Intercity Income Inequality, Growth and Convergence in China

Gordon Anderson[1] and Ying Ge[2]

[1]. Correspondence: Department of Economics, University of Toronto, Toronto, ON, M5S 3G7, Canada. E-mail address: anderson@chass.utoronto.ca

[2]. School of International Trade and Economics, University of International Business and Economics, Beijing, P. R. China, 100029. E-mail address: yige60@vip.sina.com

Abstract

In the late 1970's China embarked upon a period of wide ranging reforms amongst which the Economic Reforms and the Open Door Policy can be counted. This paper is to investigate ensuing patterns and trends in the intercity per capita income distribution in China in the 1990's, after the reforms had been in place for a decade. Inequality and polarization indices are used to illustrate basic trends, Stochastic dominance techniques are employed to provide unambiguous economic welfare and poverty comparisons across regions and over time and transition probability techniques and polarization/convergence tests are used to study the long run evolution of income distributions for cities. The results suggest a significant welfare improvement and concomitant reduction in the poor status of cities for all regions, with strict welfare dominance of the eastern coastal area over the interior. They also indicate a significant convergence trend in the center (especially in the eastern coastal area) together with a divergence trend in both lower and upper tails of intercity income distributions. Economic reforms and globalization effects in the coastal area drive the convergence in central mass, and divergence in both tails of the distribution stems from the growing coastal-inland gap due to the unbalanced pace of the economic reforms and globalization.

JEL Classification: O15, O53, R12

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1. Introduction

Following the initiation of its economic reforms in the late 1970's, the study of Chinese regional income growth and inequality has blossomed, especially since 1990. It is to be expected that, in terms of the growth and distribution of incomes, the effects of the reforms would emerge in the 1990's given that over a decade has elapsed since their implementation. The pre reform period in China is best characterized as a command economy within which a relatively immobile labour force was relocated for political rather than economic reasons[3] engendering a considerable disparity in labour productivity between urban and rural areas and between eastern and non-eastern cities. The Economic Reforms coupled with the introduction of the Open Door Policy at roughly the same time precipitated profound changes in the nature of Chinese cities and has provoked considerable interest in terms of the economic consequences of the policy change.

Most studies have focused on interprovincial income (output) growth and inequality. Lyons (1991) and Tsui (1991, 1996) all explored trends in interprovincial inequality and the factors behind its dynamic. Provincial income inequality stems from three sources: inter-rural, inter-urban and urban-rural disparities and most studies argue that urban-rural inequality is the major factor in the overall income inequality calculation. The World bank (1997) estimated that urban-rural inequality accounted for more than half of total inequality in 1995 and for about 75% of the increase of inequality since 1985. Yang (1999) also provides evidence of rising income disparity between urban and rural areas. When urban-rural inequality is larger than the inequality within urban and within

[3]For example new cities were established in Central and Western regions in response to perceived threats from the western borders and a “Back to the Land” policy was an integral part of the Cultural Revolution of the 1960's and 70's.

rural areas, the convergence or divergence across provinces may not reflect true trends of inter-rural inequality and inter-urban inequality.

This paper is one of few studies to explore the urban component of the mix by studying the changing shape of the per capita GDP distribution across Chinese cities, in so doing it draws two primary conclusions. The first, drawn from mapping the progress of intercity income distributions in economic welfare terms, is that there is a strict welfare improvement over time for all areas, with the Eastern Coastal area dominating the Interior areas in welfare terms. This conclusion is based on comparisons of complete distributions (rather than average growth rates) via stochastic dominance techniques, so that one may infer that poor cities as well as rich cities are better off on average. The power of the technique derives from the connect between particular stochastic dominance relationships and the social welfare functions (or poverty indices) to which they relate. Essentially compliance with a particular dominance relationship is a necessary and sufficient condition for an unequivocal welfare improvement (or poverty reduction) for all welfare (or poverty) indices in a particular class (e.g. Atkinson, 1987, Foster and Shorrocks, 1988). The second conclusion is drawn from examining whether or not there is a convergence trend in the intercity income distribution. Here the results are mixed: there appears to be convergence in the middle but divergence in the lower and upper tails of the income distribution, furthermore the convergence appears to be regional in nature, taking place predominantly in the Eastern Area where most of the urban development has taken place.

The remainder of the paper is organized as follows: Section 2 describes the urban system in China, the data used and sets the historical context for the study. In Section 3, the evolution of intercity income distributions in 1990's is explored, and the progress of intercity economic welfare

over time and across regions is examined. Section 4 offers some interpretations as to what underlays the changes that have been identified. Section 5 draws some conclusions.

2. The Urban System, the Historical Context and the Data

Henderson (1997) offers three definitions of an urban unit: urban place," "metropolitan area" and "urban agglomeration." Metropolitan areas and urban agglomerations are collections of contiguous urban places. Soo (2005) defines Urban agglomeration as a central city with neighbouring communities linked to it by continuous built-up areas or many commuters, however the distinction between urban agglomeration and metropolitan areas is less clear. Information about metropolitan areas is limited in China where cities are defined as "urban places" (or "city proper") that correspond to local administrative and jurisdictional entities. This administratively defined "city" is less precise than the "urban agglomeration" or "metropolitan area" because such city boundary's are significantly influenced by political factors. There are three different administrative levels of cities in the Chinese urban system: municipalities (or province-level cities), prefecture-level cities and county-level cities[4]. Municipalities and prefecture-level cities have administrative power over both the urban area of a city and the adjacent rural counties. In China urban places with townships or lower administrative levels are not treated as cities.

Information on the population and Gross Domestic Product (GDP) of all Chinese cities from 1990 to 1999 is reported in the Chinese Urban Statistical Yearbooks (State Statistic Bureau (1991-2000)). For cities at the prefecture level and above information on both "Shiqu" (urban area) and "Diqu"(urban area and rural counties) is reported, however only urban area ('Shiqu") city information is used here. Some notes of caution is in order when reviewing the population size of

[4]Actually since 1994 16 cities were defined as quasi-province level cities which, as with the municipalities we treat as prefecture-level cities.

cities. Some cities were renamed throughout the sample period, these name changes were tracked and the sample consistency maintained throughout the period. There were also some boundary changes but information on the source of the change is unavailable (if the change or reclassification was due to political factors it would induce an artificial change on city size biasing the estimation of city size distributions for example). The kernel estimates of the size distribution of city areas and the size distribution of population density indicate that during the period 1990-1999 there was a strikingly stable distribution of the two concepts for existing cities[5]. Thus while there were some quite substantive boundary changes for a few cities over ther period they had very little impact on the overall distribution of city land mass and city population density.

