Convergence among Chinese provinces revisited

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China’s sustained exceptionally high GDP growth rates during the last 20 years have sparked interest in the economy of the most-populous country on earth. However, this seemingly positive growth performance masks an enormous amount of heterogeneity. Coastal provinces enjoy much higher GDP per capita levels than western provinces do. The aim of this study is to analyze whether there is a tendency of poorer provinces to catch up with their richer neighbors. This question is examined by the application of the convergence testing approach by Phillips and Sul (2007). Starting from 1988, the hypothesis of nation-wide convergence is clearly rejected. Instead, five convergence clubs and one divergent province are detected. It is a robust finding that provinces group into clubs according to their GDP per capita level in 2010. The convergence test yields an endogenous clustering of provinces into convergence clubs which more or less corresponds to a regional clustering. This lends credence to the usual exogenous regional clustering. However, such a regional clustering is masking a considerable amount of heterogeneity as different regions accommodate provinces belonging to different convergence clubs. These results give rise to some pessimism concerning the catching up of poorer provinces to richer ones. Rather, it seems that poor and rich provinces are moving along different growth trajectories which will not lead to an harmonization of GDP per capita levels.
1 Introduction

Given its 1.34 billion inhabitants, the Chinese economy accommodates nearly 20% of world population. Thus, developments and trends within the Chinese economy are eminently important from a global welfare perspective. And although China is still a very poor country from the viewpoint of developed countries, exceptionally high growth rates of GDP per capita in the aftermath of economic reforms since 1978 have attracted much attention and gave rise to the perception of China as an upcoming world economic power. However, there is strong heterogeneity among the different Chinese provinces. It is generally hold that mainly coastal provinces generate GDP per capita growth and become wealthier while inland provinces remain poor agrarian areas. Given the current state of affairs, is there any hope that these disparities among provinces will be abolished within the course of Chinese economic development? Although it was intended to “let some people get rich first”, as Deng Xiaoping put it (quoted in Andersson et al. 2012), inequality among provinces have become a major concern for Chinese policymakers. Consequently, one of the main objectives in the Eleventh Five-Year Plan (2006-2010) was the reduction of regional disparities. On that score, it may be interesting whether there is a tendency of dosing the GDP per capita gap among provinces. Have the different provinces been set on the same path of economic development or are there structural difference in the behavior of growth in GDP per capita? From an economic point of view such considerations may be fruitfully analyzed by asking: Is there any nation-wide growth convergence among Chinese provinces? If not, are there any groups of countries exhibiting growth convergence? Which are the members of these “convergence clubs”?

There is a vast literature on growth convergence among Chinese provinces. Sakamoto and Islam (2005) use a distributional approach to study convergence and employ Markov transition matrix methodology to find that the distribution of income per capita across provinces has become bi-modal over the period of 1952 to 2003. Splitting the panel into two subperiods by exogenously taking 1978 to be a breakpoint, they find that the distribution of GDP per capita is likely to become more negatively skewed if dynamics of the post-reform period (1978-2003) continue to hold which would be encouraging from the point of view of convergence. Massoumi and Wang (2008), using a metric entropy measure, find that there is no nation-wide convergence, but small convergence clubs for both the pre- and post-reform period. They exogenously choose 1978 to be a breakpoint. They further find that there is a greater extent of convergence during the post-reform period than during the pre-reform period as they find fewer clubs for the post-reform period. In addition, they point out that the different convergence clubs cannot be characterized by features such as geographical region. However, their approach leads to some implausible clustering of regions into convergence clubs where it remains unclear which economic factors tie the different clubs together. Andersson et al. (2012) find two convergence clubs: coastal provinces as leaders and other provinces as followers. Matsuki and Usami (2008) consider multiple structural breaks in the provincial level data and try to determine convergence within exogenous clustered groups of provinces. They distinguish between Eastern, Central and Western regions and find convergence within each group.
Li and Daly (2005) reject nation-wide convergence for both pre- and post-reform. However, they find convergence within two of the three exogenously clustered geographical regions. Pedroni and Yao (2006) find that provincial income levels tended to diverge after the reforms in 1978. They dismiss the hypothesis that this lack of nation-wide divergence is due to the presence of regional convergence clubs.

