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Catch-up and Regional Disparity in Economic Growth:
An Empirical Evidence of the Convergence Hypothesis in China Case*

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Abstract

China shows marked inequality in regional income and has registered quite differing regional growth since introducing reform and opening policies. The comparison of 30 sample-provinces growth performance over 1978 to 2000 develops a way to distinguish these regions into three groups: Traditional Advanced Regions (TARs), New Advanced Regions (NARs) and Less Developed Regions (LDRs).

This paper provides empirical evidence for understanding the catch-up and convergence among regions within China by means of two approaches: the cross-section test and the unit-root test. The result of the former test shows that regions in China do not present "absolute β-convergence" nor "σ-convergence" but present "conditional β-convergence". In detail, the regional growth is positively related to the fraction of products originating from Non-State-Owned Enterprises (NSOEs), the rate of Foreign Direct Investment to gross provincial product (GPP), the regional level of per capita export, and the interregional income transfer, but negatively related to the share of local government expenditure in GPP.

The unit-root test fails to reject the null hypothesis, that is, no convergence existed for 18 provinces, in which one province belongs to the TAR group, one belongs to the NAR group and 16 provinces belong to the LDR group.

This paper presents empirical evidence showing that there was a good deal of "catch-up" between NARs and TARs within a national framework of "divergence" due to the growth performance of LDRs in the post reform and opening era. Policies with regionally heterogeneous characteristics are indicated to be powerful enough to influence regional economic structure, so as to influence their growth patterns.

1. Introduction

A major debate concerning the existence of convergence among countries or between regions within a country over time has been going on since Solow (1956) and Swan (1956) developed the neoclassical growth model. Empirical tests of the convergence hypothesis fall into two categories. The first set, basically consisting of performing cross-section regres-

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sions, rejects the no convergence null hypothesis using the subsequent growth rates for a group of economies during a particular period as a dependent variable and the initial per capita output levels in each of them as an independent variable. Barro (1991), Barro and Sala-i-Martin (1995) and Sala-i-Martin (1996a, 96b) do not indicate that there is convergence in income levels across the whole sample of 118 countries within the period 1960 to 1985, but illustrate the existence of convergence within high-income countries belonging to OCED area. Baumol, Nelson and Wolff (1994) indicate that differences in conditional levels of productivity have been decreasing across the same, whole, sample, after eliminating African countries.

The second set, consisting in time series tests, shows that there is little observable tendency for poorer economies to catch up to richer ones, and that per capita output fails to equalize across developed countries and less developed countries. According to Quah's critique (1993, 1996), the existence of β-convergence is compatible with the persistence of international inequality that remains constant or even grows especially between developed countries and developing countries. That is showing a tendency for divergence, rather than convergence, for poorer economies with respect to richer ones.

Results often have been contradictory, when different tests have been applied to output series, by a wide literature which has formally tested the convergence hypothesis. Bernard and Durlauf (1996) propose two definitions of convergence which capture some of the implications of the neoclassical growth model related to the difference between the levels of per capita income of different economies. They are 1) *Convergence as catching up* and 2) *Convergence as equality of the long-term forecast at a fixed time*. These definitions characterize convergence between a pair of economies or members of a set of economies in which every pair exhibits convergence. The definition 1) implies that the differences between the economies under analysis tend to decrease, and the definition 2) implies that the long term forecast for these differences tends to zero as the horizon grows longer, which means that there are not any shocks with indefinitely long effects.[1]

The regions within China show marked disparities in regional income and have registered quite differing growth performances over the past 20 years after the country introduced reform and opening policies.[2] Some backward regions realized rapid catching-up to advanced regions, while others stagnated in per capita outputs.[3] The objective of this paper is to explore the characteristics of regional disparity in China and to provide empirical evidence to understand the catch-up and convergence between regions in economic growth by means of two approaches: the cross-section test and the unit-root test.

The investigated panel consists of real per capita gross provincial product (GPP p.c.) across 30 provinces in mainland China for the period from 1978 to 2000. Section 2 measures the extent of real-income disparities between regions to present how these have changed since 1978. In Section 3, the estimation to test the "classical" convergence hypothesis is effected through a non-linear Least Squares procedure. In section 4, a unit-root test of the time series model is applied to identify regions tending to converge, and to distinguish them from others in China. Section 5 contains concluding remarks and hints at some further problems to be investigated.

