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# DOES REAL OUTPUT CONVERGE? A REGIONAL STUDY IN CHINA

***Abstract.*** *This study adopts flexible Fourier unit root test proposed by Enders and Lee (2004, 2009) to revisit the tendency towards convergence in real per-capita income among provinces in China. The empirical results of Flexible unit root test provide ample evidence with a high degree of confidence about two things. First, most of Eastern provinces converge and Western provinces converge to their own specific steady states. Second, our empirical results also provide no evidence of convergence among North-Eastern provinces and Central provinces. It is important for macroeconomic policy and forecasting for China Economies and these results can be an available explanation to policymakers holding long-term implications.*

**Key words:** *Flexible Fourier Unit Root Test, Real Output Converge*

**JEL Classification: C22, O1, O4**

## 1. Introduction

The feature (i.e. deterministic or stochastic) of the time-series properties of real output has important theoretical as well as policy implications for decision making. The conventional view was that time-series variables were stationary fluctuations around a deterministic trend (Kydland and Prescott, 1980; Blanchard, 1981; Barro, 1976). This implies that the variance is finite and any shocks have only a transitory impact on real output movements leading the economy towards an equilibrium value. In other words, stationary variables have anticipation of convergence to some extent.

Since starting the process of economic reform and opening its economy to outside world, Per Capita Income Disparity within China Economy has been popular issue. Many studies have examined the tendency of regions to exhibit convergence of per capita income in long term. Chen and Fleisher (1996) use the cross-sectional approach to investigate the convergence of GDP per capita in

China and find the evidence of both unconditional and conditional convergence of GDP per capita. Jian *et al.* (1996) indicate the real income convergence emerges weakly before 1978. Several reasons motivate us to re-investigate the question of China's regional per capita income convergence. First, for empirical and theoretical interest, the decline of global income inequality is largely complicated by growth performance of China over the past decades. China's achievement of rapid and continuous economic growth rate has been prominent event in world. Hence, we could not explain the global income inequality well without provincial growth path figures. Second, many empirical findings present a sound evidence of convergence across regions within countries indicating regional inequity of an integrated economy should be narrowed over time. However, a lot of corroborated empirical evidences show that opposite conclusion that majority of provinces in China diverge (Fleisher and Chen, 1997; Kanbur and Zhang, 1999; Yao and Zhang, 2001). This puzzling phenomenon interest many studies to revisit the tendency towards convergence in real per-capita income among the provinces of China. Third, we cannot confirm whether the poor performance of provinces is improved over time, nor is it clear whether the high level of per capita income in provinces is transitory phenomena. We want to realize the sustainability of economic reform but we cannot draw a scenario for long–term growth from present growth trend in China. Once China Government maintains the sustainability of economic reform successfully, it can provide helpful hints about the future tendency to other countries which are facing the similar situation.

A large amount of literatures have been executed empirically as well as theoretically to verify if income converges among countries (Ben-David and Papell, 1995; Cheung and Chinn, 1996). The core of convergence theory is inspecting the economic growth rate of two economic bodies to forecast the tendency of the economic differences. A number of studies have been carried out in the empirical field with different concepts of convergence and conclusions. There are two definitions of convergence (conditional convergence and stochastic convergence). First, if there is a negative and significant relationship between the growth rate of GDP and its level in the previous year, it can be defined as conditional convergence. Many researchers find evidence of conditional convergence for many countries with certain common characteristics. Gundlach (1997) employs conditional convergence to examine the presence of conditional convergence, suggesting that the reform period should be the presence of conditional convergence on factors mobility. Wang (2004) developed a dynamic panel data model form the Solow growth model to investigate the question of China's regional per capita income convergence giving the same suggestion as Gundlach. On other hand, the second definitions of stochastic convergence can be simply described as following. Once the income gap between two economic bodies is narrowed over time, it can be depicted as convergence. For instances, Narayan (2004) examines the stochastic convergence of interprovincial income over the 1952-1998 period by Panel Lagrange Multiplier (LM) unit root test with consideration of a structural breaks, finding that per capita real GDP among 24 provinces of China converge and that fluctuation around the deterministic trend. Although many previous literatures present evidence of convergence in China, many researchers still investigate income variations over and over again for the reason that they expect the policy of West Development may gradually influence the course of income distribution.