Another issue, well discussed in the literature, is the under-reporting problem associated with the measurement of city population size. China adheres to the Hukou system, a kind of internal passport system, to strictly limit inter-regional migration.[6] There are certain channels of registered migration tracked by the Hukou system (e.g., Henderson, 2002), however, there is also a large number of migrants without local Hukou registration. People who did not have a local household registration and who had stayed less than one year in the survey location were not enumerated in that location census, whereas people who had a local registration but had left the location were nonetheless included in the count. This may cause a bias in the city population count: cities who in reality experienced a net influx would have their populations under reported whereas those with a net exodus of people would have over-reported populations. This population count bias is difficult to address since more reliable data sources are not available for the years before 2000. A new urban

[5]The results are not reported here but available upon request.

[6] See Henderson (2002) for the detail description of this system

definition has been adopted since the Chinese Population Census of 2000 when the under-reporting problem was partially addressed. Chan (2003) discussed this population count bias with the regular statistics sources, such as the Urban Statistic Yearbooks. He compared the regular sources with the Chinese Census in 2000 and showed that the bias in the regular sources in the population count is significant. Chan and Hu (2003) checked empirically the different series of urban population estimates and presented revised urbanization and migration trends in the 1990s.

The main concern in our study is the artificial exaggeration or diminution of the respective per capita GDP measures for such cities. Generally with the urbanization process throughout the period all cities grew, so that under reporting of city size with a concomitant overstatement of per capita GDP would be the norm. However in the reform period the migration restrictions were gradually relaxed and non-registered inland migrants flowed into the richer coastal cities on a large scale. The under-reporting took place at different rates in different cities, and thus distorted the distribution of per capita GDP across cities. We will discuss this bias in next section.

[Table 1 is about here]

Table 1 shows the growth of number of cities and urban population in China from 1949 to 1999. Before The Peoples Republic of China was established in 1949, there were only 67 cities, 9 in Taiwan and 58 in China. For economic and political reasons, in 1949 four cities were dropped and 78 counties were redefined as cities, thus the total number of cities increased to 132 (excluding Taiwanese cities after 1949) with a 27.41 million non-agricultural population. There appears to be four stages in the Chinese urbanization process. The first stage, a stable growth period from 1949 to 1957 contained an adjustment period up to 1952 when the total number of cities increased from

132 to 153 and the first "Five-year Plan" (1953 - 1957) when the total number of cities increased to 176. The city non-agricultural population had grown to 54.13 million, and the level of urbanization had risen to 8.4%. The second stage includes the "Great Leap Forward" expansion period from 1958 to 1961 and the National Readjustment period from 1962 to 1965. During 1958-1961 the total number of cities increased to 208, the city non-agricultural population grew to 69.06 million, and the proportion of city non-agricultural population to national total population increased to 10.5%. In the readjustment period (1962-1965), the total number of cities decreased to 168, the city non-agricultural population decreased to 66.91 million, and the percentage of city non-agricultural population fell to 9.2%. The third stage was a period of economic stagnation (1966 - 1978) during which time the total number of cities increased only by 26. The city non-agricultural population stabilized at between 70 and 80 million; the level of urbanization hovered around 8.5%. The fourth stage was the economic reform period when the urbanization process accelerated. The total number of cities increased from 193 in 1978 to 667 in 1999, an increase of 245.6% in twenty years. The city non-agricultural population jumped to more than 200 million, and the share of non-agriculture population increased to about 20%.

[Table 2 about here]

Table 2 reports summary statistics on city sizes and real urban per capita GDP over the period of study. Columns 2- 4 of Table 2 report the average population size of cities in 1990, 1994 and 1999. The average population size of cities increased from 723000 to 816000. The standard deviation significantly increased over time, implying more city size disparity. Notwithstanding earlier qualifications real urban per capita GDP is the economic welfare instrument employed in this paper. There are very few urban area consumer price indices available (only 36 of the 600+cities had urban price indices at the end of our observation period) so the relevant provincial annual consumer

price index (CPI) is used to deflate nominal GDP into 1990 constant prices, for the years 1990 to 1999. The CPI data is compiled from various Provincial Statistics Yearbooks (1991-2000). Even these data are problematical[7] since during the decade there were several price reforms in (1992, 1994 and 1997 and 1998)which affected different cities in different ways (the '92 reform was based on rice prices, the '94 reform affected the heavy industry cities for example) where possible we provide mid decade comparisons as well as decade comparisons to mitigate the effects of these reforms. Summary statistics of both sample population weighted and non-weighted LOG (GDP per capita) are presented in Column 5 - 7 of Table 2[8]. As Table 2 shows, average city income (both weighted and un-weighted) has increased over time. Overall weighted measures of means and medians are larger than un-weighted measures implying that wealthier cities have larger populations. The increasing standard deviation (both weighted and un-weighted) reflects continuing spread of intercity income distribution over time.

One of the most obvious characteristics of the Chinese urban system is its unbalanced geographical distribution. Following the official definition of geographic areas, the cities are grouped into eastern coastal cities, central cities and western cities according to the province in which the city is located. The details of geographic division of provinces are in the data appendix.

[7]Brandt and Holz (2004) provide a detailed discussion of inter-provincial price disparities.

[8]Sample weighting is an issue for two reasons. Firstly when using these techniques to examine representative agent welfare with household based data, household size re-weighting is crucial for theoretical consistency (though practically it rarely seems to affect the qualitative nature of the results because of the limited variation in household size). Here the city is the household and, with much greater variation in its size, re-weighting sample observations by relative population size is potentially more important from a representative agent welfare perspective. Secondly, the testing and Kernel Estimation techniques employed assume within year independent and identically distributed sampling. Since a cities per capita GNP may be construed as a sample of one drawn from strata of different sizes (i.e. the cities), re-weighting is necessary to undo the impact of the stratified sampling inherent in such data.

