Are there Industrial and Agricultural Convergence Clubs in China?*

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Abstract

This paper discusses the fundaments of growth differentials accros China. Following the trade theories and endogenous growth theory, we suggest that the fundamental differences between regions arise from their resource allocations at the time of reform, whereby the capital abundant regions specialized on industrial production while the labor abundant regions specialized on labor intensive production (agriculture). In China, there are regions with oversupply of agricultural labor rendering that unproductive at margin until it has migrated to non-farming sectors of economy. In this paper, we show that regions with high share of industrial production have converged. Also those agricultural regions that have become more industrialized over the years have been catching up while the others have been left behind.

JEL Classification: O17, O40, O57.

Key Words: Growth, Agriculture, Convergence.

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1 Introduction

In 2008 China celebrated its 30-year anniversary of the reform and opening-up policy. During these years, Chinese economy grew about 8 % per year. According to World Bank estimates the amazing growth has been successful in lifting about 400 million Chinese from poverty. The increasing income has not, however, benefitted all Chinese equally and the income disparity between urban and rural China, has increased. In 1978, the annual (disposable) income per capita was 2.6 times higher for urban than for rural residents while the ratio of urban to rural income increased to 3.3 to 2008.[1] This paper takes a closer look at regional income disparities and the evolution of output during the reform period in particular.

It has been suggested that rural-urban divide may lead to provincial divergence (see Zou et al. 2008). The proponents of this view mark that the sequential reforms proceeded in different pace in rural and urban areas. The early reforms benefitted mostly rural areas, while most of the reforms put forth after 1984 have benefitted only urban regions. Thereby catch-up in income differences halted and began to grow again. While one of the most significant reforms was to introduce some market mechanisms to the agriculture, the ownership of land, however, was not transferred to households but remained with collectives of local officers. This is probably the most important factor which hampers the development of the agricultural sector today.

It is generally acknowledged, one of the drivers of Chinese growth is due to another reform which allows the rural labor force to flow 'freely' between urban and rural areas. As the labor force has shifted from the less productive agriculture to more productive industries, China has been able to increase its overall productivity[2]. According to population statistics, the number of rural laborers was approximately 310 million in 1978 while the number has increased just above 500 millions in 2007. Even though some 200 million of rural workers

[1] The income comparison is somewhat difficult, since no data for disposable income exists for rural areas. The numbers reported are calculated using disposable income for urban and net income for rural residents as in Lu and Song (2006). Using cash income for rural residents, which to my knowledge resemble the disposable income more closely, results in urban to rural ratio of 2.1 in 1985 and 2.4 in 2006, i.e., the income disparity might not be as profound as suggested.

[2] The ongoing migration will mitigate the problem of differentiated development patterns in two ways: first, workforce will flow to the region and to the industry where the productivity is higher and second, the worker remittances sent home will (unofficially) contribute to rural income.

have shifted to non-farming industries, it is estimated that still today the rural labor is still oversupplied by some 100 million (see Han 2009).

The land is among the key factors of production, the others being the labor and capital, both human and machinery, and institutions. The economic theory has been rather silent on land ownership matters, even though disputes on the ownership of land and discontent with land-related institutions have been among the factors in provoking revolutionary movements and social upheavals. One exception is Galor et al. (2008), who draw from the experience of Japan, Russia, South Korea and Taiwan, and propose a model where the high concentration of land ownership adversely affects the emergence of human capital promoting institutions (e.g. public schooling) thereby growth. In brief, the problem is that landowners do not benefit from the education reform as much as the capitalists and workers (due the low degree of complementarity of land and education). Accordingly, a land reform that sufficiently reduces the concentration of land ownership in the economy will expedite the implementation of efficient education policy and promote industrialization.

The trade theories will help to explain the uneven development of regions. Krugman (1981) and Krugman (1991) propose a two-region model whereby an initial discrepancy in capital-labor ratios between the regions will accumulate over time, leading to the division of the 'world' into a capital-rich industrial region (core) and capital-poor, agricultural region (periphery): manufacturing will concentrate in the region that gets a head start. Some evidence on preferential policies suggests this is exactly what has happened in China.

This paper promotes the agricultural-industrial divide as a cause of different growth rates of Chinese provinces after the reform and opening-up policy was initiated in 1978. We propose since the agriculture is in the lower end of productivity, the areas with the high share of agricultural production will grow slower than the areas with the high share of industrial production. We take the initial share of the value of output in agriculture to that of industry as an indicator of industrialization. According to this indicator there is a rough agricultural-industrial divide, that closely, but not fully, resembles the eastern-western divide of the regions.