In the wake of Nelson and Plossor (1982), a substantial amount of literatures to find the latent presence of unit roots in macroeconomics time series data demonstrating that time series variables are non-stationary (Wasserfallen, 1986; Cheung and Chinn, 1996). They demonstrate that presence of a unit root in time series model has consequence for the way we predict economic activity. Moreover, Perron (1989) argues that if there is structural break in time trend or levels, conventional unit root test such as Augmented Dickey Fuller (1981, ADF) and Phillips-Perron (1988, PP) will possibly suffer from power and size distortions for failing to incorporate the structural breaks in the model. Perron (1989) also shows how to incorporate dummy variables into the standard ADF test to proximate the breaks in the level and trend whereas traditional approach of using dummy variables may not be realistic. This approach has several undesirable consequences when changes are not abrupt. First, Information about the break date and the number of breaks is likely to be unknown. Maddala and Kim (1998) argue that when testing for a unit root, one should detect the number and locations of the breaks. The performance of the existing unit-root tests will strictly hinge on the assumed number of breaks and the accuracy of estimated breaks locations but it may cause an unknown pre-testing bias. Additionally, Ben-David and Papell (2000) and Papell *et al*. (2000) find evidence of more than one structural break in macroeconomic time series data, but current available test account only for one or two breaks. It is difficult to obtain asymptotic distributions and critical values for multiple and mixed breaks. Researchers demonstrate that such tests suffer from serious power and size distortions due to the asymmetric treatment of breaks under the null and alternative hypotheses (Nunes, 1997; Kim and Perron, 2009). Second, structural breaks are assumed to be instantaneous, several sharp jumps in the mean or sudden changes in the slope. As a result, the test may reject the unit root null when the noise component is integrated but the trend is changing. It leads to spurious evidence in favor of broken stationary trend. In fact, breaks should therefore be approximated as smooth and gradual processes (Leybourne *et al*., 1998). These arguments led a new area of research which sought to develop new unit root tests that are robust with respect to structural breaks and outliers in the data. As both Becker *et al*. (2004, 2006) and Enders and Lee (2009) stressed, one main advantage of Fourier unit root test is their robustness to structural breaks of an unknown form. Besides, Fourier approximation can use single frequency component to capture break. Thereby, the specification problem is how to incorporating a suitable frequency component into the estimating equation, irrespective of the date and location of the breaks. Additionally, the new test has decent power and good size by reducing the number of estimated parameters.

In this study, we employ the conception of conditional convergence, and our aim is to re-investigate whether or not tendency towards convergence in real per-capita GDP among the provinces of China during the period 1978-2009 using the unit root test with a Fourier function proposed by Enders and Lee (2004, 2009) . The result can be compared with traditional unit root test which allow only one or two breaks. We apply first order Fourier series to approximate multiple breaks because it is more realistic than using Dummy variable. In order to fill the gap of provincial time-series data in China, we are the first one to employ Fourier series to evaluate empirically whether annual data for the log-levels of 28 provincial real GDP. Our result of traditional unit root test shows that output variables in most provinces are non-stationary and difference-stationary, lending further evidence of no income convergence. On the other side, as Becker *et al*. (2006) stressed, Flexible Fourier transforms has robustness to structural breaks of an unknown form, irrespective of the date and location of the breaks. If the result of Fourier unit root test concludes that certain provinces are convergence during 1978 to 2009, it would offer an alternative explanation for the difficulty researchers have encountered in capturing the feature of breaks.

The reminder of this empirical study is organized as follows. Section 2 outlines the methodology of the Convergence model and Fourier unit root test. Section 3 presents the data used and discusses the empirical findings and policy.

## 2. Methodology

### *2.1. Convergence Analysis with Convergence Models*

The convergence rate of given provinces are assumed to be constant in a linear framework, Evans and Karras (1996) test real convergence with time series data by using the following specification:

$$\Delta G_{n,t} = \delta_n + p_n G_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i} \Delta G_{n,t-i} + \varepsilon_{n,t} \tag{1}$$

The subscript $t$ refers to the time period with $t = 1, \ldots, T$. The variable $G_{,t}$ is defined as $G_{,t} = y_{,t} - \bar{y}t$ where $y_{,t} = \log(Y_{,t})$, $y_t$ is the cross-provinces in real terms. $\bar{y}t$ is average log of per capita income at time $t$. $p = 0$ indicates that the provinces diverge, whereas $0 < -p < 1$ for province is a convergence condition. The convergence is absolute if $\delta_n = 0$ for province, whereas it is conditional if not. However, we suppose that the convergence process is not uniform. It could be that the converge only if certain institutional, political, or economic conditions are fulfilled, diverging otherwise. As a result, we adopt Flexible Fourier transform proposed by Enders and Lee (2004, 2009).

2.2 Enders and Lee’s (2004, 2009) Fourier Unit Root Test

Enders and Lee (2004, 2009) implement a variant of the Flexible Fourier transform (Gallant, 1981) to control for the unknown nature of the breaks. One advantage of this Fourier function is that it is able to capture the essential characteristics of one or more structural breaks by using only a small number of low frequency components. This is true because a break tends to shift the spectral density function towards frequency zero. Especially, this test works best in the presence of breaks that are gradual and has good power to detect U-shaped and smooth breaks.