[Table 3 about here]

The characteristics of three geographic areas in 1999 are summarized in Table 3. The eastern coastal area has significantly higher urban per capita incomes and larger urban populations than the interior area. Most large urban agglomerations are in the coastal area, especially around two cities: Shanghai and Guangzhou. In the western area, there are also large population concentrations in the Sichuan province.

[Table 4 about here]

The evolution of the spatial distribution of urban system is strongly affected by the government's regional development policy. Table 4 shows the change in the number of cities in the different regions. In 1949, the geographic distribution of cities was unbalanced: 52.3% of the total city and 69% of the total city non-agricultural population was concentrated in the eastern coastal area. From 1949 to 1957, government regional development policy shifted toward the interior area. The State made great efforts to strengthen the inland economic infrastructure and extend urbanization, during the period only 4 cities appeared in the eastern coastal area, but 23 and 17 new cities appeared in the central and western areas respectively. As a result, the proportion of cities in the eastern area was reduced to 41.5%. The proportion in the central area increased from 37.4% to 41.5%, and the western area increased from 9.8% to 17%. The proportion of the non-agricultural population in the eastern area fell from 69% to 58.8%. In the central area it increased from 20.7% to 27.5%, and in the western area it increased from 10.3% to 13.6%. From 1958 to 1978, inland urban development was still a policy priority. With the economic reforms in the late 1970's, urban development priorities shifted to the coastal area, and cities in the eastern coastal area grew much faster than the central and western areas.

3. The Patterns of Intercity Income Inequality in China

3.1 The Evolution of the Intercity Income Distribution

To examine the basic trend of intercity income inequality in China, various inequality and polarization indices are compared and reported in Table 5. The measures of inequality emphasize deviations from the global modality point and ignore clustering around local modality points, while measures of polarization place more emphasis on "clustering" around local modality points. (e.g., Esteban and Ray, 1994, Wolfson, 1994, Zhang and Kanbur, 2001).

[Table 5 about here]

Three popular measures of income inequality are employed: the weighted Coefficient of Variation and un-weighted and weighted versions of the Gini coefficient. Row 2-4 in Table 5 shows that the overall intercity inequality increased in the early 1990's and then decreased in the late 1990's. Row 5 reports the Esteban-Ray polarization index (Esteban and Ray, 1994) which is defined as:

$$P(\pi,y) = K\sum_{i=1}^{n}\sum_{j=1}^{n}\pi_i^{1+\alpha}\pi_j|y_i-y_j| \qquad (1)$$

where K is a multiplicative constant which does not affect the ordering, α is a parameter reflecting the polarization sensitivity of the measure where $0<\alpha<1.6$, y_i is real per capita GDP in city i and π_i is the i'th city's population share in the overall sample (when $\alpha = 0$ the polarization index becomes a population weighted Gini coefficient). This index indicates that urban polarization increased throughout the 1990's. Thus, while inequality appeared to increase and then diminish, polarization continued unabated throughout the period. In this context, contrary to Zhang and Kanbur (2001), polarization indices appear to make a difference in distinguishing a polarization as opposed to an inequality effect. Unfortunately the changes in both the inequality and polarization indices are very small and it is difficult to know whether they constitute significant changes in the nature of the underlaying distributions.

Following Quah, (1993, 1996) the convergence hypothesis is examined for the panel of

cities that existed in 1990[9] (i.e. cities that emerged post 1990 were excluded). It was analyzed through examining the long run dynamic evolution of the income distribution for this panel. The basic idea is that a process of either economic homogenization or persistent inequality manifest themselves in the transition matrix that converts one income distribution to another. This matrix is used to explore the dynamic evolution of the income distribution. Let F denote the distribution of intercity income and λ the associated (probability) measure. The simplest model for the evolution of $\{\boldsymbol{\lambda}_t: t\}$ is an first order time-invariant autoregression process:

$$\boldsymbol{\lambda}_{t+1} = M'\boldsymbol{\lambda}_t \qquad (2)$$

We construct the measure $\boldsymbol{\lambda}_t$ by taking Log(income relative to sample mean) and dividing the set of values into six intervals of $(-\infty, -0.8]$,$(-0.8, -0.5]$, $(-0.5, -0.2]$, $(-0.2, 0.1]$, $(0.1, 0.4]$ and $(0.4, \infty)$. $\boldsymbol{\lambda}_t$ becomes a probability vector whose entry $\lambda[i]$ is the fraction of values falling into interval i. Matrix M becomes the transition probability matrix. The (i, j)'th entry of this matrix is the probability that a city in income group i transits to income group j.

[Table 6 about here]

Row 1-8 of Table 6 report the transition matrix M. The diagonal of the matrix shows the persistence of relative city income. There is high persistence in poorest and richest groups with roughly 70% of poor cities and 67% of rich cities remaining in the same groups. In contrast, most entries in the diagonal for the middle class are less than 30%, implying that most medium income cities experienced relative income change in 1990's. The last three rows show the initial $\boldsymbol{\lambda}_t$ of 1990, the 1999 income distribution and the Ergodic row vector defined by: $\boldsymbol{\lambda}_\infty = M'\boldsymbol{\lambda}_\infty$. This corresponds to long run limit of the distribution of income across cities. In comparing the initial

[9]The notion of Beta convergence (Barro, 1998) was examined for this panel and the evidence favoured significant convergence at rates of 1.5% to 2.5% (details available on request).

distribution with the limit distribution two things can be observed. First, the proportion of the (relative) poorest and richest group significantly increases in the evolutionary process[10]. Secondly, for the middle group, the initial distribution exhibits two peaks whilst the long run limiting distribution has only a single peak suggesting some convergence in the middle of the distribution.

Two notes of caution are appropriate. The transition matrix results are based upon an analysis of cities in existence in 1990. To the extent that the new emerging cities (there were 209 of them, over 40% of the number in the panel study) had income dynamics profiles different from those in the panel and, to the extent that the dynamic processes were not parametrically constant, the results lose their significance. Consequently a non-parametric visual analysis of the Kernel estimates of the various income distributions which include the new cities is considered.