2. Establishing the Basic Facts about Regional Growth and its Dispersion

The estimates of Table 1 merge three kinds of information relative to the 30-province sample from 1978 to 2000, that is, for the period of "Economic Reform" in China.[4] These are 1) real GPP p.c. (in 2000 prices), 2) the average annual growth rate of real GPP p.c., and 3) Regional Disparity Index (RDI), that is, the ratio of real per capita gross product of each province to that of the whole country.[5]

Table 1 Economic Growth and Regional Disparity in China from 1978 to 2000

	real GPP p.c.(yuan)		Growth Rate(%)			Rgional Disparity Index	
	1978	2000	1978-89	89-2000	78-2000	1978	2000
National level	1258	7063	7.9	9.2	8.2	100	100
Beijing	3564 (2)	17936 (2)	7.3	8.8	7.6 (22)	283	254
Tianjin	3121 (3)	16377 (3)	6.3	10.3	7.8 (19)	248	232
Liaoning	2191 (4)	11017 (8)	7.5	8.5	7.6 (23)	174	156
Shanghai	5545 (1)	27187 (1)	6.4	9.6	7.5 (24)	441	385
Jiangsu	1126 (12)	11539 (5)	10.5	13.1	11.2 (3)	89	163
Zhejiang	1058 (15)	12906 (4)	11.3	14.2	12.0 (1)	84	183
Fujian	1029 (18)	11294 (6)	10.2	14.2	11.5 (2)	82	160
Shandong	1045 (16)	9409 (9)	9.1	13.2	10.5 (5)	83	133
Guangdong	1148 (8)	11181 (7)	11.1	11.8	10.9 (4)	91	158
Hebei	1136 (10)	7546 (11)	7.2	11.9	9.0 (10)	90	107
Shanxi	1072 (14)	4986 (21)	6.9	8.3	7.2 (25)	85	71
Inner Mongoliar	989 (20)	5897 (16)	8.5	9.3	8.5 (12)	79	83
Jilin	1131 (11)	6676 (14)	8.4	9.3	8.4 (13)	90	95
Heilongjiang	2108 (5)	8818 (10)	5.8	8.5	6.7 (28)	168	125
Anhui	701 (29)	5076 (20)	8.4	11.5	9.4 (6)	56	72
Jiangxi	738 (28)	4838 (23)	7.8	11.1	8.9 (11)	59	69
Henan	778 (27)	5551 (18)	8.7	11.0	9.3 (7)	62	79
Hubei	1034 (17)	7094 (12)	8.5	10.9	9.1 (9)	82	100
Hunan	1080 (13)	5733 (17)	6.6	10.2	7.9 (18)	86	81
Guangxi	883 (22)	4567 (26)	5.2	11.4	7.8 (20)	70	65
Hainan	953 (21)	6588 (15)	8.2	11.3	9.2 (8)	76	93
Sichuan	847 (24)	4904 (22)	7.6	10.0	8.3 (14)	67	69
Guizhou	560 (30)	2819 (30)	8.0	8.0	7.6 (21)	44	40
Yunnan	852 (23)	4559 (27)	8.2	8.4	7.9 (17)	68	65
Tibet	1018 (19)	4483 (28)	5.8	9.0	7.0 (27)	81	63
Shannxi	838 (25)	4607 (25)	8.7	8.1	8.1 (16)	67	65
Gansu	828 (26)	3838 (29)	6.9	8.3	7.2 (26)	66	54
Qinghai	1555 (6)	5089 (19)	4.9	6.8	5.5 (30)	124	72
Ningxia	1140 (9)	4725 (24)	7.3	6.7	6.7 (29)	91	67
Xinjiang	1271 (7)	7088 (13)	9.1	7.9	8.1 (15)	101	100

Note: 1. Real GPP p.c. denotes Real per capita Gross Provincial Product in 2000 prices.

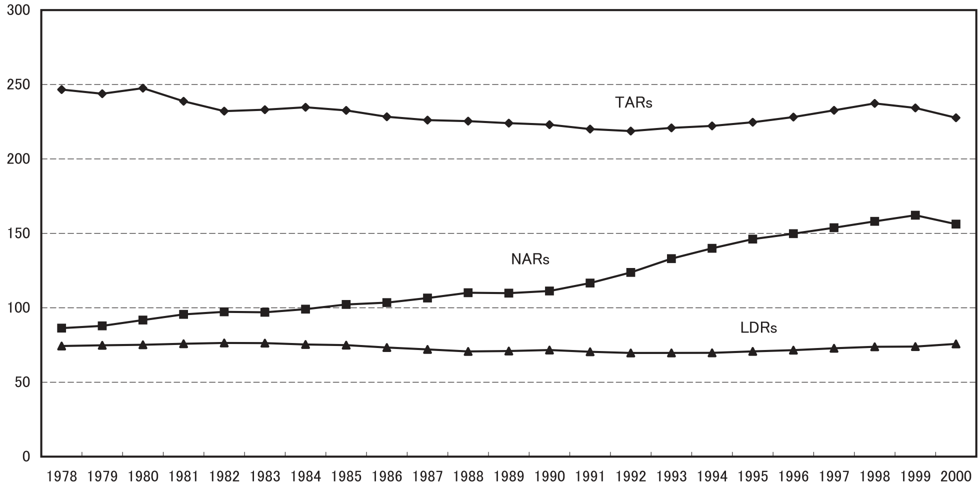
2. Regional Disparity Index (RDI) denotes the ratio of real GPP p.c. to real GDP p.c.