Enders and Lee (2004, 2009) develop their unit root test using the LM test principle. As indicated by Pascalau (2010), the LM has increased power over the DF approach. Following the Enders and Lee (2004, 2009), we consider the following data generating process (DGP):

$$\Delta G_t = \alpha_0 + \theta t + \gamma_1 \sin(2\pi kt/T) + \gamma_2 \cos(2\pi kt/T) + \varepsilon_t; \tag{2}$$

$$\varepsilon_t = \beta \varepsilon_{t-1} + u_t, \tag{3}$$

The rational for selecting $[\sin(2\pi kt/T), \cos(2\pi kt/T)]$ is based on the fact that a Fourier expression is capable of approximating absolutely integrable functions to any desired degree of accuracy. Where *k* represents the frequency selected for the approximation, and $\gamma = [\gamma_1, \gamma_2]'$ measures the amplitude and displacement of the frequency component. A desire feature of Equation (2) is that the standard linear specification emerges as a special case by setting $\gamma_1 = \gamma_2 = 0$. It also follows that at least one frequency component must be present if there is a structural break. Here, if it is possible to reject the null hypothesis $\gamma_1 = \gamma_2 = 0$, the series must have a nonlinear component. Enders and Lee (2004, 2009) use this property of Equation (2) to develop a test that can have more power to detect breaks of an unknown form than the standard Bai and Perron (1998) test. Under the null hypothesis of a unit root $\beta = 1$, where under the alternative hypothesis $\beta < 1$. Enders and Lee (2004, 2009) employ the LM methodology of Schmidt and Phillips (1992) and Amsler and Lee (1995) by imposing the null restriction and estimating the following regression in first differences:

$$\Delta G_t = \delta_0 + \delta_1 \Delta \sin(2\pi kt/T) + \delta_2 \Delta \cos(2\pi kt/T) + v_t \tag{4}$$

The estimated coefficients $\tilde{\delta}_0$, $\tilde{\delta}_1$ and $\tilde{\delta}_2$ are then used to construct the following detrended series:

$$\tilde{S}_t = g_1 - \tilde{\psi} - \tilde{\delta}_0 t - \tilde{\delta}_1 \sin(2\pi kt/T) - \tilde{\delta}_2 \cos(2\pi kt/T), t = 2....,T, \tag{5}$$

where $\tilde{\psi} = \Delta g_{,t} - \tilde{\delta}_0 t - \tilde{\delta}_1 \sin(2\pi kt/T) - \tilde{\delta}_2 \cos(2\pi kt/T)$ and $g_1$ is the first observation of $\Delta g_{,t}$. The testing regression based on the de-trended series has the following expression:

$$\Delta G_t = \theta \tilde{S}_{t-1} + d_0 + d_1 \Delta \sin(2\pi kt/T) + d_2 \Delta \cos(2\pi kt/T) + \varepsilon_t \tag{6}$$

If $\Delta G_t$ has a unit root then $\theta = 0$ and the LM test statistic (denoted $\tau_{LM}$) is the $t$-test for the null hypothesis of $\theta = 0$. The innovation process $\varepsilon_t$ is assumed to satisfy Phillips and Perron (1998)'s serial correlation and heterogeneity conditions. Equation (6) can be augmented with lag values of $\Delta\widetilde{S}_{t-j}$, $j = 1,2,...p$ to get rid of the remaining serial correlation. Enders and Lee (2004, 2009) derive the properties of the asymptotic distribution of the $\tau_{LM}$ statistic and demonstrate that it depends only on the frequency $k$ and is invariant to all other parameters in the DGP. Enders and Lee (2004, 2009) suggest that the frequencies in Equation (6) should be obtained via the minimization of the sum of squared residuals. However, their Monte Carlo experiments suggest that no more than one or two frequencies should be used because of the loss of power associated with a larger number of frequencies.