To estimate the convergence within regions, we utilize the panel unit root tests that have become the standard technique to evaluate these matters. Recently, Pesaran (2007a) has criticized the use of panel unit root tests which do not account for the cross-section dependency (first generation). He proposes the use of the modified IPS test (Im et al.

2003), which accounts for a single factor cross-section dependency (second generation). In this paper, we utilize the possibility to use different generations of these tests, whereby first and second generation panel unit root tests reveal that the evolution of output and the economic growth differ across the regions; the industrialized regions have experienced the convergence of incomes while the agricultural regions have not. We do not find evidence for the convergence of incomes in the whole data.

Contrary to intuition, we find that as an average the agricultural regions have grown faster than those initially industrialized. To evaluate this anomaly, we concentrate on those agricultural regions that have experienced a steeper decline in the share of agriculture and find that these regions on average grow faster than those who lag behind in industrialization. Those initially agricultural regions that have become more industrialized are actually catchin-up those initially industrialized where due historical reasons most of the benefits of the head start might have been used already before the grand reform. The difference in the growth rates between newly industrialized regions and laggards is rather small, one percentage point per annum, yet in thirty years it has created a huge wedge between the average incomes of these regions.

Our findings are in line with empirical growth studies, which find convergence within industrialized countries in OECD (for example Li and Papell, 1999 and Strazicich et al., 2004). With regard to divergence in agriculture, Chen et al. (2008) report similar findings for China. Our results offer support for technological catch-up hypothesis, since industrialized regions seem to exhibit convergence. On the other hand, our results are in line with markedly sceptical findings of Lehmijoki and Pääkkönen (2009), who find that poor countries were left behind due to insufficient demographic transition. Parallel to their results, our findings suggest that regions that are left behind in industrialization might need special government policies to catch-up with those mere industrialized. We conclude, policies that promote industrialization and alleviate the problems of land ownership would help to raise the agricultural productivity and promote the industrialization of those regions that lag behind.

The outline of the paper is as follows. Section 2 debates briefly the rural reform in China and the evidence for provincial convergence in China. Section 3 presents the empirical results of this paper, while Section 4 discusses the findings.

2 Background

2.1 Short introduction to reform in agriculture

The rural reform has had a vast impact on agriculture in China while the reform has not been complete. The usage rights of land were granted to households although the ownership remained with the collectives of local officers.[3] The initial land allocations to families based either on household size or household labor supply, and the contracts were for 15 years. In 1993, the tenure was to be extended for another 30 years upon the expiration of the original term of contract and can today be further extended.

Démurger et al. (2002) provide an extensive survey on geography, preferential economic policy and regional development in China. At first, the sequential economic reforms inaugurated in 1978 benefitted mainly agricultural sector, while the state began to relax the restrictions on export activities, FDI and private enterprises in 1984. From mid 1980's the noncoastal agricultural provinces started lagging behind the more industrialized Manchurian provinces and the coastal agricultural provinces. Besides being geographically disadvantaged, the interior provinces lag behind since they have too much labor in agriculture sectors, have faced stringent regulations on FDI and international trade, and have not had access to capital.

Ho and Spoor (2006) debate the institutional arrangements related to land markets in transition economies, and conclude that private land ownership is not essential for the effective functioning of the rural economy, or for a land market. Other researchers, however, have expressed more critical views. For example, Brandt et al. (2002) cite the extensive research on the agriculture in China and find several arguments for the productivity slowdown of agricultural output. First, the tenure insecurity has discouraged investment in agriculture and lowered growth. Second, the lack of institutions (credit markets, the lack of land registration system and an incomplete legal system) that would make privatization successful has hampered the growth. They find that the possibility to reallocate land was rarely used during the period 1983-1996, since village leaders and the local cadres found the process time consuming and entailing a considerable administrative expense. When the reallocation had actually happened, households were usually not compensated for any investments they had made. Nor had the households rented their land out (less that 3 per

[3] For more details see Han (2009) or Brandt et al. (2002)

cent by 1995). The problem seemed to be that since the households were expected to deliver a quota for the land, in the event of default, the household that was *originally* allocated the land would be held liable for the quota.

Ho and Lin (2003) note that the illegal land use in rural areas seem pervasive and has created opportunities for corruption: clearer land use rights are meaningless if they cannot be enforced. Guo (2001) cite the evidence on land expropriation, whereby the local leaders and the government decide to appropriate the land to establish village administration offices or private business premises. In the process of land takings, the villagers were not normally consulted nor sufficiently compensated. The institutional system in rural regions and in agriculture does not provide enough incentives to invest in agriculture, whereby its productivity is probably sub-optimal.