3. The number in high-low order of 30 provinces is in paretheses.

Source: See Statistical Resources.

As a result, 30 provinces within China are here distinguished into three groups. Four provinces with the highest income level in 1978 and decreasing trend of RDI from 1978 to 2000 are placed in the Traditional Advanced Regions (TARs). The remaining regions are grouped by the regional pattern of RDI change, with 5 increasing patterns, and 21 decreasing or roughly constant patterns. This identifies New Advanced Regions (NARs) and Less Developed Regions (LDRs). Figure 1 gives a representative picture of comparative growth performance among these three regional groups in terms of RDI.

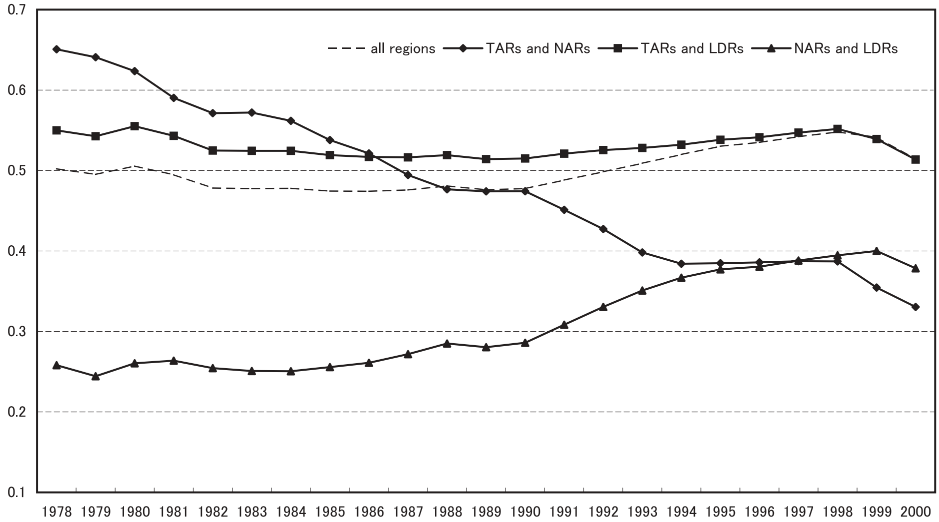
Figure 1 Evolution of Regional Disparity Index in each gourp (national level=100)



Note: 1. Regional Disparity Index here denotes the ratio of real per capita Gross Product of each group to that of nation.
2. TARs, NARs and LDRs denote the Traditional Advanced Regions group, the New Advanced Regions group and the Less Developed Regions group respectively.

Figure 2 shows the trend of the standard deviation distribution of GPP p.c. for various regions within the whole country and within a two-group scope from 1978 to 2000. Three kinds of distribution can be observed. First, a decreasing trend of "σ" from 1978 to 1989, turning to increasing trend in 1990, is shown on a national scale. Almost the same trend is found for regions within the "TARs + LDRs" scale. Second, a positive trend of "σ" is observed from the beginning of 1980, turning stronger after 1991, within the "NARs + LDRs" scale. Last, a strong reduction of "σ" within "TARs + NARs" scale from 1978 to 2000 indicates that NARs are "catching-up" with TARs.

Figure 2 Evolution of the Standard Deviation Distribution of real GPP p.c. within a two-group scope



The following facts emerge from Table 1, Figure 1 and Figure 2.

1) There was a substantial increase in real income in all regions during the period 1978 to 2000, in which a high rate of growth in China has been maintained.
2) The 30 provinces can be divided into three groups with some degree of homogeneity in terms of Regional Disparity Index. TARs have had the highest income but among the lowest annual growth rates with respect to the national level over time.[6] NARs have shown the fastest growth and achieved second-highest levels of income at the end of our study period. LDRs still kept the lowest income level at the end of study period, with values of indexes not very different from that of TARs 20 years ago.
3) The pace of regional growth over 20 years has not been steady. The annual growth rates in these regions varied considerably, so that the disparity between the highest- and lowest-rate of growth from 1978 to 2000 is above twofold. The acceleration was most marked in NARs and least so in TARs.
4) A weak reduction of the inter-regional income spread at the national scale from 1978 to 1987 was observed, but a “divergence” trend has appeared since 1990. The gap between TARs and NARs was significantly reduced over the period 1978 to 2000. The widening in the spread within a national framework was seemingly due to the disappointing performance of LDRs.
5) The within-group homogeneity of the growth performance suggests that the regions in each group had common institutional and/or policy characteristics that distinguished them from the members of the other groups.