**3. Data and Empirical Findings**

In this study, we use the annual data of 28 provinces in Mainland China between 1978 and 2010 to examine whether poor provinces tend to keep up with the rich one (Beijing) in terms of the level of per capita product. According to the highest mean of GDP per capita, we adopt real GDP per capita of Beijing which is the capital of China to represents the richest interior regions and coastal region respectively. According to definition of convergence which we adopted, we believe the influence of reform period must be studied on a province-by-province basis in China. All the data used in this study is taken from China Statistics Yearbook and CEinet Data Co., Ltd. but we omit 2 provincial real output (Tibet, Hainan). It is the reason that real GDP per capita of Tibet cannot be extracted from our data resource until 1980's and Hainan was not a province before 1988. Moreover, we incorporate real GDP per capita of Chongqing into real GDP per capita of Sichuan because Chongqing was relegated to a provincial city within the Sichuan form 1955 to 1997. With the omission of Hainan and Tibet, and the combination of Chongqing and Sichuan into a single province, we construct a data set with a total of 28 provinces. All data was expressed in logarithmic form to achieve stationary in variance before the empirical analysis. In addition, we adopt a fairly popular definition of conditional convergence. Once the income gap between two economic bodies is narrowed over time, we can view these results as convergence.

In order to build a comparison, we adopt ADF, PP, Kwiatkowski *et al.* (1992, KPSS) unit root test to investigate the question of China's regional per capita income convergence We use GDP per capita of Beijing to subtract GDP per capita of the other province, the result of unit root test are listed in Table 1. First of all, we employ traditional ADF and PP with no breaks to test the null of a unit root in the per capita real GDP of each province. We also use KPSS to examine the hypothesis to ensure the robustness of the ADF and PP test. Our results in Table 1 approximately support the results of conventional real GDP unit root literatures which describe per capita real GDP as non-stationary variable Table 1 clearly shows the ADF tests fail to reject the null of non-stationary per capita real GDP for 25 provinces except for Shanghai and Jiangxi. Moreover, Table 1 also report the PP test only rejects the null of a unit root for Shanghai when KPSS test suggest 16 provinces at 5% significant level in Table 1. According to Table 1, the traditional results without considering any structural changes indicate that there is little evidence of convergence among Chinese provinces during 1978 to 2009. However, the low power of ADF, PP and KPSS tests come from the persistence of GDP and the ignorance of structural changes. Therefore, these tests tend to accept the hypothesis of a unit root when the stationary alternative is true.

**Table 1. Univariate unit root tests with trend**

| Province | Levels | | | First Differences | | |
|---|---|---|---|---|---|---|
| | ADF | PP | KPSS | ADF | PP | KPSS |
| **Eastern regions** | | | | | | |
| Hebei | -1.74(1) | -1.47[1] | 0.47[4]* | -4.54(0)*** | -4.50[5]*** | 0.17[3] |
| Zhejiang | -1.43(1) | -1.67[1] | 0.70[4]** | -4.42(0)*** | -4.40[2]*** | 0.21[0] |
| Jiangsu | -1.44(1) | -1.53[2] | 0.68[4]** | -4.76(0)*** | -4.69[4]*** | 0.03[3] |
| Fujian | -1.02[3] | -1.67[2] | 0.56[4]** | -4.43(1)*** | -4.67[4]*** | 0.18[1] |
| Guangdong | -2.12(1) | -1.52[1] | 0.55[4]** | -3.95(0)*** | -3.92[1]*** | 0.26[2] |
| Shandong | -1.21(0) | -1.52[2] | 0.69[4]** | -4.36(0)*** | -4.40[2]*** | 0.15[2] |
| Shanghai | -2.67(0)* | -2.71[0]* | 0.58[4]** | -4.22(0)*** | -4.16[1]*** | 0.21[3] |
| Tianjin | -1.23(0) | -1.47[2] | 0.23[4] | -4.79(0)*** | -4.94[2]*** | 0.31[2] |
| **Western regions** | | | | | | |
| Ningxia | -1.45(1) | -1.24[1] | 0.39[4]* | -4.21(0)*** | -4.10[0]*** | 0.19[1] |
| Xinjiang | -2.01(0) | -1.781[3] | 0.08[4] | -5.65(0)*** | -5.52[1]*** | 0.20[2] |
| Inner Mongolia | -1.120) | -0.42[3] | 0.49[4]* | -3.77(0)*** | -3.82[3]*** | 0.23[3] |
| Gansu | -1.78(0) | -1.62[3] | 0.72[4]** | -5.23(0)*** | -5.19[3]*** | 0.21[3] |
| Guizhou | -1.75(0) | -1.23[4] | 0.48[4]* | -4.42(0)*** | -4.32[0]*** | 0.19[2] |
| Qinghai | -1.63 (0) | -1.51[3] | 0.55[4]** | -5.42(0)*** | -5.42[3]*** | 0.22[2] |
| Yunnan | -1.43(0) | -1.69[3] | 0.13[4] | -5.47(0)*** | -5.58[2]*** | 0.19[2] |
| Sichuan | -0.45(0) | -0.84[1] | 0.67[4]** | -5.62(0)*** | -5.52[1]*** | 0.09[1] |
| **North-eastern regions** | | | | | | |
| Jilin | -1.56(1) | -1.62[0] | 0.08[3] | -4.81(0)*** | -4.78[1]*** | 0.14[0] |
| Heilongjiang | -0.45(0) | -1.54[2] | 0.61[4]** | -3.53(3)*** | -3.55[0]*** | 0.08[1] |
| Liaoning | -1.59(0) | -1.31[1] | 0.48[4]* | -5.35(0)*** | -5.20[3]*** | 0.13[3] |
| **Central regions** | | | | | | |
| Shanxi | -1.56(0) | -1.66[3] | 0.31[4] | -6.52(0)*** | -6.32[1]*** | 0.12[2] |
| Henan | -1.47(1) | -1.52[2] | 0.56[3]** | -4.11(0)** | -4.33[0]*** | 0.07[1] |
| Anhui | -1.58(1) | -1.55[1] | 0.18[3] | -4.83(0)*** | -4.71[0]*** | 0.08[0] |
| Hubei | -1.19(0) | -1.14[3] | 0.26[4] | -6.31(0)*** | -6.01[3]*** | 0.19[3] |
| Shaanxi | -1.69(3) | -1.64[3] | 0.11[3] | -5.31(0)*** | -5.39[3]*** | 0.21[3] |
| Hunan | -1.54(0) | -1.55[2] | 0.07[2] | -5.13(0)*** | -5.52[0]*** | 0.13[1] |
| Guangxi | -1.39(3) | -1.499[1] | 0.18[4] | -4.31(0)*** | -4.00[3]*** | 0.06[1] |
| Jiangxi | -2.89(3)** | -2.54[3]** | 0.16[4] | -5.09(0)*** | -5.52[2]*** | 0.17[3] |