The growth prospects of the agricultural sector have also been investigated. Cai et al. (2002) investigate the impact of labor market distortions on regional disparity and economic growth in 29 Chinese regions for the first twenty years after reform. They employ a measure of comparative labor productivity in agriculture to that of industry and show that labor market distortions hamper regional growth. In addition, there is conditional growth convergence within China. Evaluating the regions during 1990-2003, Chen et al. (2008) find that technical progress has been the major source of productivity growth in agriculture and that the regional disparities in productivity growth have got worse over time.

2.2 Evidence for economic growth and convergence in China

There is a vast amount of literature on the growth in China. In particular, the sources of the cross-provincial variations of economic growth have been scrutinized. Li et al. (1998) estimate the Solow-Swan growth model for 29 Chinese provinces during 1978 and 1995. Accordingly, lower population growth, greater openness to foreign countries and more investment both in physical and human capital contribute to growth. Moreover, they find a tendency for regional economies to converge. Evaluating a shorter time span, Chen and Feng (2000) find that degree of privatization, access to higher education and international trade lead to an increase in growth, while high fertility, high inflation and the presence of state-owned enterprises reduce the growth rate among the provinces. They also find support for the convergence hypothesis within Chinese regions. More recently, Kuo and

Yang (2008) find evidence for that knowledge capital, international and regional technology spillovers and absorptive ability of a region (human capital) have a positive impact on Chinese regional economic growth.

Zou et al. (2008) measure the effect of different factors contributing to economic growth by counterfactual econometric analysis in 28 Chinese regions from 1981-2004. They find that factors like infrastructure, human capital and urbanization contribute significantly to provincial economic growth and to the provincial divergence in particular. Using the same set of data, Zou and Zhou (2007) classify the Chinese regions to developed and developing club according to the initial technology of a region. They find evidence for convergence at the national level as well as for growth convergence within clubs, a speed of which is higher in developed club. Accordingly, the impact of infrastructure on growth is somewhat paradoxical as it is positively correlated with growth convergence in national level and within the developed club, while being negatively related with growth convergence in the developing club.

Maasoumi and Wang (2008) evaluate the properties (moments) of the distributions of growth rates across provinces. Implementing cluster analysis for 28 regions both pre- and post-reform data, they reject the hypothesis of a nationwide convergence. Instead, they find evidence for small convergence clubs for both periods. Foremost they suggest that the convergence clubs are not characterized by simple features as region or the extent of policy preference level.

There is also some evidence for the cross-section dependency in terms of provincial spill-over effects in sectoral value added. Xu (2002) decomposes provincial sectoral real value-added growth into common national effects, industry-specific effects, and province-specific effects. The data shows that province-specific factors account only for one-third of the variance of real output growth in the short run. The coastal areas seem to follow the business cycle most closely, while the central region follows the national growth cycle partly due to spillover effects from the neighboring coastal region. Other regions manifest even countercyclical patterns. Their findings are confirmed by Brun et al. (2002).

3 Agriculture-industry divide and convergence

3.1 Evidence on conditional convergence

We draw the annual data on Chinese provincial incomes from All China Data Center. We have data on real GDP per capita for 22 provinces, five autonomous regions and four municipalities, for all of which we now on refer as provinces. The data is from 1978 to 2007, i.e., for the first 30 years of the reform.

We use the share of agricultural output to that of industrial as an indicator of the industrialization. We use simple clustering technique to partition the data into two clubs. We mimimize the distance of each observation of a club from the club average, i.e. the sum of squared residuals is minimized as in regression tree analysis originally proposed by Durlauf and Johnson (1995).[4] While this divide is rather simple, it seems to catch the essential differences between the regions (see Appendix A). The first club contains most of the agricultural regions that are located in western and central China (14), while the second club mainly contains coastal and central regions where production is dominated by industrial production (15). The unweighted average real growth per capita has been 7 % in the industrial club while it has been 7.7 % in agricultural club. The differences in the average growth rates between the clubs are remarkably small.