This paper presents a novel approach to study convergence among Chinese provinces by using the convergence testing procedure presented in Phillips and Sul (2007). They model the structure of the panel as a “non-linear, time-varying coefficients factor model” which allows various potential paths towards convergence and individual heterogeneity. Exploring this panel data model, Phillips and Sul develop a simple regression based convergence test which they call log t test and whose asymptotic properties are well-defined. Further, they propose a new method for determining convergence clubs based on a simple clustering algorithm. Clustering then happens endogenously which is more powerful than the usual exogenous clustering.

In the last few years, the convergence testing approach by Phillips and Sul (2007) has been used for analyzing several questions of convergence. Fritsch and Kuzin (2011) analyze convergence in European price level, unit labour cost, income and productivity data over the period of 1960 to 2006 using the test procedure by Phillips and Sul. Rughoo and Sarantis (2012) use the log t test to investigate the integration process in the European Union retail banking sector during the period 1995 to 2008. Apergis et al. (2012) examine convergence in the European Insurance Sector. Caporale et al. (2009) test for convergence in stock returns for five EU countries. More related to the subject of this paper, Bartkowska and Riedl (2012) identify convergence clubs in per capita incomes of European regions by using the clustering algorithm presented in Phillips and Sul (2007). Mapa et al. (2011) apply the log t test in order to determine if Philippine regional economies converge.

In the literature, it is common to divide Chinese data into two subperiods, one ranging from 1949 to 1977 and the other one from 1978 to present. The reason for this is that the Chinese economy underwent some enormous structural changes in the post-Mao period starting with economic reforms in 1978 which are associated with the name of Deng Xiaoping. Starting convergence testing from the 1950s, thus, does not seem convincing. However, it may not be the best idea to simply select 1978 as the breakpoint date separating two subperiods. Economic reforms triggered in 1978 take some time to work their way through the economy. Instead of exogenously choosing 1978 as a breakpoint and analyzing the time period from 1978 to 2010, I use a formal breakpoint analysis to find that for most Chinese provinces there is a structural break in the estimated AR model between 1987 and 1989. Hence, I choose to run the convergence testing procedure beginning in 1988.

Using the clustering mechanism proposed by Phillips and Sul (2007), five convergence clubs and one diverging province are identified. It is a robust finding that provinces cluster in accordance with their GDP per capita levels in 2010. The different clubs broadly
correspond to geographical regions and are thus, in accordance with usual exogenous clustering according to geography.

The rest of the paper is organized as follows. Section 2 gives a short description of the data and its filtering and describes the procedure of determining the start date for the convergence test. Section 3 offers some descriptive statistics with focus of interprovincial disparities. The empirical approach and its methodology is presented in Section 4. Section 5 explains the main findings of this study on convergence among Chinese provinces. Section 6 concludes.

2 Data

People’s Republic of China consists of 23 provinces, five autonomous regions and four Centrally Administered Municipalities (see figure 1). In this paper, all these administrative regions are labeled as “provinces”. For Tibet and Hainan, data prior to 1987 is missing so that these two provinces are excluded from the sample. In addition, Chongqing became a new Municipality in 1997 and is also excluded from the sample. Thus, the final sample consists of 28 provinces.

Obtaining reliable data even on key Chinese economic indicators is a delicate thing as the historical statistical record does not fulfill Western standards (see Pedroni and Yao 2006). This paper uses data on GDP growth from Hsueh and Li (1999). It seems that

\footnote{source: http://www.xhes.com/v1024/mapsofchina.htm}
this data set is the most trustworthy one. Pedroni and Yao (2006) hold that “they [Hsueh and Li] have published the most complete set of Chinese national income”. The variable of interest in this study is annual real GDP per capita. No such variable is included in Hsueh and Li (2009). In order to construct it, I use data on the GDP growth rate at comparable prices ranging from 1952 to 1995 from Hsueh and Li (1999). From 1996 on, the statistical record on GDP growth rate at comparable prices from the Chinese Statistical Yearbooks is used. Population growth rates also come from the Chinese Statistical Yearbooks. These two variables, GDP per capita at comparable prices and population growth rates, are then combined to obtain real GDP per capita levels and growth rates.

