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The Nexus of Income and Size Distribution of Chinese Cities, 1984 - 2003

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Abstract: We estimate the distribution dynamics of city income and size in China during 1984-2003 using stochastic kernel. Our results show that intra-distribution mobility are significant in both income and size and provide evidences on China experienced internal brain drain.

JEL: O15, O18, R11
Keywords: City Income, City Size, Distribution Dynamics, Kernel Density, China

I. Introduction

Income distribution in China has been the subject discussed by economists, for example Tsui (1991, 1993), Kanbur and Zhang (2005) and Ho and Li (2006a). Although China experienced economic growth in the last two decades, regional income inequality was shown to be worsened. In the development process, educated labors move from economic stagnated regions to prosperous regions to earn a higher wage. The rural-urban migration changes the size of cities and agglomeration enhances spillover of human capital to promote further growth. Anderson and Ge (2005) show that the growth of city size converges in the post-reform period whereas

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Xu and Zhu (2006) show that the growth of city size is positively affected by GDP per capita. However, there is no study connect these two dynamic phenomena. In this article, we fill this gap by examining the distribution dynamics of city income and city size togather during 1984 - 2003 and infer the relationship between them.

To uncover the distribution dynamics of income and size in Chinese cities from 1984 to 2003, we employ the stochastic kernel approach proposed by Quah (1997) and applied to provincial output of China by Aziz and Duenwald (2003). Our empirical results indicate significant intra-distributional mobility in city income and city size, the latter of which is more persistent. The Chinese universal One-Child policy restricts the natural population growth rate comparable across cities whereas the household registration system (Hukou) limits people move away from their origin to more economically prosperous cities. An exception is made for university graduates whose can study and work in cities other than their origins. Under the aforementioned policies, the differences in demographic evolution[3] in urban area are most likely caused by migration of skilled workers from the poor and economically stagnant region to rich and fast-developing region. Therefore, it provides indirect evidences of internal brain drain hypothesis in China.

The paper is organized as follow. The next section discusses the data used in this study. In section 3, we introduce the model of stochastic kernel for estimating distribution dynamics. In section 4, we discuss the results. Section 5 concludes.

II. Data

The data of city GDP per capita and population for 1984 and 2003 is obtained from China City Statistics Yearbooks 1985 and 2004 published by China National Bureau of Statistics. Both yearbooks record the data from the end of previous year. The city data used here only refers to the data for the urban area (not include the suburb area). The number of cities in the Yearbooks changed from less than 300 in 1984 to more than 600 in 2003 with most of the new cities being located in the costal area. It is

3 The demographic evolution studied here only pertains to the registered urban residents who possess the citizenship of their residential city. Namely, it does not include immigrants who do not have Hukou in the city.

worth to note that the urbanization process in temporary China is different from the European or US's experience, where urbanization is mainly caused by the expansion of existing cities. In China, as shown in Anderson and Ge (2005), the urbanization takes the form of the emergence of new cities to a large extent. Therefore, the boundaries for the existing cities in 1984 are comparable to those in 2003. In order to smooth the urbanization process during 1990s, the Chinese policy makers adopted new administrative system over cities gradually and divided cities into three different categories: sub-provincial-level cities, prefectural-level cities and county-level cities from the highest to the lowest administration level. We focus on prefectural- and up level cities because of the lack of data for county-level cities. In the empirical analysis, we use the standardized income level and population size relative to their means.

Figure 1 and 2 show the univariate and bivariate density estimates of the standardized city income. In figure 1, the mass of density concentrates on the low income level, which is consistent with the result at provincial level by Aziz and Duenwald (2003),.with a shift in the density from the low income level to the average level over the studied period. However, from the joint density estimation (figure 2), it shows that a single city pair in 1984 and 2003 is more likely fall into low income range. In terms of city size, figure 3 and 4 show similar patterns, but the shift in city size is less than that in income. Although the distribution of standardized income and size distribution for 2003 has similar shape as that for 1984, it might actually mask a great deal of internal mixing as individual cities move up and down in the overall income and size distribution.