To discover the cross-section dependency in the data, we ran two tests. The first one is the CD-test proposed by Pesaran (2007a)

$$CD = \sqrt{\frac{2T}{N\left(N-1\right)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\gamma}_{ij}\right), \tag{1}$$

where T and N are the number of observations in time and cross-sections, and $\hat{\gamma}_{ij}$ is the residual correlation between countries i and j, these residuals being obtained from individual ADF(p) regression. The test statistic is normally distributed with $N\left(0,1\right)$, but the drawback is that it lacks power when the population average pair-wise correlation tends to zero. Another test, proposed by Breusch and Pagan (1980)

[4] While some authors have used more complex techniques to uncover the number and size of the clubs, we resort the most simple version of the technique, since our research question does not require the use of the more complicated methods.

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\gamma}_{ij}^{2} \tag{2}$$

is based on $\chi^2_{N(N-1)/2}$ distribution. While this test is not adversely affected by the zero averages, it is likely to exhibit substantial size distortions when N is large and T is small.

Table 2 presents the test results for Club 1 (agricultural), Club 2 (industrial) and the whole data. These CD tests for clubs do not find evidence for the cross-section dependency as it is not statistically significant at 5 % level of significance, while it suggests that cross-section dependency is present in the data as whole. Since the test is biased if the average cross-section residual correlation tends to zero, which seems to be the case here, it is probably not fully reliable. The LM-test, however, is significant for all three data sets, indicating that cross-section dependency is present in our data. As we cannot clearly rule out the possibility of the cross-section dependency, we estimate the second generation unit root test and those first generation unit root tests which are known to be the most robust in the presence of the moderate cross-section dependency.[5]

	Club 1	Club 2	Full Sample
$\hat{\gamma}$	-0.01	-0.03	0.02
N	14	15	29
$CD-test$	-0.61	-1.70	1.91
$LM-test$	567.1	593.0	2485.5
$d.f.$	91	105	406

Table 1: Descriptive statistics from Clubs 1–2.

To test for the convergence we estimate the following model:

$$\Delta\left(y_{i,t}-\bar{y}_t\right)=\alpha_i+\rho_i\left(y_{i,t-1}-\bar{y}_{t-1}\right)+\left(u_{i,t}-\bar{u}_t\right), \tag{3}$$

where $\bar{y}=\frac{1}{N}\sum_{i=1}^{N}y_{i,t}$ and $u_{i,t}$ is *iid*. We test the conditional convergence, whereby the unit root test includes a country-specific constant α_i allowing some heterogeneity in the growth model.[6]

[5] For more details see Pesaran (2007) and Lehmijoki and Pääkkönen (2009).

[6] Pesaran's second generation unit root test is based on IPS-test (CIPS, hereafter), whereby the unconditional convergence cannot be tested with it.

Figure 1 in Appendix A presents the evolution of the average log output of Club 1, Club 2 and the Full Sample from 1978 to 2007. While it appears that all these three series are relatively smooth, there might be a break in the data in early 1990's, which may cause the unit root tests not to reject the false hypothesis of a unit root if the break is not accounted for. Unfortunately, this is not possible in panels, but we note that since the tests are applied for the de-meaned data, as suggested by equation (3), de-meaning should mitigate the problem if most of the series within a club exhibit same pattern and experience similar breaks. We use Quandt-Andrews break point test (Andrews, 1993) for individual series and regress the de-meaned output to its first lag, constant and trend. It appears that in 4 cases out of 14 there seems a break present in Club 1, while in Club 2 there seems to be break in 5 out of 15 regions (see Appendix B). We conclude that for most of the series de-meaning mitigates the problem of structural breaks.

Table 2 presents the results from the unit root tests. The results for Club 1 are interesting since none of the unit root tests reject the null of non-stationarity, i.e. the convergence hypothesis does not gain any support. The results for the Club 2 are different, since all the tests support the rejection of non-stationarity. We find evidence for the conditional convergence within industrialized regions. Lastly, for the Full Sample only Choi's inverse normal test suggests that non-stationarity should be rejected, while the other two tests fail to reject the null.[7]

	Club 1		Club 2		Full Sample	
	test	p-value	test	p-value	test	p-value
IPS	0.76	0.79	-1.92	0.03	-1.08	0.14
Choi	31.77	0.28	44.24	0.05	86.58	0.01
CIPS	-1.44	0.89	-2.21	0.04	-1.61	0.78

Table 2: Unit root tests Clubs 1–2 and whole data.