In order to perform the regression based convergence test proposed by Phillips and Sul (2007), it is preferable to work with filtered data so that the long run growth components are separated from short term fluctuations. In this paper, the Hodrick-Prescott filter is used to do so. However, the HP-filter comes with its boundary value problem. In order to avoid such a problem, I perform five-year forecasts of GDP per capita growth based on an AR-model estimation for each province. The individual lag lengths for the AR models are chosen in accordance with the Bayes Information Criterion. Then the HP-filter is applied to the whole time series and afterwards, the forecasts are abandoned.

When investigating the time series of GDP per capita for the different provinces with respect to potential structural breaks, the R package strucchange by Zeileis et al. (2012) is used. The breakpoint test is basically a QLR test which is applied to the time series of GDP per capita growth rates. For 22 provinces, the breakpoint is either in 1988 or in 1989. The earliest break occurs in 1980 in Tianjin. The latest breakdate is 1989. The median breakpoint lies in 1988 which is the reason for why this year is chosen to be the starting point for the convergence testing. In addition, there is an event in the chronology of Chinese economic history lending credence to the importance of 1988 as breakdate. In 1988, the Chinese constitution is amended by an article which permits private firms to operate as a complement to the socialist economy (Jaggi et al. 1996). There were reforms prior to this amendment, but this legal act formally constituted what became known as the Chinese “dual track” economy. It is interesting to observe how both legal acts and economic time series lag behind the economic reality. In 1988, economic reality became manifest in both the constitution and the time series for GDP per capita.

The log t test of Phillips and Sul (2007) is then applied to provincial filtered real GDP per capita levels from 1988 to 2010.

3 Descriptive Statistics

In recent times, media marvels at Chinese GDP growth rates which have been among the highest in the world. As figure 2 illustrates, average growth in real GDP per capita

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2[http://www.stats.gov.cn/english/statisticaldata/yearlydata/]

3As a reference point, real GDP per capita from 2010 is used. Having this number at hand, it is possible to reconstruct a time series of real GDP per capita from 1952 to 2010

4HP filtered data
from 2000 to 2010 on a nationwide level was about 11 % per year.

Figure 2: real GDP per capita growth in China

There was considerable less growth in real GDP per capita during the 1960s and 1970s. Under the leadership of Mao Zedong (1949-1976), China underwent some tumultuous times, including devastating projects like the “Great Leap Forward” from 1958 to 1960 or the Cultural Revolution from 1966 to 1969 both causing economic turbulence and low growth performance in the 1960s. Nevertheless, even under Mao’s command, the Chinese economy witnessed significant increases in real GDP per capita. Yet, the transition to an epoch of sustained growth rates above 8 % per year did not happen until 1978 when the first economic reforms were established transforming China slowly into a partly market based economy (‘dual track economy’, cf. Jaggi et al. 1996). As also shown in figure 3, the Chinese economy took off to an era of sustained growth in the midst 1980s, leading to increasing GDP per capita levels in all provinces.

Figure 3: provincial GDP per capita

This impressive growth record masks a great deal of heterogeneity among different Chinese provinces, though. In 2010, the richest Chinese province (Shanghai) was about 12 times richer than the poorest one (Gansu). This is a remarkable gap whose size is far beyond what is observed in other developing countries.
While there was also some widening of the gap between the richest province and the poorest province prior to the onset of economic reforms, this gap became increasingly larger during the post-reform era. Figure 4 depicts the evolution of the minimum, maximum and median of provincial GDP per capita levels. The figure clearly shows the widening of the income gap between the richest and the poorest province starting in the 1980s.