III. Methodology

As suggested in Quah (1993) and applied to China by Bhalla et al (2003), Li (2003) and Ho and Li (2006), the Markov transitional matrix with the choice of the intervals used to classify income level can be employed to study dynamics of income distribution over time. However, Bulli (2001) argues different classification schemes may yield different results and many even destroy the Markov properties of the process. To avoid these problems, a continuous version of the transition probability matrix can be estimated as a stochastic kernel. In this approach, discrete income states are replaced by a continuum of city income levels, thereby avoiding arbitrary income categories. Although the stochastic kernel approach has this key advantage, it relies upon graphical methods of interpretation and does not have summary statistics as those derived in Shorrocks (1980).

Suppose the income (or demographic) distribution at time t can be described by a density function $f_t(x)$ and it will evolve over time. At time $t+\tau$, the density prevailing is $f_{t+\tau}(x_{t+\tau})$. Suppose that the process describing the evolution over time is time-invariant and first-order, it can be characterized by

$$f_{t+\tau}(x_{t+\tau}) = \int g_{\tau}(x_{t+\tau} \mid x_t) f_{\tau}(x_t) dx \tag{1}$$

where $g_{\tau}(x_{t+\tau} \mid x_t)$ denotes the conditional density after τ periods and represents the continuous analogue of the transition matrix in discrete Markov process. Denote a joint density by $h_{\tau}(X)$ where $X = [x_{t+\tau}, x_t]$. We estimate $h_{\tau}(X)$ as

$$h_{\tau}(X) = \frac{1}{nh^2} \sum_{i=1}^{n} K\left(\frac{1}{h}(x - x_i)\right) \tag{2}$$

where K(.) is a kernel function and h is the bandwidth or the smoothing parameter. We use a bivariate Gaussian kernel function

$$K(x) = \frac{1}{2\pi} \exp(-\frac{1}{2} x' x) \tag{3}$$

and choose the optimal bandwidth h according to Silverman's (1986) rule of thumb. We estimate the conditional density $g_{\tau}(x_{t+\tau} \mid x_t)$ = $h_{\tau}(X) / h_{\tau}(x_t)$ where $h_t(x_t) = \int h_{\tau}(x, x_t) dx$ is the marginal density of x_t. The kernel density estimates are computed from the standardized data on a support defined on the Cartesian product set [-1, 2] × [-1, 2].

IV. Empirical Results

The estimated conditional density $g_{\tau}(x_{t+\tau} \mid x_t)$ for the city GDP per capita and population size from 1984 to 2003 are depicted by a contour plot in figure 5 and 6 respectively. The horizontal and vertical axes in the contour plot present the standardized incomes in the initial and terminal years respectively, while the points with the same level of density are connected. Cities with similar income at 1984 may transit to very different income levels subsequently, or vice verse. In Figure 5, the density mass is not concentrated along the diagonal (implies persistence), or on two extreme modes at the two ends of the 45-degree line (implies polarization) or around the 0- level line (implies convergence) over time. However, we observe some downward mobility in the distribution of cities lying at the low end of the income level. There is a peak in the stochastic kernel that lies below the 45-degree line in the south-west of the diagram, which indicates that the initially poor cities below the mean have a high probability to become even more disadvantageous relative to the mean income after two decades. For rich cities above mean in 1984, the evolution of the income per-capita shows a mixed picture. Middle-income cities whose income level is slightly above the mean have a strong trend to upgrade themselves, for instance, the cities in Southeastern China which were initially poorer than those in Northeastern, but overtook them during last two decades. The cities initially belong the wealthiest club (most Northeastern cities) do not successful maintain their status.

Figure 4 illustrates the conditional density for the size distribution of Chinese cities which resembles that for city income in terms of the overall shape. The main difference between these two distributions lies in that the cities with population at the low end in 1984 are more likely to be concentrated around 45-degree line rather than moving upward. For cities with populations slightly above the mean, they have similar chances to decrease, remain and increase the population size over time. The initial populous cities tend to have a higher growth rate in population.

Comparing the kernel, we observe that city size is more persistent than that of income distribution as the contour is more perpendicular to the x-axis. It can be due to the Household Registration system. As argue in Au and Henderson (2006), the system restricts the agglomeration to take place in full scale and lower productivity growth. In order to find out the linkage between the dynamics of city income and size, we conduct linear regressions for two terms: the regression of the population size in 1984 and the population growth on the initial income level controlling for the geographic regions. The regression results show that cities with higher income level in 1984 tend to have a larger population as well as a higher subsequent population growth in the following two decades.