As to the speed of convergence, estimating equation (3) as a pooled fixed effects model,

[7] We also tested for the presence of a unit root allowing the break point by Zivot-Andrews test (Zivot and Andrews, 1992). In the agricultural club, most of the individual series are stationary with the exception of Fujian, Jianxi, Hubei, Hunan and Yunnan. In the industrial club, the non-stationarity is even rarer, since only Hebei, Heilongjiang and Shandong indicate non-statonarity. Most of these regions do not experience the break, thereby the test lacks power. Of those data of Yunnan, Hebei and Heilongjian are stationary when regular ADF-test is used.

gives the average rate of convergence within Club 2. While this evidence is merely suggestive, we find that $\bar{\rho}$ equals -0.032, which is significant at the conventional 5% level of significance. With this speed, the income differences should be cut half from the original in 22 years, which is somewhat faster than typically estimated in cross-section of countries. The faster phase, however, makes sense since there are no such barriers to spill-overs in place within China that one may observe in a cross-section of countries.

To summarize, we find strong evidence for conditional convergence within industrial regions while there is no support for the convergence in agricultural regions or the whole economy. Next we discuss the reasons for non-convergence within agricultural provinces.

3.2 Decline in the value of output in agriculture

While the gross value of output had increased in both sectors from 1978 to 2007, the increase in the value of industrial output has been more dramatic; approximately three times of that of agriculture. Table 3 shows that the share of the agriculture to industry has decreased in all of the provinces in China, the average reduction being 55.3 %. The decline has been more pronounced in agricultural club, 58.4 %, since those regions that were already industrialized in 1978 have not been able to downsize the share of the agriculture as much as those less industrialized.

Dividing the agricultural club to two according to the size of the decline in the share of agriculture, allows us to study whether the different trends in outputs have been caused by different phases and paces in industrialization. Hence, we split Club 1 to those that have downsized the share of agriculture more than the club average (Inner Mongolia, Zhejiang, Anhui, Fujian, Jiangxi, Henan and Hainan) and to those that have downsized the share of agriculture less than the club average (Hubei, Hunan, Guangxi, Sichuan, Yunnan and Xinjiang). The average growth rate in the first group is 8.1 %, in the second group 7.1 % and the club average is7.7 %.[8] While this difference seems small, only 1 percentage point, in thirty years time it creates a wedge in the incomes as the provinces that have grown faster are now on average 10.3 times richer than in 1978, while those that have grown slower are now only 7.8 times richer than in 1978. We take this as an indication that industrialization

[8] Or to put it other way around, if we concentrate on those agricultural regions that have experienced higher than average growth rates, we find that they have downsized the agriculture more than others in that club.

indeed promotes catch-up.

4 Conclusions

The 1978 economic reform has turned out to be a great success and benefitted hundreds of millions of Chinese. Yet, despite the remarkable growth income disparities have increased as not all Chinese have benefitted equally.

In this paper, we find that initially industrialized regions have experienced the convergence of incomes while we find no evidence for convergence of incomes either within agricultural regions or in the national level. Among our findings is that some agricultural regions have leaped forward as the share of agricultural production has decreased and regions have become more industrialized. As has been well documented, in many of these regions the excess rural labor has migrated to the industrial sector, which has increased the total regional productivity. Some of these newly industrialized regions have grown faster than those initially industrialized, as most of the benefits of the head start might have been used already before the grand reform. The latter leap strengthens the finding that a catch-up is due to industrialization.

For those agricultural regions, which have experienced slower growth, there are some remedies we propose. Above all is that the government should solve the institutional shortcomings, as institutions should help to promote the productivity of these regions by increasing the possibilities and incentives to invest on land and education. We believe the government is on the right track in promoting the migration from agriculture to more productive sectors and regions.

A Clubs

Table 3 describes that data for 29 regions in the sample. Club 1 is the agricultural while Club 2 is the industrial club. The industrial production has increased its importance in Chinese production structure and all the regions have become more industrialized trough the increase of the industrial value added. Growth rates are real growth per capita averages from 1978 to 2007.

Club 1				Club 2			
	Share of agriculture (%)		Growth		Share of agriculture (%)		Growth
Region	1978	2007	78-07	Region	1978	2007	78-07
I. Mongolia	53.5	22.0	10.1	Beijing	12.9	2.8	7.8
Zhejiang	49.7	4.4	8.7	Tianjin	4.3	2.4	6.0
Anhui	66.4	26.1	6.4	Hebei	34.6	18.0	9.0
Fujian	57.5	13.5	10.5	Shanxi	14.5	6.4	8.4
Jiangxi	67.0	23.0	8.2	Liaoning	13.3	11.7	5.5
Henan	55.8	19.0	10.1	Jilin	33.5	21.0	6.2
Hubei	50.5	23.9	8.3	Heilongjiang	28.7	27.7	6.8
Hunan	57.0	31.3	7.9	Shanghai	3.6	1.1	4.1
Guangxi	66.0	44.2	6.3	Jiangsu	31.3	5.7	10.0
Hainan	133.3	54.7	5.3	Shandong	34.4	9.6	8.6
Sichuan	60.7	30.6	5.8	Guangdong	41.6	5.1	7.7
Guizhou	66.6	27.7	5.5	Shaanxi	37.6	17.6	8.2
Yunnan	72.2	31.0	5.9	Gansu	29.0	21.2	4.6
Xinjiang	56.4	32.3	8.4	Ningxia	34.7	14.8	5.5
				Qinghai	44.1	17.1	6.6
Average growth			7.7%	Average growth			7.0%