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively. The number in parenthesis indicates the lag order selected based on the recursive *t*-statistic, as suggested by Perron (1989). The number in the brackets indicates the truncation for the Bartlett Kernel, as suggested by the Newey-West test (1987).

The result of Fourier unit root test is displayed in Table 2. The failure to reject the unit root null for most provinces without any consideration of structural breaks may reflect the inappropriate use of the hypothesis for ADF, PP, and KPSS test, and then we use Fourier series to approximate breaks, instead of using dummy variable to capture the feature. Fourier unit root test which introduced by Enders and Lee (2004, 2009) is an ideal methodology to examine whether the time series data contain unit root. As Enders and Lee (2004, 2009) mentioned, Fourier approximation can capture multiple structural breaks well with a low frequency component advanced, thus, instead of selecting number of break dates. Thereby, our first step is to find the best frequency, we estimate Equation (5) for each integer $k$ = 1, ... , 5 following the recommendations of Enders and Lee (2004, 2009) that a single frequency can capture a wide variety of breaks. The residual sum of squares (RSSs) in Table 2 demonstrates that a low frequency works best in approximating the breaks of 27 provinces. The significant $F(\hat{k})$ statistic which showed in the Table 2 illustrates that sine and cosine should be contained in the estimated model. The fifth column in Table 2 show the number of lags of $\Delta S_t$ needed to remove serial correlation in residuals. According to $\tau_{LM}(\hat{k})$ in Table 2, we have a failure of rejecting the null hypothesis of non-stationary of real GDP per Capita converge for China at the 10% significance level, exceptions are Hebei, Inner Mongolia, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, Sichuan, Yunnan, Gansu, and Qinghai and Xinjiang. In sum, our evidence demonstrated that 14 out of 27 provinces are convergence over period 1978 to 2009. In other words, those provinces with a steady growth rate and stabilization policy have only a permanent influence on the real output levels of 12 provinces in China.

**Table 2. Income Convergenve with a Nonlinear Fourier Function(based on Beijing)**

| Province | Residual Sum of Squares (RSSs) | $\hat{k}$ | $F(\hat{k})$ | The number of Lags of $\Delta S_t$ | $\tau_{LM}(\hat{k})$ |
|---|---|---|---|---|---|
| **Eastern regions** | | | | | |
| Hebei | 0.0001 | 2 | 104.66* | 11 | -4.54*** |
| Zhejiang | 0.0003 | 4 | 64.79* | 10 | -23.40*** |
| Jiangsu | 0.0254 | 2 | 375.00** | 12 | -18.79 *** |
| Fujian | 0.06652 | 4 | 4870.67*** | 12 | -148.0*** |
| Guangdong | 0.0082 | 1 | 27748454*** | 12 | -1409.98*** |
| Shandong | 0.0232 | 1 | 64.30* | 11 | -6.32*** |