V. Conclusion

The non-parametric analysis shows the evolution of city income and size distribution. Moreover, the dynamics of city income and size go hand in hand which exhibit economies of agglomeration, but the city size is more persistent. It indirectly supports our hypothesis that under the Household Registration and One-Child policies, skilled work labors tend to move from the poor and economic stagnant region to rich and fast-developing region, especially move to the cities in southeastern China. The empirical results provide indirect evidences for internal brain drain across Chinese cities with skilled labor force flooding into economically prosperous cities. The agglomeration of the intelligent will lead to the rise of the skilled city (Glaeser and Saiz, 2004) and deteriorate the regional income inequality in China. The widening gap of human capital between cities creates structural imbalance and obstacle to sustainable economic development. Future research on the population policy and regional development in China is warranted.

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Figure 1: The Univariate Density Estimate of City Income Distribution in China: 1984 – 2003 (Source: China Statistical Yearbook, 1985 & 2004)

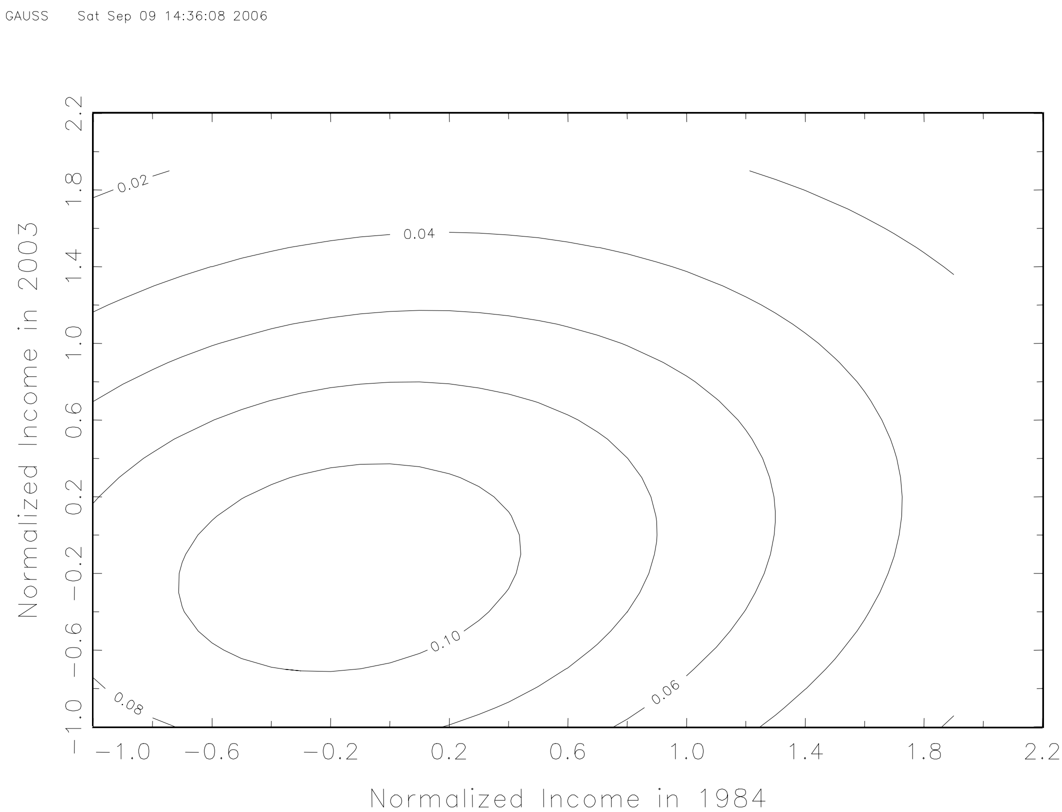

Figure 2: The Bivariate Density Estimates of City Income Distribution in China: 1984 - 2003 (Source: China Statistical Yearbook, 1985 & 2004)