A similar picture emerges when investigating the Gini coefficient for inequality of GDP per capita distribution among Chinese provinces (figure 5). There was a sharp increase in inequality during the 1960s and early 1970s, followed by a soft decrease during the 1980s. In the 1990s, inequality among provinces rose again up to the middle of 2000s where a relatively sharp decrease set in. This decline was a politically forced one as reducing income gaps between provinces was one of the main objectives in the Eleventh Five-Year Plan (2006-2010).

Table 1 gives an overview over position of each province in a ranking based on GDP per capita for 1958, 1978 and 2008. In terms of real GDP per capita in 2008, Shanghai is the richest province of China. Beijing and Tianjin enjoy similarly high GDP per capita levels. These three provinces used to be the richest ones also back in 1958 and 1978. Gansu and Shanxi always were and currently are the poorest provinces. Comparing 1958
to 2008 a remarkable ascent within the ranking was done by Jiangsu and Zhejiang which is mirrored in a gradual descent of Hunan, Heilongjiang and Xinjiang.

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Table 1: relative success of each province

With respect to convergence, figure 6 may be instructive. It shows the evolution of inter-provincial standard deviation in GDP per capita levels and growth. The concept of \( \sigma \)-convergence, with \( \sigma \) denoting the standard deviation of cross-sectional GDP per capita level or growth rate, implies a reduction in the dispersion of GDP per capita (see Islam 2003). The dispersion of GDP per capita levels has strictly increased during the last decades, whereas the dispersion of growth rates in GDP per capita, starting from a very high level in the late 1960s, declined in the last 40 years. Thus, there is absolutely no evidence in favour of \( \sigma \)-convergence in terms of GDP per capita levels. The evolution of dispersion of GDP per capita growth rates is more promising from the viewpoint of \( \sigma \)-convergence.\(^5\)

... old trails

The concepts of \( \sigma \)- and of \( \beta \)-convergence were the main workhorses of convergence testing over the last 50 years (see Islam 2003). Based on the seminal work by Solow (1957), the convergence hypothesis came to the fore of the literature on economic growth. A basic prediction of the Solow growth model is that poorer countries will have higher growth rates in GDP per capita as diminishing marginal returns to capital imply that there is a higher marginal productivity of capital in capital-poor countries. As a result, there should be a negative correlation between the initial income level and subsequent growth rates (ceteris paribus). In growth regressions, the parameter in front of the initial income variable typically was labeled \( \beta \), which gave rise to the notion of \( \beta \)-convergence. However, this approach to convergence testing has several problems. Allowing for conditional convergence, meaning that countries converge to different steady states, raises the

\(^5\)And indeed, conducting the log t test of convergence on growth rates of GDP per capita yields a nation-wide convergence. However, this result is not meaningful from the viewpoint of poorer provinces catching up to richer provinces.
need to include controlling variables in the regression. It might be the case that some of these right hand side variables are endogenous and thus, cause an endogeneity bias. In addition, potential omitted variable problems may arise in such growth regression rendering the approach quite fragile.

Cointegration analysis turned out to be a pathbreaking way of looking at time series and converging behavior. Long run equilibrium relationships between two variables are normally thought of being econometrically represented in cointegration (see Dolado et al. 2007). In the simplest case, two time series $X_{it}$ and $X_{jt}$ are cointegrated if their difference $X_{it} - X_{jt}$ is stationary. This indicates comovement or convergence between the two series. In terms of convergence, the goal then is to check whether GDP per capita series of different countries or provinces are cointegrated. However, cointegration analysis does in general not allow for transitional divergence which is featured in the approach by Phillips and Sul (2007) as I will show in the next section.