3. The Cross-section Test: "Classic Approach" to Convergence

Two measures of convergence are used in this section, and both are members of the "classical approach" (Sala-i-Martin 1996b:1020-1022). The first measure is a simple regression of average growth rate of real gross per capita product in any region overtime. A negative coefficient associated with the initial income levels of a region indicates that a poorer region with lower initial income is "catching up" by higher growth rate with a rich region which had higher initial income. It can be measured in absolute or conditional terms, defined as follows.

For the fundamental differential equation of the neoclassic model in the neighborhood of the steady state, Eq. (1) is modified to examine the regional absolute "β-convergence",

$$(y_{i,t} - y_{i,0})/t = a - [(1 - e^{-\beta t})/t]\, y_{i,0} + u_i \tag{1}$$

where y_{it} and y_{i0}, both in logs, are denoted in terms of real per capita gross output of province i in years t and 0 respectively as the empirical literature has generally focused on, u_{it} is a stochastic error with the usual characteristics, and β is the speed of convergence.[7] The regional "β-convergence" is equated with a positive value of β, treating $\beta \leqq 0$ as the no convergence null hypothesis.

An equation of the form

$$(y_{i,t} - y_{i,0})/t = a - [(1 - e^{-\beta t})/t]\, y_{i,0} + \phi X_i + u_i \tag{2}$$

is modified to include a set of control variables X_i for province i. In this paper, a positive β means regional economies can converge to different long-run equilibria depending on conditions that hold on two sets of exogenous factors. One set of proxy variables, including regional dummy variables, regional level of secondary schooling and industrial structure in the initial year of study period, stand for the steady state of province i. This set is included to examine the regional "conditional β-convergence" obeying a version of the Solow growth model. The other set includes regional Non-State-Owned Enterprises (NSOEs) output, Foreign Direct Investment (FDI) flow, export, local fiscal expenditure and interregional income transfer to estimate the impact of economic policies on regional growth.

The second measure, named "σ-convergence", is based on the trend of standard deviation distribution of inter-regional output over time. The existence of equality is possible as regions have reached their steady states, and "σ-convergence" is indicated when the coefficient declines over time.

$$\sigma(t) = \alpha + \gamma T_t + \mu_t \tag{3}$$

T_t is noted respect to time trend. The existence of "σ-convergence" is proved as $\gamma<0$.[8]

The test to equations (1) and (2) is effected with non-linear least square estimation procedure and the test to Eq. (3) with GLS procedure.[9]

Table 2 shows that β is significant in Model 1. But the coefficient of determination is too low (R^2 =0.077) for the regression model to fit the data. Since deviations of y_{i0} from its mean almost do not translate into different values for the average annual growth rate (left side of Eq. (1)), y_{i0} has little explanatory power in support of the absolute β-convergence hypothesis.[10]

Table 2 Results of the Cross-setion test to β-Convergence

	β	R1	R2	ER	NY1	NY2	R^2	A.R^2	S.E.	No
(1)	0.014 ***						0.077	0.076	0.022	570
	(9.48)									
(2)	0.020 ***	0.020 ***	0.031 ***				0.356	0.352	0.018	570
	(15.26)	(7.48)	(14.98)							
(3)	0.021 ***	0.014 ***	0.032 ***	0.032 ***			0.363	0.359	0.018	570
	(15.89)	(3.56)	(15.18)	(2.61)						
(4)	0.019 ***	0.021 ***	0.035 ***	0.102 ***	0.088 ***	−0.006	0.439	0.433	0.017	570
	(14.38)	(5.72)	(17.25)	(6.82)	(3.86)	(−0.25)				

Table 2 (continue)

	β	SNSOE	SFDI	LEX	SFE	TR	R^2	A.R^2	S.E.	No.
(5)	0.018 ***	0.002 ***					0.312	0.309	0.019	570
	(15.52)	(13.98)								
(6)	0.018 ***		0.002 ***				0.188	0.186	0.02	551
	(13.81)		(8.34)							
(7)	0.023 ***			0.009 ***			0.289	0.286	0.019	570
	(19.19)			(13.29)						
(8)	0.015 ***				−0.001 ***		0.138	0.135	0.021	570
	(10.59)				(−6.33)					
(9)	0.022 ***					0.019 ***	0.175	0.172	0.021	570
	(15.91)					(8.23)				
(10)	0.024 ***	0.001 ***	0.001 **	0.001	0.000	0.009 ***	0.433	0.427	0.017	570
	(21.00)	(5.65)	(2.23)	(0.88)	(−1.12)	(3.11)				

