \beta NTRG_{it} + e3_{it}$	5.77 (19.35)	0.001 (0.29)	0.0001	-0.0015	7.0246	0.08
$NTRG_{it} = \alpha_i + \beta SDPG_{it} + e4_{it}$	16.70 (6.43)	0.083 (0.29)	0.0001	-0.0015	49.867	0.08

Note: Data has been taken from RBI Handbook of Statistics on Indian Economy 2012-13 and State Finance 2012-13.; Estimated on the basis of Equation 11.; Software used STATA 11.0

Table 6 : Kao test for panel cointegration for the period 1980-81 to 2011-12: Residual Based

DF Test for Residual	τ- statistics	1% critical value
$e1_{it} = SDP_{it} - \alpha_i - \beta NTR_{it}$	-7.295*	-3.430
$e2_{it} = NTR_{it} - \alpha_i - \beta SDP_{it}$	-10.024*	-3.430
$e3_{it} = SDPG_{it} - \alpha_i - \beta NTRG_{it}$	-31.582*	-3.430
$e4_{it} = NTRG_{it} - \alpha_i - \beta SDPG_{it}$	-28.527*	-3.430

Note: Data has been taken from RBI Handbook of Statistics on Indian Economy 2012-13 and State Finance 2012-13.; Residual calculated on the basis of equation 12.; Software used STATA 11.0 * Significant at 1 percent level.

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