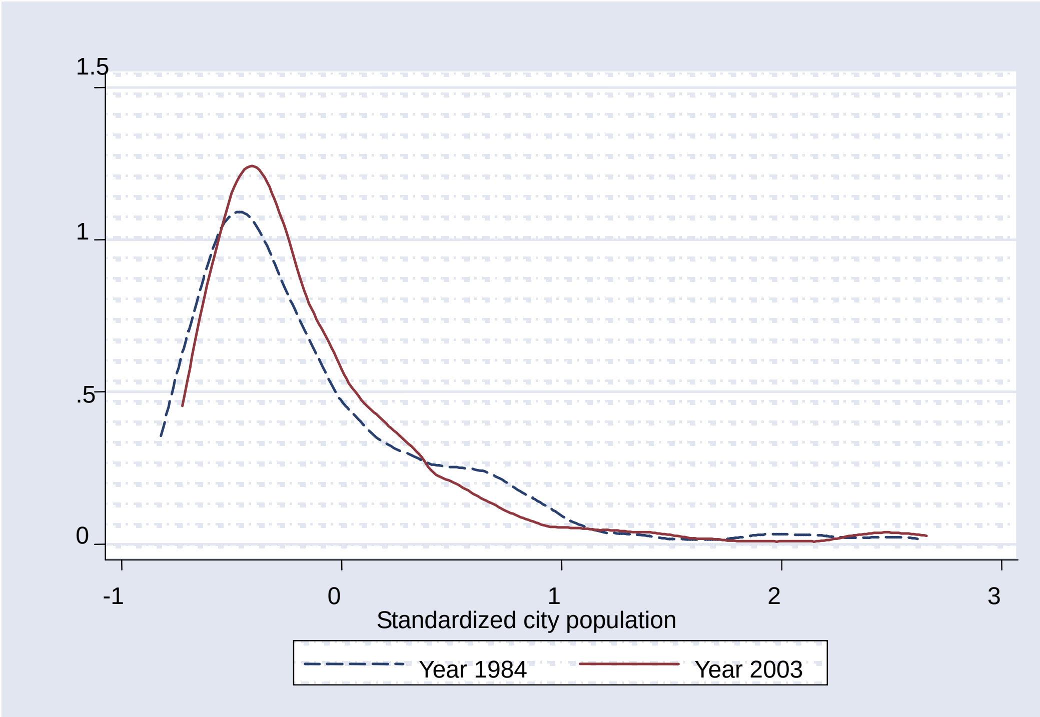

Figure 3: The Univariate Density Estimate of City Size Distribution in China: 1984 - 2003 (Source: China Statistical Yearbook, 1985 & 2004)