Note: 1. All models were estimated using Non-linear Least Squares Regression in Eview.
2. R1and R2 are regional dummy variables to distinguish TARs, NARs and LDRs from each other. R1=1, R2=0 for TARs, R1=0, R2=1 for NARs, and R1=R2=0 for LDRs.
3. ER denotes the rate of enrolment in secondary education to regional population in 1982.
4. NY1 and NY2 are the fraction of products originating from Agriculture and Industry in 1978 respectively.
5. SNSOE denotes the annual average fraction of products originating from Non-State-Owned Enterprises over 1978-97.
6. SFDI denotess the annual average rate of Foreign Direct Investment to Gross Provincial Product over 1990-97.
7. LEX denotes the annual average of regional exports per capita in logs over 1992-97.
8. SFE denotes the annual average rate of local government expenditure to GPP over 1978-97.
9. TR denotes the interregional income tranfer.
TR= the average differential between labor productivity and wage (in logs) over 1978-90.
10. Tibet is not included in regression 8 for no available data of FDI in it.
11. Significant level is indicated by ***=1%,**=5%,and *=10% and t statistic is in parenthesis.

Source: See Statistical Resources.

However, the quality of the regression model is improved with R^2 growing from 0.077 to 0.356 conditionally on regional dummies R1 and R2. In Model 2, the t statistic corresponding to a significantly positive β also increases as with coefficients corresponding to regional dummies. Besides, the estimated coefficients of R1 and R2 are significantly positively related to real per capita GPP growth.

Furthermore, the quality of regression estimation goes further up in Models 3 and 4, corresponding to inclusion of the rate of enrollment in secondary education to regional population ER, standing for regional level of secondary schooling. ER is significantly positively related to real GPP p.c. growth. The fractions of products originating from agriculture and industry in the initial year of study period NY1 and NY2 are added in Model 4. They increase the R^2 from 0.363 to 0.439, and increase the t statistics corresponding to regional dummies and the rate of enrollment in Model 3.

Just as in most of the “classical convergence” literature, the estimated β by Models 2 to 4 is around 0.02, which is consistent with the neoclassical “uniformity”.

The influence relating to variables standing for proxies for regional development policy is estimated by Models 5 to 10. As a result, real GPP p.c. shows a tendency for convergence positively related to the fraction of products originating from NSOEs, the rate of FDI to GPP, the level of export per capita and the differential between labor productivity and real average wage and, negatively related to the rate of local government expenditure to GPP with a high level of significance.[11]

Table 3 Regressions of Interregional Standard Variance to Time Trend

Sample		Time Trend	t statistic	R^2	No.
Nation	1978–1997	0.001	1.6	0.124	600
	1978–89	−0.003	−4.6 ***	0.678	360
	89–1997	0.006	8.9 ***	0.919	270
TARs + NARs	1978–1997	−0.016	−45.0 ***	0.991	180
	1978–89	−0.016	−24.2 ***	0.983	108
	89–1997	−0.017	−13.8 ***	0.965	81
TARs + LDRs	1978–1997	−0.001	−3.0 **	0.340	500
	1978–89	−0.003	−6.3 ***	0.796	300
	89–1997	0.002	3.2 **	0.592	225
NARs + LDRs	1978–1997	0.008	10.2 ***	0.853	520
	1978–89	0.003	4.0 ***	0.611	312
	89–1997	0.014	12.7 ***	0.959	234

Note: 1. The GLS regression procedure is carried out for all samples.

2. σ-convergence is proved by a significantly negative coefficient of time trend.

3. Significant level at: *=10%, **=5%, ***=1%

Source: See Statistical Resources.

In addition, Table 3 tests the σ-convergence hypothesis for the 30-province sample over the period 1978-97, which is further divided into two shorter periods: 1978-89 and 1989-97. For the national sample, the existence of σ-convergence can be observed significantly over the period 1978-89. For the TARs+NARs sample, σ-convergence is shown significantly over 1978-89, 1989-97 and the whole period 1978-97. That means the gap between TARs and NARs was reduced by NARs' "catch-up." For the TARs+LDRs sample, "divergence" emerges significantly over 1989-97. And for the NARs+LDRs sample, a "divergence" process continued over the whole period 1978-97. These results show that the "no σ-convergence" null can not be rejected within a whole national framework over the period 1979-97.

Different from the prediction of the neoclassical growth model, by which Barro (1991), Barro and Sala-i-Martin (1991,1992), Sala-i-Martin (1996a, 1996b) hold that relatively homogeneous economies such as regions within a country, should show all three types of convergence, the empirical evidence is in favor of the conditional β-convergence hypothesis and against the absolute β-convergence hypothesis and the σ-convergence hypothesis in China case. The policies with regionally heterogeneous characteristics are indicated to be powerful enough to influence regional growth patterns.[12]

In order to give a possible explanation about conditional convergence in regional disparity, related to the differential structural features among regions, two definitions of convergence proposed by Bernard and Durlauf (1996:165-166) are employed in the unit-root test in the next section.