4 Methodology

Convergence Testing: the log t test

This paper employs the nonlinear time varying factor model proposed by Phillips and Sul (2007) in order to analyze convergence among Chinese provinces. Phillips and Sul (PS henceforth) start by decomposing panel data $X_{it}$ (in this paper: real GDP per capita) as

$$X_{it} = g_{it} + a_{it}$$  (1)

where $g_{it}$ represents a systematic component giving rise to cross sectional dependence, and $a_{it}$ represents a transitory component. There is no assumption on any particular parametric specification for $g_{it}$ and $a_{it}$ which makes the approach quite general and flexible. In a next step, PS separate common from idiosyncratic components by the following transformation:
\[ X_{it} = \left( \frac{g_{it} + a_{it}}{\mu_t} \right) \mu_t = \delta_{it}\mu_t \text{ for all } i \text{ and } t \] (2)

\( \mu_t \) represents a single component and \( \delta_{it} \) is a time varying idiosyncratic element (factor loadings coefficient). \( \mu_t \) may be interpreted as a common trend, whereas \( \delta_{it} \) measures the relative share in \( \mu_t \) of individual \( i \) at time \( t \). As such, \( \delta_{it} \) is a measure of individual distance between the common trend component \( \mu_t \) and \( X_{it} \). This time varying factor model allows for a new way of thinking about convergence. The usage of common stochastic trends (\( \mu_t \)) captures long run comovement in aggregate behavior without demanding the existence of cointegration and allows for modelling transitional dynamics. Idiosyncratic factor loadings \( \delta_{it} \) feature mechanisms for heterogenous behavior across individuals. Convergence is defined in terms of the ratio of two time series \( X_{it} \) and \( X_{jt} \). Convergence exists if

\[ \lim_{k \to \infty} \frac{X_{it+k}}{X_{jt+k}} = 1 \text{ for all } i \text{ and } j \] (3)

The advantage of this approach compared to standard cointegration analysis becomes obvious here. Assume that the two time series \( X_{it} \) and \( X_{jt} \) are not cointegrated. This is the case if \( X_{it} - X_{jt} = (\delta_{it} - \delta_{jt})\mu_t \) is unit root nonstationary and \( \delta_{it} \not= \delta_{jt} \). However, \( \delta_{it} \) and \( \delta_{jt} \) converge to some common \( \delta \) as \( t \to \infty \) so that one could argue that \( X_{it} \) and \( X_{jt} \) are asymptotically cointegrated. If the speed of divergence of \( \mu \) is faster than the speed of convergence of \( \delta_{it} \), then the residual \( (\delta_{it} - \delta_{jt})\mu_t \) may still have nonstationary characteristics and standard cointegration test will have problems to detect the asymptotic comovement. In this sense, the test by Phillips and Sul (2007) has more power than standard cointegration analysis.

It is possible to rescale the common factor \( \mu_t \) to give the relative loading coefficient which is of great importance in the approach of PS and the following convergence test. The relative loading coefficient \( h_{it} \) is defined as

\[ h_{it} = \frac{X_{it}}{\sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}}{\sum_{i=1}^{N} \delta_{it}} \text{ for all } i \text{ and } t \] (4)

\( h_{it} \) then measures the loading coefficient \( \delta_{it} \) in relation to the panel average at time \( t \). It may be called “transition coefficient” as it simulates the transition path for province \( i \) relative to the “average province”. The cross sectional mean of \( h_{it} \) is 1 by construction. In addition, if the factor loading coefficients \( \delta_{it} \) converge to \( \delta \), the relative transition coefficients \( h_{it} \) converge to 1. Finally, the long run cross sectional variance of \( h_{it} \) converges to zero if there is convergence:

\[ \sigma_t^2 = \frac{1}{N} (h_{it} - 1)^2 \to 0 \text{ as } t \to \infty \] (5)

PS assume a certain form for the loading coefficients \( \delta_{it} \):

\[ \delta_{it} = \delta_i + \sigma_{it} \xi_{it} \text{ with } \sigma_{it} = \frac{\sigma_i}{L(t)^{\alpha}} \] (6)
where the different components satisfy certain regularity conditions. From (6) it becomes obvious that when $\delta_i = \delta$ for all $i$, then the null hypothesis of convergence amounts to the weak inequality $\alpha \geq 0$. The conditions for convergence are

$$p \lim_{k \to \infty} \delta_{i+k} = \delta \iff \delta = \delta \quad \text{and} \quad \alpha \geq 0 \quad (7)$$

$$p \lim_{k \to \infty} \delta_{i+k} \neq \delta \iff \delta \neq \delta \quad \text{or} \quad \alpha < 0 \quad (8)$$

So there is the possibility of local convergence to multiple equilibria in case of divergence with $\delta_i \neq \delta$ and $\alpha \geq 0$.

