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An Empirical Analysis of Income convergence or divergence of India: *A case study of NER States*

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Abstract

This paper examines per capita income convergence across eight states of North Eastern Regions- Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura using annual data covering 1980-81 to 2012-13 using LST linearity test and KSS- non stationary test. The findings however do not provide enough evidence in favour of the convergence hypothesis even though the regions have similar socioeconomic background, physical infra structure and access to the same financial system, administrative institutions and technology. It is evident from the study that the per-capita income differentials of each states of NER from the regional average are linear in nature except for Nagaland and Sikkim. Further, this finding noticed that states like- Arunachal Pradesh, Meghalaya, and Mizoram exhibits convergence of per-capita income differentials with respect to regional average, where as Assam, Manipur, Nagaland, Tripura and Sikkim shows divergence behaviour of per-capita income differential.

Therefore, proper attention in terms of providing infrastructural as well as technological and financial support to the lagging regions may be needed in promoting more balanced development of the country. It is worth mentioning in this regards that the current strategy of pro growth seem to be an appropriate way of expediting per-capita income convergence across NER region in India.

Index Terms/Key words- ADF-Test, LST Linearity test, KSS Non-linearity test, convergence and divergence

1. INTRODUCTION

Income convergence, the tendency for per capita income of different economies to equalize over time, is one of the predictions of Solow's (1956) neoclassical growth model. Over the past decade, much theoretical and empirical work has been done in this area. The implications of convergence or lack of convergence, for long-run relationships between different countries has led to a surge of interest and debate.

Solow's model predicts that convergence exists among different economies regardless of initial conditions once the determinants of aggregate production functions are controlled for.

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It therefore requires a negative correlation between initial per capita output and its growth rate, so that poorer countries will catch up with wealthier countries.

Income convergence may be investigated by the time-series stationary property of the differential series. Specifically, a finding of stationarity is taken as evidence of stable as long-run co-movement between the two countries' incomes thereby implying income convergence over time. Otherwise, the result would be interpreted as income divergence (Bernard and Durlauf, 1996). One commonly employed stationary test in the testing of income convergence is the augmented Dickey-Fuller (*ADF*) test (Dickey and Fuller, 1979). It has been widely reported that empirical evidence based *ADF* test is generally in favour of income divergence (see for example, Li and Papell, 1999). Nonetheless, as Li and Papell (1999) and some other authors have empirically demonstrated, *ADF* test is biased towards the non-rejection of stationary thereby producing results that favour income divergence. In this respect, among others, Li and Papell (1999) are able to provide more evidence of convergence, after properly taken care of the structural breaks in their proposed stationary tests, in the OECD economies, as compare to the *ADF* counterparts.

The current study contributes to the existing literature of income convergence by looking at the same old issue from a new perspective — non-linear point of view. This attempt is motivated by the findings of Liew *et al*. (2003), who argue that linear testing procedure may fail in the non-linear context, and also Liew *et al*. (2004), who show empirically that non-linear stationary tests of Kapetanois *et al*. (2003) perform better than *ADF* in detecting stationarity in the presence of non-linearity. As such, this study examines the income convergence hypothesis the context of Japan and the rest of East-Asian economies in the non-linear perspective

2. LITERATURE REVIEW

Pioneered by Baumol (1986), numerous studies exploring convergence have been developed. While Romer (1986) and Delong (1988) challenge the hypothesis of cross-country convergence, Barro (1991) and Mankiw, Romer, and Weil (1992) find that convergence can be achieved among economies that exhibit similar characteristics and when human capital variables such as education and savings rates are controlled for. They refer to this cross-section notion of convergence as conditional convergence.

Another form of convergence examines long-run output movements. Bernard and Durlauf (1995) define convergence between two (or more) countries when the long run forecasts of output differences tend to zero as the forecasting horizon tends to infinity. Tests for the time series notion of convergence require cross-country per capita output differences to be stationary. In the bivariate case, this requires that the outputs be cointegrated with cointegrating vector. We refer to this notion of convergence as time series convergence. If they are cointegrated with cointegrating vector, there are common trends in output. Thus cointegration between economies is a necessary, but not a sufficient condition for convergence. The time series evidence has not been supportive of the convergence hypothesis. Quah (1990) and Ben-David (1994) do not find general evidence of convergence

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among a large number of countries using the Summers-Heston (1988) data. Campbell and Mankiw (1989) fail to find convergence among OECD countries which display similar economic characteristics. Bernard and Durlauf (1995), in a study of 15 OECD countries from 1900 to 1987, reject convergence but find substantial evidence of common trends.