[Figure 1 about here]

Panel A of Figure 1 plots the Kernel density estimate of city relative income distribution (defined as log (GDP per capita normalized by sample mean)) for 1990 and 1999. Panel B shows the distribution for the weighted sample. First, the large intercity income disparity and the spread of the income distribution. In 1990, the ratio of GDP per capita in richest city to the poorest city was about 51, this increased to 87 in 1999. There is also an increase in the cross-city spread of relative incomes with the standard deviation increasing from 0.58 in 1990 to 0.65 in 1999. Note also the increase in mass in the lower and upper tails of the distribution, with the poorest cities become relatively poorer and the richest cities become richer. Second, the 1990 distribution exhibits a "bi-modality" property and this property becomes more significant after the distribution is weighted by population. In contrast, the 1999 distribution is single-peaked and looks roughly normal reflecting convergence in

[10]Asymptotically normal tests of the null of increases in the lower and upper tail probabilities are 3.43 and 0.86 respectively each failing to reject the null.

the middle range of the distribution. All of this accords with the results for the limited 1990 sample of cities reaffirming the two important trends in the intercity income distribution from 1990 to 1999: firstly, the central mass of distribution increases over time and secondly, the dispersion within the distribution increases over time with a polarization trend in the lower and upper tails.

3.2 The Spatial Urban Welfare Gap

While the substantial interregional income inequality is often mentioned in the literature, there is no direct empirical test of the coastal-inland city welfare gap. In this section we employ stochastic dominance techniques to examine the welfare gap across different geographic areas. Atkinson (1970), Foster and Shorrocks (1988) highlight the importance of the nature of mass relocation in income distributions for empirical welfare comparisons. They provide specific criteria for the distributional change necessary and sufficient to engender an unambiguos welfare improvement for welfare functions in particular classes. The criteria are formulated in terms of stochastic dominance rules which are techniques for comparing mass location in probability distributions, the rules may be written as follows. Letting two income distributions A and B be described by the pdf's of income (y) denoted $f_A(y)$ and $f_B(y)$ respectively, define:

$$F^i(y) = \int_0^y F^{i-1}(z)dz \qquad (3)$$

where $F^0(y)=f(y)$. "i'th order"stochastic dominance of f_A over f_B (denoted $f_A \succeq_i f_B$) is defined as: $F^i_A(y) \leq F^i_B(y) \ \forall \ y$ (with strict inequality somewhere). In this context, $f_A \succeq_1 f_B$ corresponds to social preferences based upon a monotonic utilitarian social welfare function, $f_A \succeq_2 f_B$ corresponds to social preferences for mean preserving progressive transfers and $f_A \succeq_3 f_B$ corresponds to social preference for mean preserving progressive transfers at lower income levels. Note also that $f_A \succeq_i f_B$ implies $f_A \succeq_{i+k} f_B$ for all k > 0 so that dominance at order 1 implies

dominance at all higher orders. Suitable empirical approximations to these theoretical concepts permit comparisons to be made between income distributions both of the same group over time and between groups.

These same orderings are informative as to the progress of the "poor cities" in China. If one were to establish a level of per capita income (a city poverty line) Y^p below which a city were deemed to be poor, indices of the extent of "poor cities" in China could be generated and used to compare their plight over time and between regions. However, whenever poverty indices are employed, debate invariably ensues regarding ambiguities in the ordering engendered by "which index?" and "which poverty line?" considerations. In a seminal paper Atkinson (1987) proposed resolving these arguments by considering conditions on two income distributions under which poverty indices in a particular class would always obey the same inequality for a range of values of the city poverty line. The results were profound, the same stochastic dominance relationships in (2) above, established over the range $0 < Y^p < Y^*$, imply that all poverty indices in a particular family (defined by the order of dominance) will obey the same inequality for all poverty lines $Y^p < Y^*$. Establishing such a stochastic dominance relationship corresponds to establishing a very general ordering that is unambiguous with respect to all poverty indices within a given class and all poverty line choices within the given range[11]. Statistical tests for stochastic dominance conditions have been developed in Anderson (1996), Davidson and Duclos (2000), McFadden (1989) and Barrett and Donald (2003), we follow the Davidson and Duclos approach in this work.

Here two questions are considered: first, is there a welfare disparity between the urban cities in the Eastern costal area and those in interior? Second, does the welfare of urban cities improve over

[11]Foster and Shorrocks (1988) highlight the relationship between these poverty ordering techniques and similar social welfare ordering techniques Anderson (2003) applies the orderings to study the progress of the poor in the USA.

time? Three null hypotheses are entertained: first, the intercity income distribution in the Central Area is dominated by the corresponding Eastern Area distribution. Second, the intercity income distribution in the Western Area is dominated by the corresponding Eastern Area distribution. Third, the intercity income distribution in the Western Area is dominated by the corresponding Central Area distribution.

In each case the pooled sample of log per capita GDP are split into deciles to determine the partition structure.

[Table 7 about here]

Table 7 reports the welfare ranking of city income distribution in different areas in 1990 and 1999. All three null hypotheses are not rejected. The Eastern Coastal area stochastically dominates both interior areas in the first order, and Central area stochastically dominates Western area in the second order. These results provide strong evidence of a significant welfare gap between the urban cities in coastal and interior areas, furthermore it is a gap that persists over time.

[Table 8 about here]

Table 8 reports the welfare comparison of intercity income distributions over time. The 1990's are unambiguously a period of welfare improvement for urban cities in China, all areas benefitted from the rapid income growth in 1990's. In terms of the prevalence and degree of "Poor" cities the results imply that, for any "poor city" per capita income criterion, the prevalence of poor cities is always greater in the Central and Western Areas than it is in the Eastern Coastal Area and the "depth of poor city deprivation" is greater in the Western than in the Central Area. However the prevalence of poor cities diminished in every area between 1990 and 1999.