Table 3: Clubs, their shares of the value of agricultural output to that of industrial 1978 and 2007, and economic growth

Figure 1 illustrates the average log output performance in both clubs and in the full sample. It appears, that all averages move in tandem, whereby the income differences between the clubs has not decreased. Also, the regions seem to share a common break(s)

in early 1990's.

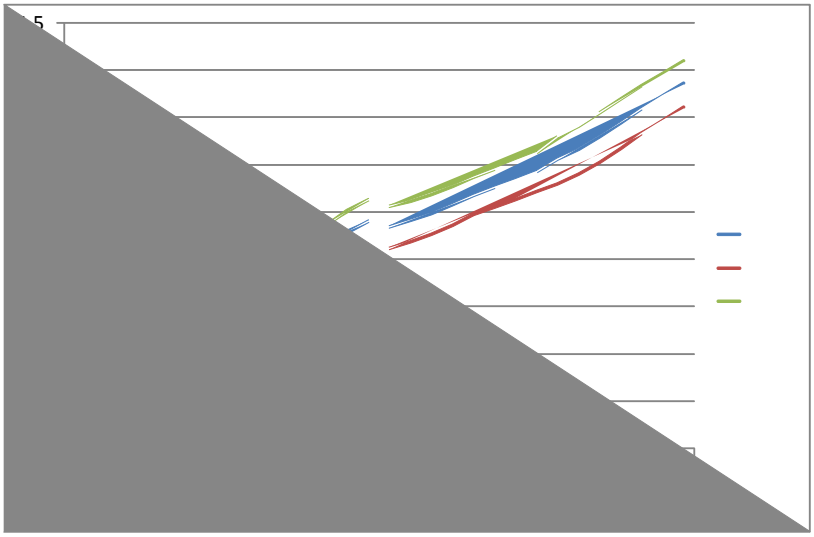

Figure 1: The average evolution of the outputs in Club 1, Club 2 and Whole data.

B Break points, unit roots, and speed of convergence

Table 4 presents the results from Quandt-Andrews break point test in the presence and absence of trends and Zivot-Andrews unit root tests for individual series. For the sake of simplicity, in case of break point tests we report only whether the test statistic is statisically significant or not. Also for the unit root tests, we only report whether we can reject the null of unit root or not.

Club 1				Club 2			
	break point test		individual		break point test		individual
Region	no trend	trend	unit root	Region	no trend	trend	unit root
I. Mongolia	5%	n.s.	reject	Beijing	n.s.	5%	reject
Zhejiang	n.s.	n.s.	reject	Tianjin	n.s.	1%	reject
Anhui	n.s.	1%	reject	Hebei	n.s.	n.s.	not reject
Fujian	5%	n.s.	not reject	Shanxi	n.s.	n.s.	reject
Jiangxi	n.s.	n.s.	not reject	Liaoning	1%	n.s.	reject
Henan	n.s.	n.s.	reject	Jilin	1%	1%	reject
Hubei	n.s.	n.s.	not reject	Heilongjiang	n.s.	n.s.	not reject
Hunan	5%	n.s.	reject	Shanghai	1%	5%	reject
Guangxi	1%	n.s.	reject	Jiangsu	n.s.	n.s.	reject
Hainan	1%	1%	reject	Shandong	n.s.	n.s.	not reject
Sichuan	1%	1%	reject	Guangdong	5%	n.s.	reject
Guizhou	1%	1%	reject	Shaanxi	n.s.	n.s.	reject
Yunnan	n.s.	n.s.	not reject	Gansu	5%	1%	reject
Xinjiang	n.s.	n.s.	reject	Ningxia	1%	n.s.	reject
				Qinghai	n.s.	n.s.	reject

Table 4: Results from the break point tests and individual unit root tests when break points are allowed

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