The study of Rangarajan et al. (2014) found that for the three periods 1980-81 to 1993-94, 1993-94 to 2004-05 and 2004-05 to 2012-13, there is no evidence of convergence but in the recent period there is strong evidence of catching up by the lower income states. Their study further confirms that states with lower per capita income in 1993-94 like Assam, Madhya Pradesh, Uttar Pradesh and Bihar have made significant gains in growth rates in the recent period 2004-05 to 2012-13.

3. OBJECTIVE OF THE STUDY

This study aims to investigate the existence of income convergence (equality) and divergence (inequality) among eight states of NER using linear and non-linear stationary tests on income differentials between the selected states and the regional average.

4. DATA AND METHODOLOGY

4.1. DATA

For the analysis we used the annual NSDP per-capita of eight States of North Eastern Regions- Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura using annual data covering 1980-81 to 2012-13.

4.2. EMPIRICAL MODEL

The empirical investigation is started by first conducting a formal linearity test of Luukkonen *et al*. (1988). As the results of this test suggest the presence of non-linearity, we then apply the Kapetanois *et al*. (2003) nonlinear test of stationarity.

***LST* Linearity Test**

This study adopts the Luukkonen *et al*. (1988) (*LST*) linearity test in our context to determine whether the logarithm differences of real per capita GDP between the two sample countries, ($\ln Y_{it} - \ln Y_{At}$) exhibits linear or non-linear behaviour:

$$(lnY_{it} - lnY_{At}) = \alpha_{it} + \sum_{k=1}^{p} \alpha_k (lnY_{it-k} - lnY_{At-k}) + \sum_{k=1}^{p} \beta_{1i} (lnY_{it-k} - lnY_{At-k})\,(lnY_{it-d} - lnY_{At-d}) + \sum_{k=1}^{p} \beta_{2i} (lnY_{it-k} - lnY_{At-k})(lnY_{it-d} - lnY_{At-d})^2$$

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$$+ \beta_{3i}(lnY_{it-k} - lnY_{At-k})(lnY_{it-d} - lnY_{At-d})^3 + \varepsilon_t \quad (1)$$

where Y_{it} is the real NSDP per-capita of individual state under investigation and Y_{At} is the average regional per-capita and ε_t is white noise residuals with zero mean and constant variance assumption, p stands for the autoregressive lag length whereas d is called the delay parameter. Note that p and d have to be determined empirically based on sample data, see Liew *et al*. (2005) in this regard. Practically, the null hypothesis to be tested is that

Ho: all β's=0 (2)

against the alternative hypothesis is that at least one **β** is non zero, i.e., the existence of a type of non-linearity k known as Smooth Transition Autoregressive, **STAR(p)** process. The F-type test statistic is employed to accomplish this test. The optimal lag length, ***p***, and the delay parameter, ***d***, have to be determined in advance. Following Tsay(1986), the optimal p is fixed based on PACF. The linearity test is performed for a class of ***d*** ranges from 1to 12. The optimal ***d*** is chosen from the one that minimises the ***p*** value of the F-test statistic. The results of this *LST* linearity test are reported in Table 1.

***KSS* Non-linear Stationary Tests**

In order to test the convergence or divergence of income, the KSS non-linear stationary test (Kapetanois *et al*. (2003)) is conducted, which enables us to detect the presence of non-stationarity against non-linear but globally stationary STAR process, can be represented by:

$$\Delta(lnY_{it} - lnY_{At}) = \delta(lnY_{it-1} - lnY_{At-1})^3 + \epsilon_{it} \quad (3)$$

Or

$$\Delta(lnY_{it} - lnY_{At}) = \sum_{i=1}^{p} \beta\Delta(lnY_{it-k} - lnY_{At-k}) + \delta(lnY_{it-1} - lnY_{At-1})^3 + \varphi_{it} \quad (4)$$

ϵ_{it} and φ_{it} are stochastic error terms each with zero mean and constant variance assumption. Specifications (3) and (4) correspond to the conventional Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) stationary tests with no intercept and trend terms in the non-linear framework. The divergence or convergence could be tested on δ using the t statistic with the null hypothesis of **Ho: *δ*=0**(divergence) against the alternative of **H1: *δ*>0**(convergence). Results of simulation study show that these non-linear stationary tests produce are robust results if the data generating process of the series under study is in fact non-linear in nature (Kapetanois *et al*. 2003).