[Figure 2 about here]

The dynamic evolution of income distribution patterns within the different geographic areas

also appears to be different. Figure 2 (A) and (B) show the Kernel Density estimates of the relative income distribution within the coastal area and the interior area, respectively. For the cities in the eastern coastal area, there is a substantial income convergence trend. The bi-modal distribution of 1990 converges to the single peak of 1999, and the income dispersion decreases over time. In contrast, there is no significant income convergence trend within the interior areas, but some polarization in the form of an extended lower tail is apparent.

Following Anderson (2004), (2004a) the stochastic dominance tests can also be modified to examine particular forms of convergence or polarization of distributions over time. By interpreting the various forms of dominance as types of separation with dominance of the i'th order of distribution A over distribution B being interpreted as i'th order right separation of A from B. When rich and poor city distributions are separately identified, polarization can be examined statistically by performing the relevant stochastic dominance tests jointly on successive realizations of the relevant city distributions. When, as in the present case, the observed distribution is an unknown mixture of unobserved rich and poor city distributions, the problem is to analyse the consequences of polarization within the observed mixture. Inferences can be made by associating the lower and upper tails of the observed mean normalized mixture with the respective poor and rich city distributions. Thus letting superscripts represent successive time periods and partitioning the mean normalized distributions at the value 1 and considering the relative progress of the mean normalized distributions $f^1(w|x<1)$, $f^2(w|x<1)$, $f^1(x|x>1)$ and $f^2(x|x>1)$ where $f(w|.)$ Is the distribution of the transformed variable $w = -x$, two conditions need to hold simultaneously:

1) $f^2(x|x>1)$ dominates $f^1(x|x>1)$ at the i'th order (establishing that the right tail at least i'th order right separates in period 2)

2) $f^2(w|x<1)$ dominates $f^1(w|x<1)$ at the i'th order (establishing that the left tail at least i'th order left separates in period 2).

[Table 9 about here]

In essence these divergence or polarization tests establish whether or not there has been a decrease in the mass at the centre of the mean normalized distribution. Table 9 reports the results of these tests for both un-weighted and population weighted distributions. There appears to be little polarization or convergence in the overall distribution of per capita urban GDP in China, however there does appear to be strong evidence of convergence in the Eastern region distribution with some weaker evidence of convergence in the Central and Western regions over the 1990's.

The population count bias due to the under-reporting problem may distort intercity income distribution comparisons and the bias is related to patterns of migration. Previous studies of Chinese migration show that the internal migration control has been relaxed and localized, resulting in an increased inter-regional mobility of the population in the 1990s (e.g.,Chan and Zhang, 1999, Wang, 2004 , Lin, Wang and Zhao, 2004). The geographic pattern of migration flow significantly changed during the 1990's. Lin, Wang and Zhao (2004) studied the regional inequality and interregional migration and showed that inland-to-coast migration dramatically increased in the 1990s and dominated the inter-provincial migration (with a share of 60.1%). In contrast, coast-to-inland migration shrank to 6.1%, and within-coast migration and within-inland migration significantly decreased to 18.6% and 15.2%, respectively.

With the large volume of unregistered migrants from the underdeveloped inland area to coastal area, the coastal-inland income gap in our empirical findings may be overestimated. One

typical example is Shenzen, a city in south eastern coast. Chan (2003) showed that GDP per capita of Shenzen ranked number 1 in 2000 according to Urban Statistical Yearbook, but only number 23 if population size is measured according to new urban definition in the 2000 Population Census. It was significantly overestimated due to a large amount unreported migrants inflow. Our study also shows a polarization trend in the lower and upper tails during the period 1990-1999. The under-reporting problem may overstate this polarization trend. The poor small cities tend to experience net migration outflow while these migrants still keep the local hukou and thus are included in local population count. Thus the income level of theses cities may be underestimated. In contrast, unregistered migration inflow may contribute to rapid growth of income in large rich cities, and thus overestimate divergence trend.

4. Urban Growth, Reform and Globalization

The empirical analysis of intercity income inequality in China has highlighted two main features. First, the central mass of distribution increased together with a polarization trend in the lower and upper tails during the period 1990-1999. Second, there is a significant welfare gap between coastal and inland cities, and the convergence trend is more evident in the eastern coastal area. The interesting question is: what are the main forces shaping the intercity income distribution?

The literature has identified several important sources of urban growth: human capital accumulation, infrastructure investment, industry structure, openness to trade and FDI, policy and

various geographic factors (e.g., Barro and Sala-i-Martin, 1995, Glaeser et al. 1995, Simon and Nardinelli,2002, Glaeser and Shapiro, 2003). In the case of China, economic reforms and globalization are two important contributing factors to urban growth. Economic reforms started in the agricultural sector in the early 1980's and expanded into the urban industrial sector in the late 1980's. The purpose of the reforms was to transform China from a closed centrally planned system into a modern market economy open to the world market. In the 1990's, there was a significant decline in the state sector and a rapid expansion of the non-state sector (including township and village enterprises, private enterprises and joint ventures). During this period, China also experienced an accelerated globalization process, with a substantial inflow of foreign direct investment and rapid growth in foreign trade. Previous empirical studies show that economic reforms and globalization significantly affect the city growth and thus shape the intercity income distribution. For example, Wei (1993) found that access to export and foreign investment was positively associated with higher growth rates across Chinese cities during 1980-1990. Zhang (2002) found that the main driving force behind urbanization are economic growth, structural changes and especially inflows of foreign direct investment. Lin and Song (2002) showed that foreign direct investment are positively related to per capita GDP of cities. Jones, Li and Owen (2003) showed that favorable development policy and foreign direct investment have positive effect on the growth rate of Chinese cities. Anderson and Ge (2004) examined the impact of economic reforms and foreign investment on city growth in 1990-1999, controlling for other factors such as human capital accumulation, industrial structure and infrastructure investment. They found that the development of the non-state sector and increased

openness to foreign investment significantly encouraged city growth.