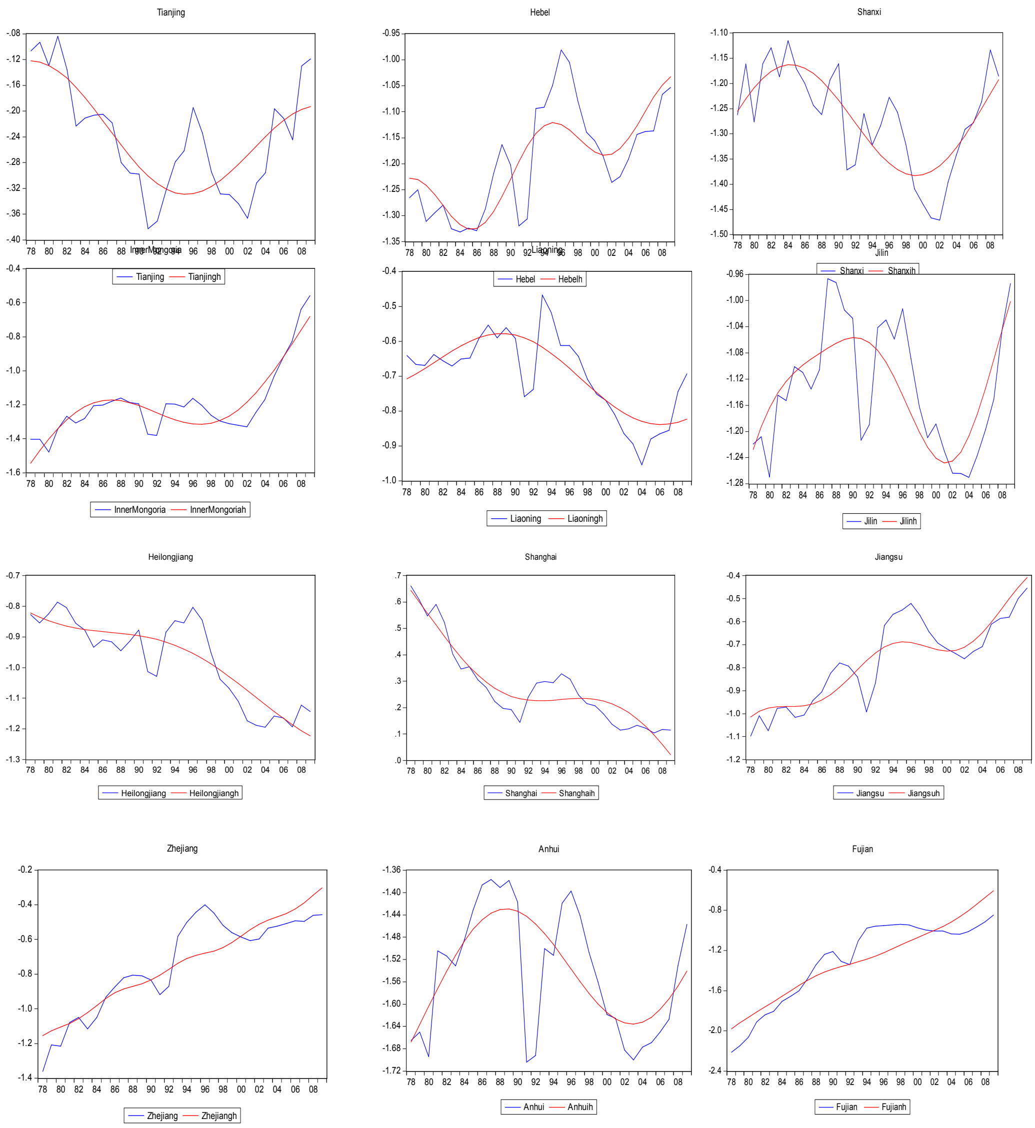
| | | | | | |
|---|---|---|---|---|---|
| Shanghai | 0.0074 | 1 | 13.98*** | 6 | -4.77 *** |
| Tianjin | 0.0036 | 1 | 6364.23*** | 10 | -3.32 |
| **Western regions** | | | | | |
| Ningxia | 0 | 1 | 12988.23*** | 11 | 0.51 |
| Xinjiang | 0.0045 | 3 | 1.42* | 6 | -3.91* |
| Inner Mongolia | 0.0563 | 1 | 6.43*** | 4 | -4.18*** |
| Gansu | 0.0001 | 4 | 37.76** | 11 | -15.80*** |
| Guizhou | 0.0014 | 2 | 6708.67*** | 12 | -623.34*** |
| Qinghai | 0.2958 | 2 | 6781.34*** | 10 | -4.73*** |
| Yunnan | 0.3364 | 2 | 770.65** | 12 | -204.11*** |
| Sichuan | 0.0587 | 2 | 581902.56*** | 12 | -1035.61*** |
| **North-eastern regions** | | | | | |
| Jilin | 0.0382 | 2 | 11.68** | 6 | -2.78 |
| Heilongjiang | 0.0695 | 1 | 517.59** | 11 | -0.99 |
| Liaoning | 0.2746 | 1 | 12671.97*** | 5 | 1.00 |
| **Central regions** | | | | | |
| Shanxi | 0.0023 | 1 | 4602853.40*** | 12 | 5.26 |
| Henan | 0.2414 | 1 | 1403.78** | 9 | 4.50 |
| Anhui | 0.0328 | 2 | 4.01** | 5 | -2.41 |
| Hubei | 0.3367 | 1 | 21551.56*** | 12 | 7.16 |
| Shaanxi | 0.0076 | 1 | 45.06*** | 5 | -0.93 |
| Hunan | 0.5525 | 1 | 1818.45** | 12 | 1.45 |
| Guangxi | 0.7143 | 3 | 106.67* | 8 | 2.51 |
| Jiangxi | 0.0254 | 3 | 149523*** | 10 | 179.70 |