For the brevity of reporting, the t -statistics estimated from Equations (3) and (4) are reported as t_{KSS1} and t_{KSS2} respectively in Table 2 for p = 7, as is practiced in Liew *et al*. (2005). However, as suggested in Kapetanois *et al*. (2003), we also conduct test of Equation (4) for ***1≤ p ≤12*** and report the maximum test statistics as t**.** All these *KSS* test statistics are to be compared with the same set of critical values simulated by Liew et al.(2005) as conventional *t*

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critical values are no more applicable in this non-linear framework due to the asymptotically distribution of δ which has been proven non-normal.

5. EMPIRICAL RESULTS

Result of LST linearity test is given in Table 1. From this Table 1, it is observed that the null hypothesis of the absence of non-linearity in all cases has been rejected by the *F* statistics at less than 1% significance level. This finding suggests that the data generating process of income differentials between the average regional per capita income and per capita income of NER states are found to be linear in nature except for Nagaland and Sikkim. Hence, the conventional *ADF* test, — which do not account for non-linearity — is no doubt inappropriate to be employed to examine the issue of income convergence Nagaland and Sikkim of the states of North Eastern regions.

Table 1: Results of LST Linearity Test

States	p	d	F-Stat	msv
Arunachal Pradesh	1	1	1.940	0.1479
Assam	1	2	1.1740	0.3395
Manipur	1	10	0.447	0.9870
Meghalaya	1	3	0.6140	0.6125
Mizoram	1	6	2.0171	0.1423
Nagaland	1	8	4.3762	0.0167**
Sikkim	1	2	14.1475	0.0071*
Tripura	1	10	2.0695	0.1423

Source: Author's estimation

Notes: i. The marginal significance value of the *F* statistic is denoted as *msv*. The optimal autoregressive lag length *p* is determined by inspecting the PACF of the series. The optimal delay parameter *d* is chosen from the one that minimizes the marginal significance value of the *F* test statistic.

ii. *and ** indicates the rejection of null hypothesis at 1% and 5% level of significance.

Table 2 reports the results of stationarity test for all states using ADF test (for linear data) and KSS test (non linear data). The t_{KSS1} test statistics based on equation (3) shown that the null hypothesis of non stationary (divergence) cannot be rejected for both Nagaland and Sikkim. As for t_{KSS2} test and t_{KSS3} test statistics based on equation (4) the evidence of divergence is found for these states. In case of other states, the results of the ADF test suggest that income convergence is only found for Arunachal Pradesh, Meghalaya and Mizoram, but not for Assam, Manipur and Tripura.

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Table 2: Results of Stationary Tests

States	Linearity Test	Non Linearity test(KSS)		
	ADF(p)	t_{KSS1}	t_{KSS2}	t_{KSS3}
Arunachal Pradesh	-2.5084(0)**	-----	-----	-----
Assam	0.0312(4)	-----	-----	-----
Manipur	1.5634(0)	-----	-----	-----
Meghalaya	-2.9308(0)**	-----	-----	-----
Mizoram	-6.0414(0)*	-----	-----	-----
Nagaland	-----	-1.1178	0.7621(7)	0.1323(2)
Sikkim	-----	-0.0560	-1.2797(7)	-0.0560(1)
Tripura	-0.6557(1)	-----	-----	-----

Source: Author's estimation

. *and ** indicates the rejection of null hypothesis at 1% and 5% level of significance.

Notes: *p* refers to the optimal autoregressive lag length of the implied test. For the *ADF* test, *p* is automatically determined by computer programme based on the minimum Akaike information criterion (*AIC*). As for the first and second *KSS* tests, *p*=7 is fixed in advance. In the third *KSS* test, *p* is chosen from the one that maximizes the test statistics.

In summation, using linear and non linear stationary test (ADF and KSS tests) three states - Arunachal Pradesh, Meghalaya and Mizoram are found exhibits convergence behaviour with respect to the regional average per capita income where as the rest of the states in this study namely Assam, Manipur, Nagaland, Tripura and Sikkim show divergence behaviour.

7. CONCLUSION

This study aims to investigate the existence of income convergence or divergence among eight states of the North Eastern Regions of India. Using linear and non linear stationary test on income differentials between these states and regional average, it is found that only Arunachal Pradesh, Meghalaya and Mizoram exhibits income convergence(equality) while rest five states exhibits income divergence(inequality).

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