The previous literature has also shown that the unbalanced pace of reform and globalization across regions is an important source of rising regional inequality, especially the coast-inland disparity (e.g., Chen and Fleisher,1996, Gao, 2004, Fu, 2004, Kanbur and Zhang, 2005). Gao (2004) found that exports and foreign direct investment have strong positive effects on regional industrial growth. Fu (2004) investigated the spillover and migration effect of exports and FDI and showed that exports and FDI have played an important role in increasing regional disparities in China. Kanbur and Zhang (2005) showed a positive relationship between trade openness and interregional inequality. The unbalanced pace of economic reform and globalization across cities reshaped the intercity income distribution. It became apparent that before and during the early part of the reform period the large cities were those with a dominant share of state enterprises. The role of these cities was challenged by the economic reforms. Relative to the smaller poorer cities which grew faster and the large numbers of new cities which were untrammeled by a large state sector, their growth was limited by the declining performance of the state sector. Globalization in the reform period encouraged the development of the coastal region in particular three regions developed substantially, the Pearl River Delta, the Yangzi River Delta and the Bo Sea Ring. Foreign Trade and Foreign Direct Investment significantly changed the internal economic geography, encouraging the rapid growth of hitherto smaller coastal cities (see for example Shenzen city which grew from a village to a middle sized wealthy city during the period).

The unbalanced pace of the economic reforms and globalization between coastal and inland area may well explain the coastal-inland welfare gap and why the convergence mainly

come from coastal area. The eastern coastal regions clearly have the geographic and policy advantage in attracting foreign investment and generating foreign trade. Previous studies demonstrated a geographic concentration of foreign trade and investment in China in the coastal area (e.g., Naughton, 1996, Sun, Wilson and Yu, 2002). The Coastal area also has also transformed more rapidly from a central planning system into a market economy. The rapid development of new and existing cities with little or no state sectors was much more prevalent in the eastern coastal region. Since the coastal area enjoyed most benefit from the economic reforms and globalization, there is little surprise in observing that the coastal cities strictly dominate the inland cities in welfare and that the convergence trend mainly comes from coastal area. Divergence in both tails of the distribution mainly stems from the coastal inland gap. Certain poor western cities got little benefit from the economic reforms and globalization, and the growth of these cities was below average. In contrast, certain large and rich coastal cities, for example Shanghai, are growing into international urban giants in a globalizing world, and will maintain the leading role at or near the apex of the urban hierarchy (e.g., Yusuf and Wu, 2001).

5. Conclusions

Since the onset of Economic reforms in China in the late 1970's the progress of its growth and economic welfare has been of interest. Restrictions in labour mobility were relaxed to a considerable degree, markets were opened up both domestically and internationally and urbanization took place at an unprecedented rate. The last decade of the century may be thought of as a period when the effects of these reforms could be observed in the nature of the growth process. This paper has reported the results of employing several techniques to investigate the evolutionary pattern of intercity income inequality and welfare in China from 1990 to 1999. Inequality and Polarization

indices reflecting the trends over the decade, Stochastic Dominance techniques applied to rank welfare states over time and across regions, unconditional convergence and transition matrix analyses performed on a panel of cities over the period, the visual interpretation of Kernel estimates of income distributions and stochastic dominance techniques adapted for studying polarazation/convergence trends have all been reported.

The Stochastic Dominance results indicate strong welfare gains over the period in all regions together with significant and persistent welfare disparities between cities within Eastern coastal area and those in the interior. In this sense the poor are making absolute gains over time so that later income distributions are always socially preferred to earlier distributions. The inequality and convergence results, which are always based upon mean income normalized analyses, suggest that this is not the case in a relative sense. The inequality and polarization indices indicate an increase and then abatement in inequality and a sustained increase in polarization throughout the period (unfortunately the magnitude of the differences in the indices were of such a small order as to be equivocal), highlighting the idea that inequality and polarization can simultaneously take opposite paths.

Finally Kernel density estimation and polarization/convergence tests revealed a convergence trend in the center of the income distribution, drawn mainly from cities in the Eastern Coastal Area, together with evidence of divergence in the form of an extension of both lower and upper tails of the income distribution. Overall there appears to be a strong and persistent trend in economic welfare however the evidence on convergence in the economy is mixed with a converging trend in the center of the distribution while the tails of the income distribution seem to be moving further apart.

All in all the reforms appear to have precipitated economic growth and welfare gains

throughout urban China without rich cities gaining at the expense of the poor in an absolute sense though the Eastern region appears to be progressing more rapidly than the Central and Western regions. In a relative sense there does appear to be a convergence trend with some evidence of divergence in the tails of the distribution. These effects appear to predominate in the Eastern region where the largest portion of Urban growth, both in economic and population terms, has occurred.

Appendix 1. Data

The three geographic areas are designated as follows: The Eastern Coastal Area is comprised of the nine provinces Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, Hainan, and three municipalities Beijing, Tianjin and Shanhai. The Central Area is made up of nine provinces: Heilongjiang, Jilin, Inter-Mongol, Shanxi, Henan, Hubei, Hunan, Jiangxi, Anhui. The Western Area includes nine provinces: Shanxi, Ningxia, Gansu, Xinjiang, Qinghai, Sichuan, Guizhou, Yunnan, Xizang. In 1997 Congqin city was separated from Sichuan province as the fourth municipality, here it is still included in Sichuan province for the purpose of consistency.

For the Markov Chain analysis our sample excludes new cities that emerged and the cities that exited (dropped below 100000 population) after 1990. There are total 467 cities in 1990. Nine cities exited in this period: Fuyu in Liaoning Province, Jiaojiang and Huangyan in Zhejiang Province, Huaihua in Hunan Province, Wanxian and Peiling in Sichuan Province, Waiting and Dongchuan in Yunnan Province, and Sihezhi in Xingjiang Province. Three cities are were excluded due to missing variables: Lasha and Rikezhen in Tibet and Meizhou in Guangdong province. Thus 455 cities remain in the sample.