Based on these considerations, PS construct a regression based convergence test. The null hypothesis of convergence is

$$H_0 : \quad \delta_i = \delta \quad \text{and} \quad \alpha \geq 0$$

which is tested against the alternative

$$H_1 : \quad \delta_i \neq \delta \quad \text{for all} \quad i \quad \text{or} \quad \alpha < 0$$

The test proceeds in three steps. First, the cross sectional variance ratio $H_t$ is constructed where (see (5))

$$H_t = \frac{1}{N} \sum_{i=1}^{N} (h_{it} - 1)^2 \quad \text{with} \quad h_{it} = \frac{X_{it}}{N^{-1} \sum_{i=1}^{N} X_{it}}. \quad (9)$$

In a second step, the robust t statistics $t_{\hat{b}}$ for the coefficient $\hat{b}$ from the following regression is computed:

$$\log \left( \frac{H_t}{H_1} \right) - 2\log L(t) = \hat{a} + \hat{\beta} \log t + \hat{u}_t \quad (10)$$

PS suggest using $L(t) = \log(t + 1)$ as a slow varying function. The fitted coefficient of $\log t$ then is $\hat{\beta} = 2\hat{a}$ where $\hat{a}$ is the estimate of $\alpha$ in $H_0$. Finally, a simple one-sided t test of the inequality $\alpha \geq 0$ in the null hypothesis is applied using $\hat{b}$ and HAC (autocorrelation and heteroskedasticity robust) error. Note that under convergence, $h_{it} \to 1$ and $H_t \to 0$ as $t \to \infty$ for given $N$. As PS show in their paper, this test, which they call the log t test, has well defined asymptotic properties.

**Determining Convergence Clubs: clustering algorithm**

As PS point out, rejection of the null hypothesis does not necessarily mean that there is no evidence in favor of convergence among subgroups of the panel. They develop an empirical clustering algorithm which avoids any exogenous clustering scheme. Whereas it is quite common in the literature on convergence among Chinese provinces to work with exogenously clustered subgroups, the approach by PS allows for an empirical clustering.

The clustering algorithm consists of four steps.
In a first step, the individual provinces in the panel are ordered according to the last observation in descending order. Next, the first \( k \) provinces with the highest GDP per capita are selected to form a subgroup \( G_k \) for some \( N > k \geq 2 \). The log \( t \) regression is run and the test statistic \( t_k = t(G_k) \) is calculated for this subgroup. The core group size \( k^* \) is obtained by maximizing \( t_k \) over \( k \) according to the criterion

\[
k^* = \arg \max_k \{t_k\} \text{ s.t. } \min \{t_k\} > -1.65
\]  

(11)

Third, one province out of the complementary set to the core group \( G_{k^*} \) is added to the \( k^* \) core members. Then the log \( t \) test is run again and the \( t \) statistic from this regression is denoted as \( \hat{t} \). The additional province is included to the convergence club if \( \hat{t} > c \) where \( c \) is some previously chosen critical value. This procedure is repeated till the first converging subgroup is found. In the last step, a subgroup of provinces is formed for which \( \hat{t} < c \). Then the log \( t \) test is run to check whether \( \hat{t}_k > -1.65 \). If so, there exist two converge clusters. If not, steps 1 to 3 are repeated on this subgroup. This routine allows the detection of an arbitrarily high number of converging subgroups.

5 Empirical Results

The log \( t \) test and the corresponding clustering mechanism proposed by Phillips and Sul (2007) is implemented on MATLAB\(^6\). The relative transition parameters \( h_{it} \) are of fundamental importance to the notion of convergence. If these parameters converge to 1, the log \( t \) test would deliver the convergence result. The various relative transition curves for the 28 provinces are depicted in figure 7.