4. The Unit-root Test

The first definition is *Convergence as catching up*.[13] The existence of convergence implies that the differences between the levels of per capita output of different economies are expected to decrease in value. The second definition is *Convergence as equality of the long-term forecast at a fixed time*.[14] The long term forecast for these differences tends to zero as the horizon grows longer. Continuing their analysis, Bernard and Durlauf hold, firstly, that convergence according to the latter implies the existence of convergence in the sense of the former, but not the reverse, and secondly that the existence of β-convergence, although it is consistent with the former, is compatible with models which violate the latter.

If any shock, with indefinitely long effects, occurred in any region/regions in the process of development, the differential of per capita output between this region/these regions and any other region come to contain either a deterministic or unit-root component. In this case, the second definition of convergence is violated. Hence a test consistent with two definitions appears. The non-convergence hypothesis can be evaluated by the existence of unit-root in the series of the differential between the per capita output of related regions and that for the national average. In particular, applying the Augmented Dickey-Fuller test (ADF) to the differences, the non-convergence hypothesis is rejected if the null hypothesis of the existence of unit root can be rejected.[15]

It is supposed that there is an equilibrium differential for every region between its per capita product and that of the nation (in logs), as in the following expression:

$$(y_{it} - y_{.t}) = (y_i^e - y_.^e) + u_{it} \tag{4}$$

where left-side is the differential of per capita product between region i and that of the nation in moment t, right-side is the equilibrium differential with deviations which are formed by a deterministic linear trend and a stochastic process such as the following.

$$u_{it} = v_{i0} + \beta_i t + v_{it} \tag{5}$$

where v_{i0} is the original deviation of region i with respect to its equilibrium differential. β_i is the speed of convergence, and it is possible that the differential economies present different rates of convergence. v_{it} are the deviations with respect to deterministic trend at moment t. Replacing in (4):

$$(y_{it} - y_{.t}) = (y_i^e - y_.^e) + v_{i0} + \beta_i t + v_{it} \tag{6}$$

The existence of the convergence hypothesis according to the first definition implies that if $v_{i0}>0$, then $\beta_i<0$, and vice versa. That means if a region is initially above its equilibrium differential it must later grow less than the national aggregate to return to it. The opposite must happen if it is initially below its equilibrium differential.

For the existence of convergence, these deviations must constitute a stationary stochastic process. We model v_{it} as an ARMA (1,0) process as follows:

$$(1 - \rho_i L)v_{it} = e_{it} \tag{7}$$

where L is the lag operator, ρ_i is the coefficient of the lagged v_{it}, and e_{it} is a random shock without autocorrelation.

In order to derive ARMA(p, q) processes with p and q values larger than 1 and 0 respectively, Eq. (7) is substituted in Eq. (6), and Eq. (6) is rearranged as follows:

$$dy_{it} = a_i + b_i t + \rho_i dy_{i,t-1} + \sum_{m=1}^{k} d_{im} \Delta dy_{i,t-m} + e_{it} \tag{8}$$

$$\begin{aligned} with \quad & dy_{it} = y_{it} - y_{.t}\; dy_i^e = y_i^e - y_.^e \\ & \Delta dy_{it} = dy_{it} - dy_{it-1} \\ & a_i = (1 - \rho_i)(dy_i^e + v_{i0}) + \rho_i \beta_i && (9) \\ & b_i = (1 - \rho_i)\beta_i && (10) \end{aligned}$$

where the k extra regressors are added in the preceding regressions to eliminate possible nuisance-parameter dependencies in the limit distributions of the test statistics caused by temporal dependence in the disturbance. The number k of extra regressors is determined by a significance test of the estimated coefficients d_{im}.[16]

Since ρ_i is the coefficient of dy_{it-1}, if $\rho_i>1$ or $\rho_i=1$, the variance of $\{dy_{it}\}$ increases with time and goes to infinity by which the existence of convergence (in the sense of definition 2) is rejected. In order for convergence to exist, the condition of $\rho_i<1$ is necessary so that the output differences decline over time. The Augmented Dickey-Fuller test (ADF) takes the unit root as the null hypothesis: $\rho_i=1$. Since explosive series do not make much economic sense, this null hypothesis is tested against the one-sided alternative: $\rho_i<1$.

$$\Delta dy_{it} = a_i + b_i t + c_i dy_{i,t-1} + y_{it-1} \sum_{m=1}^{k} d_{im} \Delta dy_{i,t-m} + e_{it} \tag{11}$$

$$with \quad c_i = -(1-\rho_i) \tag{12}$$

The test is thus carried out by estimating Eq. (12) with dy_{it-1} subtracted from both sides of Eq. (8). The null and alternative hypothesis correspond then to $c_i=0$ and $c_i<0$. If the null hypothesis can be rejected, that means the alternative hypothesis is accepted, and the existence of convergence can be proved.