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Table 1

The Number of Cities and Urban Population in China

Year	Total cities	National Urban Population (10000's)		Share in National Population	
		Urban Population	Non-agriculture	Urban Population	Non-agriculture
1949	132	3949.05	2740.57	7.3	5.1
1952	153	4788	3491.01	8.3	6.1
1957	176	7077.27	5412.69	10.9	8.4
1961	208	10131.47	6906.32	15.4	10.5
1965	168	8857.62	6690.63	12.2	9.2
1970	177	9324.11	6644.92	11.2	8.0
1978	193	11657.06	7986.66	12.1	8.3
1980	223	13418.42	9083.04	13.6	9.2
1985	324	21231.49	11821.7	20.1	11.2
1990	467	33542.83	15037.77	29.3	13.2
1994	622	47782.76	19165.35	39.9	16.0
1999	667	53171.72	22465.80	42.6	18.0

Table 2

Summary Statistics of City Growth in China, 1990's

	Size (10000 persons)			Log (GDP per capita)		
Year	1990	1994	1999	1990	1994	1999
Mean	72.3	77	81.6	7.6	7.97	8.26
Weighted Mean	-	-	-	7.7	8.05	8.37
Median	56.2	62.4	63.9	7.5	7.92	8.23
Weighted Median	-	-	-	7.69	8	8.34
Std. Dev.	74.3	71.5	87.9	0.58	0.63	0.63
Weighted Std. Dev.	-	-	-	0.64	0.68	0.69
Weighted Std. Dev.	0.96	1.12	1.6	6.27	6.26	6.57
Maximum	784	953	1127	10.21	10.53	11.04
Number of cities	464	620	664	464	620	664

Table 3

Characteristics of Three Geographic Areas, 1999

Characteristics	Eastern Area	Central Area	Western Area
Number of cities	300	247	120
Population (million)	508.64	443.10	287.71
Population Share	(41.04%)	(35.75%)	(23.21%)
GDP Per Capita (yuan)	1837.37	1021.25	827.32
GDP Share	(57.42%)	(28.48%)	(14.10%)
Urban Population (million)	278.74	177.67	85.55
Urban Population Share	(51.43%)	(32.78)	(15.79)

Table 4

The Number of Cities Within Different Geographical Areas

Year	Total cities	Eastern Area	Central Area	Western Area
1949	132	69	50	13
1960	199	73	82	44
1970	177	68	75	34
1978	193	69	84	40
1980	223	78	100	45
1985	324	113	133	78
1990	467	181	193	93
1994	622	278	231	113
1999	667	300	247	120

Table 5

Indicators of Inequality and Polarization

Inequality Index	1990	1994	1999
Weighted CV (inequality)	0.083	0.0845	0.0838
Gini coefficient (inequality)	0.037	0.0374	0.035
Weighted Gini coefficient (inequality)	0.0474	0.0482	0.047
Esteban-Ray Index[2] (polarization)	0.0036	0.0038	0.0044

[1] The intervals are calculated in terms of log per capita GDP rather than levels which substantially deflates inequality indices from their usual levels.

[2] α, the polarization sensitivity coefficient, was set at 1, similar results were obtained when its value was set at 0.5 and 1.5.

Table 6

Income Transition Matrix, 1990-1999

Initial Year	Final Year 1999					
1990	(-∞,-0.8]	(-0.8,-0.5]	(-0.5,-0.2]	(-0.2, 0.1]	(0.1, 0.4]	(0.4, ∞)
(-∞,-0.8]	**0.7**	0.17	0.066	0.05	0.02	0
(-0.8,-0.5]	0.32	**0.28**	0.24	0.13	0.01	0
(-0.5,-0.2]	0.13	0.25	**0.33**	0.24	0.04	0
(-0.2, 0.1]	0.02	0.19	0.24	**0.22**	0.13	0.2
(0.1, 0.4]	0	0	0.12	0.38	**0.28**	0.22
(0.4, ∞)	0	0	0.03	0.09	0.21	**0.67**
			λ_t			
1990	0.141	0.209	0.2	0.119	0.178	0.154
1999	0.2	0.156	0.178	0.187	0.11	0.169
Ergodic	0.268	0.16	0.161	0.155	0.092	0.164

Table 7

Stochastic Dominance Ranking of Income Distribution Among Three Areas

Null Hypothesis	1990		1999	
	Unweighted	Weighted	Unweighted	Weighted
Central area is dominated by Eastern area	[yes, 1]	[yes, 1]	[yes, 1]	[yes, 1]
Western area is dominated by Eastern area	[yes, 1]	[yes, 1]	[yes, 1]	[yes, 1]
Western area is dominated by Central area	[yes, 2]	[yes, 2]	[yes, 2]	[yes, 2]

Note: [Yes, i] indicates no rejection of null hypothesis in order "i" based upon a P(null)<.05 decision criteria.

Table 8

Stochastic Dominance Ranking of Income Distribution Over Time

Area	Unweighted Sample		Weighted Sample	
	1990-94	1994-99	1990-94	1994-99
Eastern	[↑, 1]	[↑, 1]	[↑, 1]	[↑, 1]
Central	[↑, 1]	[↑, 1]	[↑, 1]	[↑, 1]
Western	[↑, 1]	[↑, 1]	[↑, 1]	[↑, 1]
Total Area	[↑, 1]	[↑, 1]	[↑, 1]	[↑, 1]

Note: [↑, i] indicates welfare improves over time in order "i" based upon a P(null) < .05 decision criteria

Table 9

Convergence Ranking of Income Distributions Over Time

Area	Unweighted Sample			Weighted Sample		
	1990-94	1994-99	1990-99	1990-94	1994-99	1990-99
Eastern	[↑, 2]	[none]	[↑, 1]	[↑, 2]	[↑, 2]	[↑, 1]
Central	[none]	[none]	[↑, 1]	[none]	[none]	[↑, 3]
Western	[↑, 2]	[none]	[none]	[↓, 1]	[↑, 1]	[↑, 1]
Total Area	[↑, 1]	[none]	[↑, 1]	[none]	[none]	[none]

Note: [↑, i] indicates convergence over time ([↓, I] correspondingly indicates divergence) of order "i" based upon a P(null) < .05 decision criteria.