![Relative transition curves](image)

**Figure 7: Relative transition curves**

Values of \( h_{it} \) above 1 mean that a province performs above the “average province”, values below 1 imply that a province performs worse than the “average province”. On a

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\(^6\)I am indebted to Monika Bartkowska who provided me with the MATLAB code for implementing the testing procedure.
The descriptive level, a contraction of the different relative transition curves would indicate overall convergence among provinces. And indeed, testing for the whole time period from 1954 to 2010 yields nation-wide convergence. However, such a convergence test is spurious since there were substantial changes in the structure of the Chinese economy giving rise to structural breaks within the time series of real GDP per capita. Testing for structural breaks hints at 1988 being the breakdate for the “average province's” time series of GDP per capita. Thus, it makes sense to start the convergence test in 1988. Doing so, the hypothesis of nation-wide convergence is rejected (t statistic of -6.83). Instead, five convergence clubs and one diverging province is found. The clubs are shown in table 2.

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Table 2: Convergence Clubs (Test starting in 1988)

The position of each province in the GDP per capita ranking in 2010 is indicated in parentheses. The currently richest province in the sample, Shanghai, is diverging, i.e. belongs to no convergence club. The five convergence clubs are composed of provinces in accordance to the GDP per capita ranking in 2010. The richest ten provinces following Shanghai form the first convergence club. The next seven richest provinces constitute the second convergence club. The next three richest provinces form the third convergence clubs. The last two convergence clubs are composed of the poorest Chinese provinces. From the viewpoint of convergence, this result is disappointing. Not only that there is no evidence for nation-wide convergence, but there is also no evidence in favor of partial convergence between poor and rich provinces. In contrast, currently rich provinces form their own convergence club (Club 1), middle income provinces form two clubs (Club 2 and Club 3), and currently poor provinces constitute two clubs (Club 4 and Club 5). Such a convergence behavior works at consolidating existing GDP per capita differences. Figure 8 plots the relative transition curves for the various convergence clubs.
These results are robust to changes in the starting date for convergence testing within a reasonable range. It makes no qualitative difference whether the convergence test is started in 1988 or between 1985 and 1987. In any case, four convergence clubs and one diverging province are found. The diverging province is Shanghai again, and the four convergence clubs are still composed of provinces primarily according to GDP per capita levels in 2010. Only the province of Sichuan switches into a convergence club of richer provinces.

It is common in the literature to investigate Chinese GDP per capita time series from 1978 onwards where the first economic reforms were announced and implemented. As mentioned earlier, it is, however, not plausible that the mere announcement of economic reforms triggers a structural break within the Chinese economy. Rather, it will take some time until reforms exert their influence. The conducted break test finds that this is the case for most of the provinces in the years 1988 and 1989 which is the reason for why the convergence test runs from 1988 to 2010. However, in order to make the innovative approach by Phillips and Sul (2007) and its application to Chinese provinces comparable to previous studies, the convergence testing procedure is also applied starting in 1978. The resulting clubs are listed in table 3. Three convergence clubs are detected. And again, these clubs are strictly composed by provinces ordered by GDP per capita levels in 2010. The first club comprises the 21 richest provinces, while the third club consists of the five poorest provinces. With regard to interprovincial disparities, this result is ambiguous. On the one hand, the first convergence club comprises 21 provinces which seem to be on the same growth trajectory as richer provinces. So one might expect to observe declining disparities between these provinces in the future. On the other hand, the remaining seven provinces cluster into two convergence clubs which do not seem to be on the same growth trajectory. It is doubtful whether these provinces will catch up to the provinces in the first convergence club. Taking these results seriously, China might end up with a big cluster of quite wealthy provinces (Club 1) and a smaller cluster of poor provinces (Club 2 and Club 3).
Comparing the convergence test starting in 1978 and 1988, it is evident that the results do not differ qualitatively. In both cases, provinces disperse into different convergence clubs according to their GDP per capita levels in 2010. Starting from 1978, there are fewer clubs. In any case, there is no nation-wide convergence and it seems unlikely that disparities among provinces will close given the current state of affairs. Of course, the Chinese administration may put effort into elevating poorer provinces into “better” convergence clubs. And indeed, this is what happens in reality as the decline of inter-provincial disparities was one the main goals in the Eleventh Five Year Plan (2006-2010). The mission is not accomplished, though.