Table 4 Results of the Unit-root test to Regional Convergence

Province	k	a_i	(t stat.)	b_i	(t stat.)	c_i	(t stat.)	
TARs group								
Beijing	1	1.303	3.7	−0.007	−3.1	−1.073	−3.7	**
Tianjin	6	1.153	3.2	−0.010	−1.8	−0.988	−3.5	*
Liaoning	3	0.200	1.8	−0.002	−2.7	−0.346	−1.7	
Shanghai	7	5.884	5.1	−0.021	−3.2	−3.123	−5.3	***
NARs group								
Jiangsu	6	0.046	1.1	−0.059	−0.9	2.746	1.0	
Zhejiang	7	−0.727	−4.1	0.115	4.3	−3.786	−4.2	**
Fujian	1	−0.006	−0.4	0.003	2.3	−1.000	−4.3	**
Shandong	7	−1.040	−3.6	0.062	3.8	−3.850	−3.6	*
Guangdong	7	−0.243	−12.0	0.035	12.5	−0.967	−20.6	***
LDRs group								
Hebei	5	−0.101	−3.0	0.015	3.8	0.468	2.3	
Shanxi	0	−0.004	−0.2	−0.005	−1.8	−0.442	−2.1	
Inner Mongolia	0	−0.022	−0.9	−0.001	−1.0	−0.293	−1.8	
Jilin	0	0.007	0.4	0.001	0.8	−0.575	−2.5	
Heilongjiang	1	0.288	4.1	−0.015	−4.1	−0.677	−4.3	**
Anhui	5	−0.588	−4.9	−0.001	−0.4	−1.557	−4.8	**
Jiangxi	7	−0.040	−0.8	0.026	5.8	0.955	4.1	
Henan	4	−0.478	−2.6	0.003	1.3	−1.117	−2.5	
Hubei	7	0.098	−5.6	0.004	3.0	−0.856	−3.3	
Hunan	6	−0.066	−0.8	0.005	0.8	0.028	0.1	
Guangxi	5	−0.470	−4.7	−0.002	−0.7	−0.761	−4.3	**
Hainan	1	−0.146	−2.0	−0.110	1.9	−0.486	−2.6	
Sichuan	1	−0.382	−4.2	−0.003	−2.4	−1.111	−4.1	**
Guizhou	6	−0.228	−1.5	−0.026	−2.8	−0.641	−2.8	
Yunnan	1	−0.297	−2.9	−0.001	−0.8	−0.586	−3.1	
Tibet	5	0.167	0.7	−0.022	−0.9	−0.783	−1.3	
Shaanxi	7	−1.176	−6.1	−0.007	−3.0	−4.340	−6.3	***
Gansu	7	−0.226	−1.9	−0.008	−2.6	−1.454	−2.8	
Qinghai	2	0.041	1.4	−0.011	−2.1	−0.374	−2.2	
Ningxia	0	−0.013	−0.8	−0.004	−1.5	−0.304	−1.7	
Xingjiang	0	0.000	0.0	−0.001	−0.5	−0.169	−1.1	

Note: 1. The results were obtained by completing Augmented Dickey-Fuller test in Eview.
2. k is determined as described in the paragraph following Eq.(12).
3. Using Mackinnon critical value to reject hypothesis of a unit root at *=10%, **=5%, ***=1%
Source: See Statistical Resources.

Table 4 shows that the unit-root hypothesis can be rejected in ten cases at a significant level of 5% or less, and two cases at 10%. They are Beijing (5%), Tianjin (10%), Shanghai (1%), Zhejiang (5%), Fujian (5%), Shandong (10%), Guangdong (1%), Heilongjiang (5%), Anhui (5%), Guangxi (5%), Sichuan (5%) and Shannxi (1%).

That is, the hypothesis of convergence is confirmed in 3 of 4 regions in TARs and 4 of 5 regions in NARs, but only in 5 of 21 regions in LDRs. This result is consistent with the existence of β-convergence, conditionally on regional dummy variables, illustrated by models 2 to 4 of the cross-section tests in section3.

These findings provide one explanation for the finding that only conditional convergence for regional disparity can be observed in China. Although a convergence tendency is observed between some regions, especially in TARs and NARs, this is not true for other regions (most regions belong to LDRs). It is clear that these regions have contributed to the "divergence" of the regional disparity in economic growth.