Figure 1 Kernel Estimation of City Relative Income Distribution in China, 1990 and 1999

Figure 1 (A): Unweighted Sample

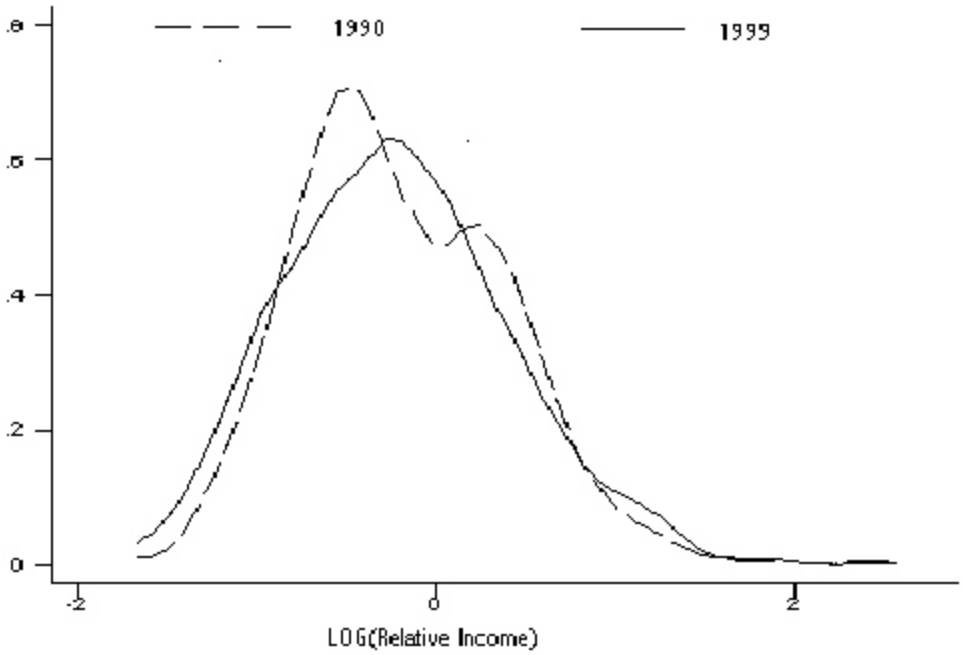

Figure 1 (B): Weighted Sample:

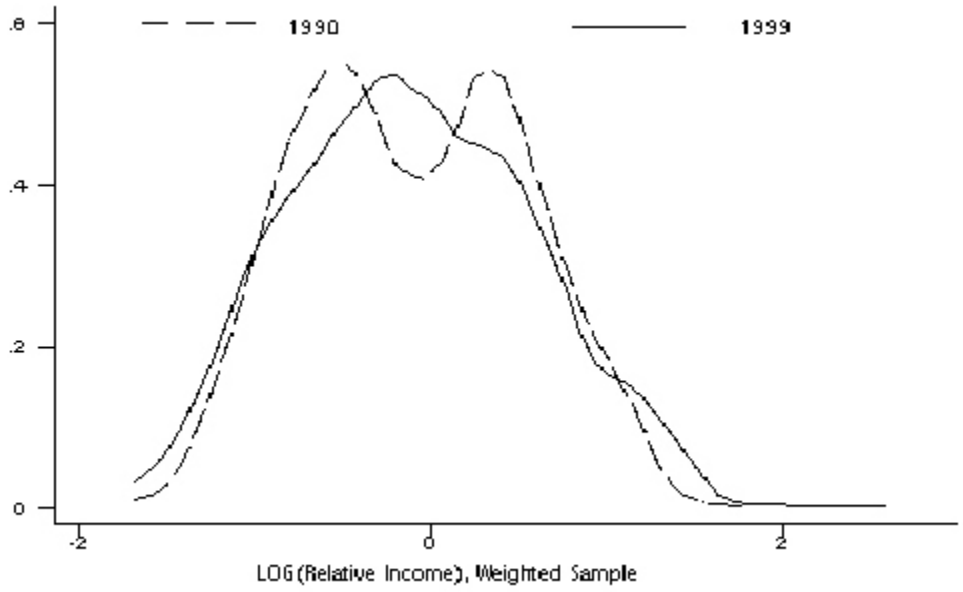

Figure 2 Kernel Estimation of City Relative Income Distribution Within Different Geographic Areas, 1990 and 1999

Figure 2 (A): Eastern Cities

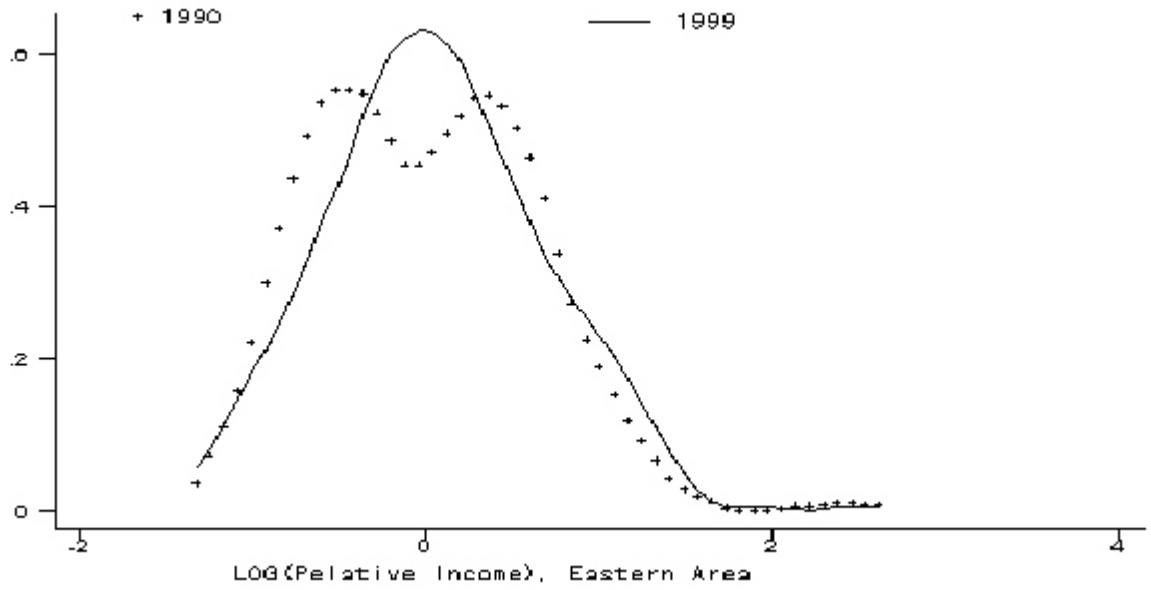

Figure 2 (B): Interior Cities