Note: *** ,** and* indicate significance at the 0.01 ,0.05and 0.1 levels, respectively.
Critical values for the $\tau_{LM}(k)$ statistic are taken from Enders and Lee (2009) Table1a.

Regional income inequality is a social and political problem. Organization for Economic Cooperation and Development (2002) has investigated political, historical, and geographic factors causing increasing disparity in China and warned of possible severe consequences that could shake the political regime. An excessively wide regional gap could not only corrode social stability but also disrupt political stability. We divide Chinese provinces into 4 parts: Western Group (Inner Mongoria, Gansu, Xinjiang, Qinghai, Sichuan, Ningxia, Yunnan), Eastern Group (Tianjing, Hebel, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong), North-Eastern Group (Heilongjiang, Jilin, Liaoning) which has been a core of heavy-industry and, these three provinces are often regarded as the ‘‘iron-rust belt’ regions, and Central group (the rest of provinces). Then, we clearly find convergence exist in Eastern Groups, and the other evidence of convergence in West Groups with one exceptions (Ningxia). China is deeply subject to policy regimes, and its evolution of the economic development strategies are almost based on political and nationalism consideration. Thus, if we want to revisit the tendency towards convergence in real per-capita income among the provinces of China, we should explain convergence with policy episodes. In our study, we suggest that a number of policies are useful to reduce the income gap during the ongoing transformations to market-oriented economy. Our empirical results reveal that convergence of Eastern Group and disparities of Central Groups could be attributed to the introduction of market reform in 1978. We view focusing on costal development strategy as main culprit for inequality in Central Group and North-Eastern Group. We believe that the eastern development policy which made foreign and domestic being invested mostly in the eastern regions, with the interior China being starved of funds. In addition, the prosperously Eastern Groups did not cause spillover effects on the neighbor regions but started to expand regional income variations. For instance, Eastern Groups have benefited since the establishment of four special economic zones in 1981. Four special economic zones in Xiamen (Fujian), Shenzhen, Zhuhai, and Shantou (Guangdong) attract a strong inflow of foreign direct investment from Hong Kong and Taiwan due to close geographic proximity and preferential policy. The relative economic stagnation in central regions has lower employment activities, resulting in labor migrating from neighbor regions to eastern regions. It mostly coincides with our studies that labor market distortions affect China's regional economic growth and cause disparities in Central Group and North-Eastern Group. In other words, our empirical result is inconsistent with notion that fully removing barriers to labor mobility will help reduce cross-province wage inequality.

Our results support that "Development Strategy of Western Regions" launched in 1999 do improve the inequality in west regions over time. Under China's Western Development Strategy, the Chinese government started to develop hydro power, mining, and tourism as the first priority programs. Although the economic policy require a large amount of capital investment, the Western Group successfully take advantage of natural resources to attract domestic (eastern) and foreign investment. The question of whether convergence exists in Western Group has been gradually determined by accumulated investment. By accepting these investments, Western Group can overcome its shortage of transportation and lagged technology. On the other side, China improved the relationship with Indochina peninsula countries in 1990s, signing a framework to integrate the regional economy (China Free Trade Agreement) in 2002. As result, it integrates the regional economic between south-west China and south-east Asia eventually. In sum, this study indicates that it is important for China to formulate and adhere to policies that will help it to develop the economy more equally among all areas.

Finally, we not only describe the data but also plot the log real per capita GDP for each province in Figure 1 because a rough visual analysis of the tendencies can provide us information to make an instinct analysis about convergence in 27 provinces. In addition, we can clearly observe structural shifts in the trend of the data and the estimated time paths of the time-varying intercepts. The visual analysis indicates that the convergence of real per capita GDP may exist in China if the convergence is viewed as the decrease of the disparity between provinces.