It is conventional in the literature on Chinese convergence to exogenously cluster provinces into Western, Eastern and Central provinces. For example, Matsuki and Usami (2008) employ an exogenous geographical clustering which is shown in table 4 (number in parentheses indicates convergence club membership when testing from 1988 onwards).

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Table 3: Convergence Clubs (Test starting in 1978)
Table 4: Exogenous geographical clustering in Matsuki and Usami (Sichuan missing)

Comparing this exogenous geographical clustering with the endogenous clusters derived from the convergence testing procedure of Phillips and Sul (2007), it is apparent that the non-divergent provinces of the “Eastern region” all belong (with the exception of Hebei) to the first convergence club. Thus, they converge in GDP per capita levels. The provinces of the “Central region” disperse into the second and third convergence club. The province of Inner Mongolia is converging within the club of the Eastern provinces. The “Western region” provinces are comprised by the fourth and fifth convergence club. Only the province of Guangxi made it into the third convergence club. Overall, the geographical clustering more or less corresponds to the endogenous clustering in this paper. With some deviations, Eastern provinces cluster into Club 1, Central regions into Club 2 and Club 3, and Western provinces are part of Club 4 and Club 5. Thus, the usual exogenous geographical clustering is supported by the findings of this paper. However, the standard approach to check for convergence among these three regions is revealed as being too superficial. There are not three (regional) convergence clubs, but five convergence clubs. Consequently, regional clustering masks some heterogeneity among provinces as different regions typically accommodate members of more than one convergence club. For example, it is true that provinces in the Western region are on a worse growth trajectory than richer provinces. However, there are two convergence clubs within this region so that this region does not follow a single growth trajectory.

6 Conclusion

China’s sustained exceptionally high GDP growth rates during the last 20 years have sparked interest in the economy of the most-populous country on earth. However, this seemingly positive growth performance masks an enormous amount of heterogeneity. Coastal provinces enjoy much higher GDP per capita levels than western provinces do. The aim of this study was to analyze whether there is a tendency of poorer provinces to catch up with their richer neighbors. This question was examined by the application of the convergence testing approach by Phillips and Sul (2007) which was already used in other fields of economic research. This approach is a very flexible one not relying on
stationarity of the time series to be analyzed. Further, transitory divergence paths are possible allowing for heterogeneity in the panel.

When conducting the convergence test, the starting date to be chosen is based on a breakpoint analysis performed on the GDP per capita time series for the different provinces. QLR testing detects 1988 as the median breaking date. Starting from 1988, the hypothesis of nation-wide convergence is clearly rejected. Instead, five convergence clubs and one divergent province are detected. The resulting number of convergence clubs change from five to four if the starting date for the convergence test is altered by up to four years. However, it is a robust finding that provinces group into clubs according to their GDP per capita level in 2010. The convergence test yields an endogenous clustering of provinces into convergence clubs which more or less corresponds to a regional clustering. Such a regional clustering is masking a considerable amount of heterogeneity, though, as different regions accommodate provinces belonging to different convergence clubs.

These results give rise to some pessimism concerning the catching up of poorer provinces to richer ones. Rather, it seems that poor and rich provinces are moving along different growth trajectories which will not lead to an harmonization of GDP per capita levels.

Future research may be dedicated to the analysis of why provinces cluster in the way they cluster in this study. As Islam (2003) points out, it is a disadvantage of endogenized grouping algorithms that they are silent about potential policy implications. A deeper analysis of provincial characteristics is required as well as a profound analysis why certain provinces perform better than others.

References