5. Conclusion

In this paper, comparison of 30 sample-provinces' growth performance in term of Regional Disparity Index over the past 20 years was developed as a way to classify regions of China in three groups: Traditional Advanced Regions (TARs), New Advanced Regions (NARs) and Less Developed Regions (LDRs). Regions in each group have some degree of homogeneity, i. e., initial income level, the pace of growth, the pattern of convergence, over the period 1978 to 2000. Those with the highest initial income level, the TAR group have shown a lower annual growth rate compared. The NAR group have registered the fastest growth and achieved the second-highest level of income at the end of the study period. The LDR group has the lowest income level, which is not very different in relative terms from that of TARs 20 years ago.

The results of the "classical approach" to convergence hypothesis across 30 provinces of China show that regions present neither absolute β-convergence nor σ-convergence but only conditional β-convergence. The empirical evidence illustrated how economic policies with respect to NSOEs, Foreign Direct Investment, export, local government expenditure and interregional income transfer, have had an influence on economic performance of regions.

The empirical analysis for the existence of unit-root in deterministic trends has shown evidence against the existence of convergence in 18 provinces, of which 16 provinces belong to LDRs. The results indicate that the growth performance of LDRs contributed to the "divergence" with respect to the country as a whole.

It is clear that there was a good deal of "catch-up" between TARs and NARs, within an overall national framework of "divergence", due to the growth performance in LDRs over time. The policies with regionally heterogeneous characteristics are shown to be powerful enough to influence growth patterns of particular regions, so as to influence the extent of convergence among them.

Notes

1 Following the procedure proposed by Zivot and Andrews (1992), Utrera and Koroch (1998) develop a unit-root testing procedure for the case of Argentina, concerning the dynamic properties of macroeconomic time series.

2 It also seems clear that growth is faster after the transition to a market economy in 1978 than it was in the "Command Economy" period from 1949 to 1978.

3 Arayama and Takeuchi (1993) proposed the dichotomy between "advanced" regions and "poor" regions within China.

4 The sources of data used are presented in the Statistical Resources

5 It measures the multiple of any provincial average income to national level. See Ohtomo (1992:66).

6 Shanghai, Beijing, Tianjin and Liaoning, in real GPP p.c. term, are ranked 1st, 2nd, 3rd, and 4th in 1978 and 1st, 2nd, 3rd, and 8th in 2000 respectively. But in the order of the annual growth rate of GPP p.c. between 1978 and 2000, they are ranked among the worst provinces. See Table 1.

7 $\beta=(1-\alpha)(\delta+n+x)$ with α being the exponent of capital in a Cobb-Douglas function, δ the capital depreciation rate, n the population growth and x the rate of technological change.

8 Sala-i-Martin (1996a, 96b) proves the β-convergence is a necessary but not sufficient condition for the variance of regional income distribution to show a negative trend. For this reason, σ-convergence is used together with β-convergence in "classical approach". σ-convergence exists when $\sigma(t+1)<\sigma(t)$, $\sigma(t)$ being the standard deviation of a per capita GPP (Gross Provincial Products) between regions at moment t.

9 The derivatives of the regression equation (1) or (2) with respect to the parameters depend upon parameters, that is, the model of (1) and (2) is nonlinear in parameters (Green 1997:451).

10 It is also necessary to pay attention to the speed of convergence. It is estimated at about 1% per year that means the gap is closed in 70 years if per capita income of richer region is twice as much as that of poorer region.

11 The difference between labor productivity and real average wages in each province can be the possible measure for income transfer from profit-making enterprises which are located mainly in advanced regions to deficit enterprises which are located in the backward regions, especially results in Stated-owned enterprises in China. The real average wage for all workers in each province can be available in the period of 1978 to 1990.

12 It is observed that interregional income transfer, FDI and export are contributing to raise the per capita output in manufacturer sector and service sector in regions of China over 1978 to 1997 (Arayama and An 2000).

13 Economies i and j converge between dates t and t+T if the per capita product disparity at t is expected to decrease in value as following: If $y_{i,t} > y_{j,t}$, then $E(y_{i,t+T}-y_{j,t+T} | X_t)<y_{i,t}-y_{j,t}$, where X_t denotes all the information available at moment t.

14 As $\lim_{k\to\infty}(y_{i,t+k}-y_{j,t+k} | X_t)=0$, economies i and j converge if the long-term forecasts of per capita product for both economies are equal at a fixed time t.

15 Including the presumption that, if there is a structural change, its date is not known a priori but rather is gleaned from the data, Zivot and Andrews (1992:253-254) developed a unit-root testing procedure concerning the dynamic properties of macroeconomic time series. Accordingly, Utrera and Koroch (1998) develop

the model that combines the definition of β- convergence in the cross-section test with the information of time series. The same analytical methods are applied in this paper to test the empirical model.

16 See Zivot and Andrews (1992:253)

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