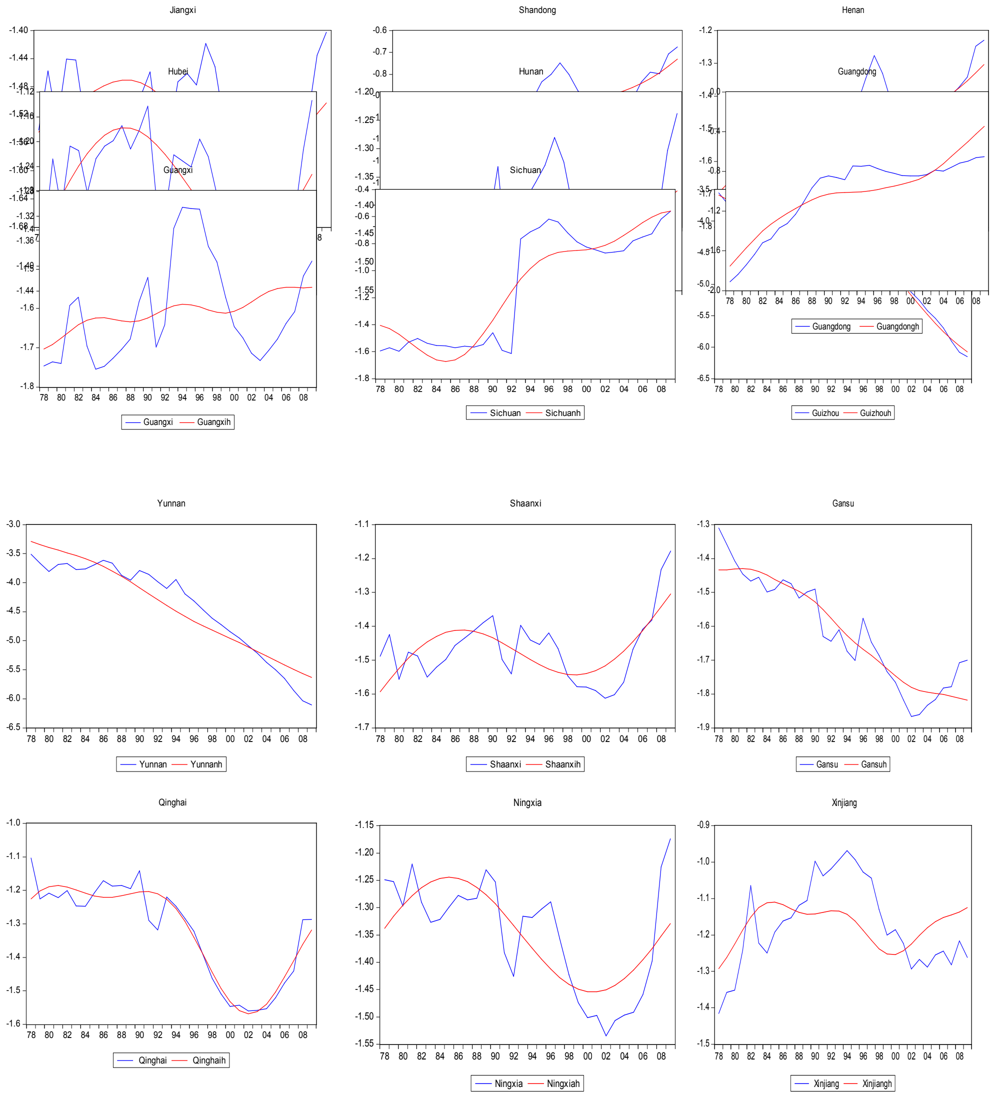



**Figure 1. Plots of Per Capita Real GDP Convergence for China and Fitted Nonlinearities**

## 4. Conclusion

We employs Fourier unit root test advanced by Enders and Lee (2004, 2009) to re-investigate the presence of convergence in China. Fourier unit root test not only consider a better way to approximate breaks than conventional Dummy variable does but also has higher power than standard univariate. These empirical results provide ample evidence with a high degree of confidence about two things. First, most of Eastern provinces converge and Western provinces converge between 1978 and 2009. Second, our empirical results also provide little evidence of convergence among North-Eastern provinces and Central provinces. Consequently, our results support that "Market Reform Policy" in 1978 and "Development Strategy of Western Regions" in 1999 do improve the inequality in western and eastern regions over time. It is important for macroeconomic policy and forecasting for China and these results can be an available explanation to economists, financial institution, and policymakers holding long-term for their likely implications.

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