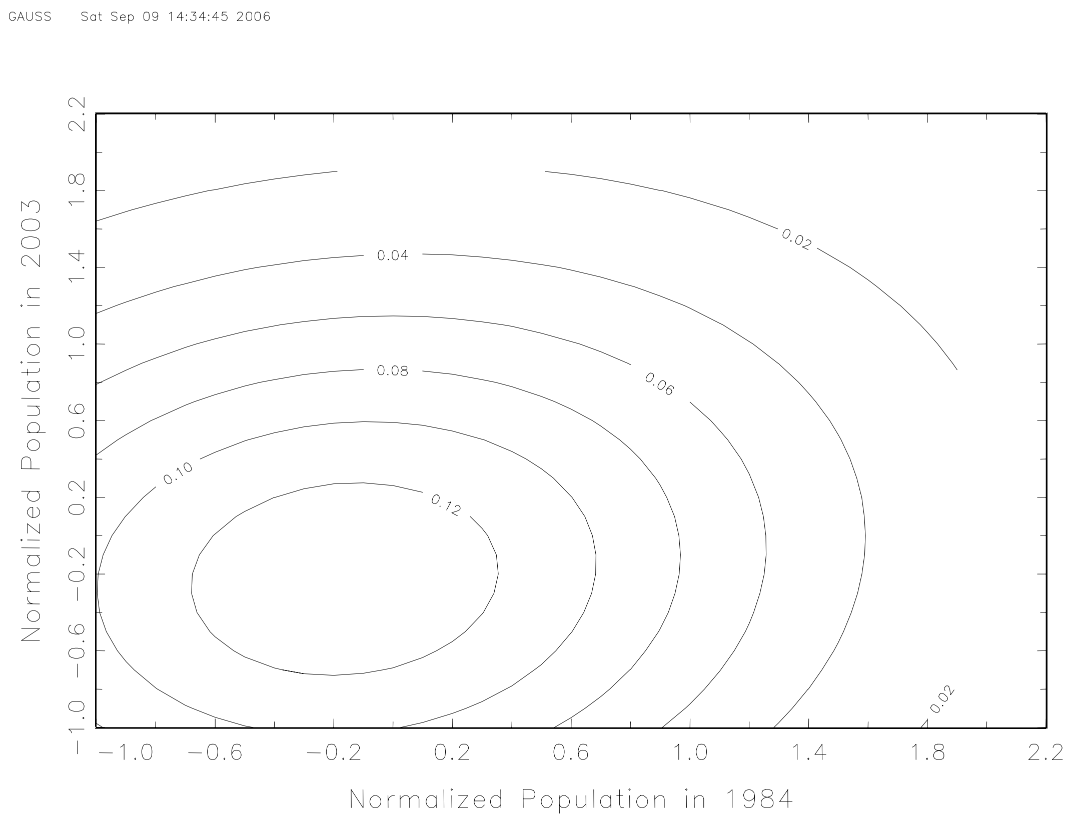

Figure 4: The Bivariate Density Estimates of City Size Distribution in China: 1984 – 2003 (Source: China Statistical Yearbook, 1985 & 2004)

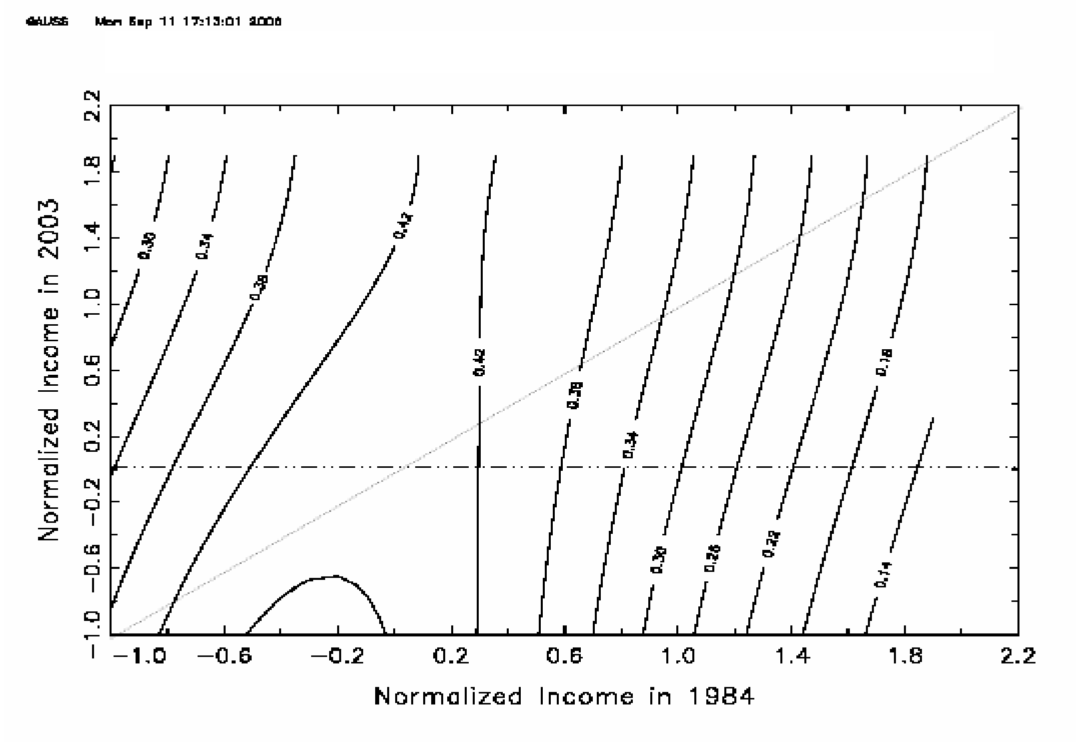

Figure 5: Contour Plot of Conditional Density for City Per Capita Income in China, 1984-2003 (Source: China Statistics Yearbooks, 1985 & 2004)

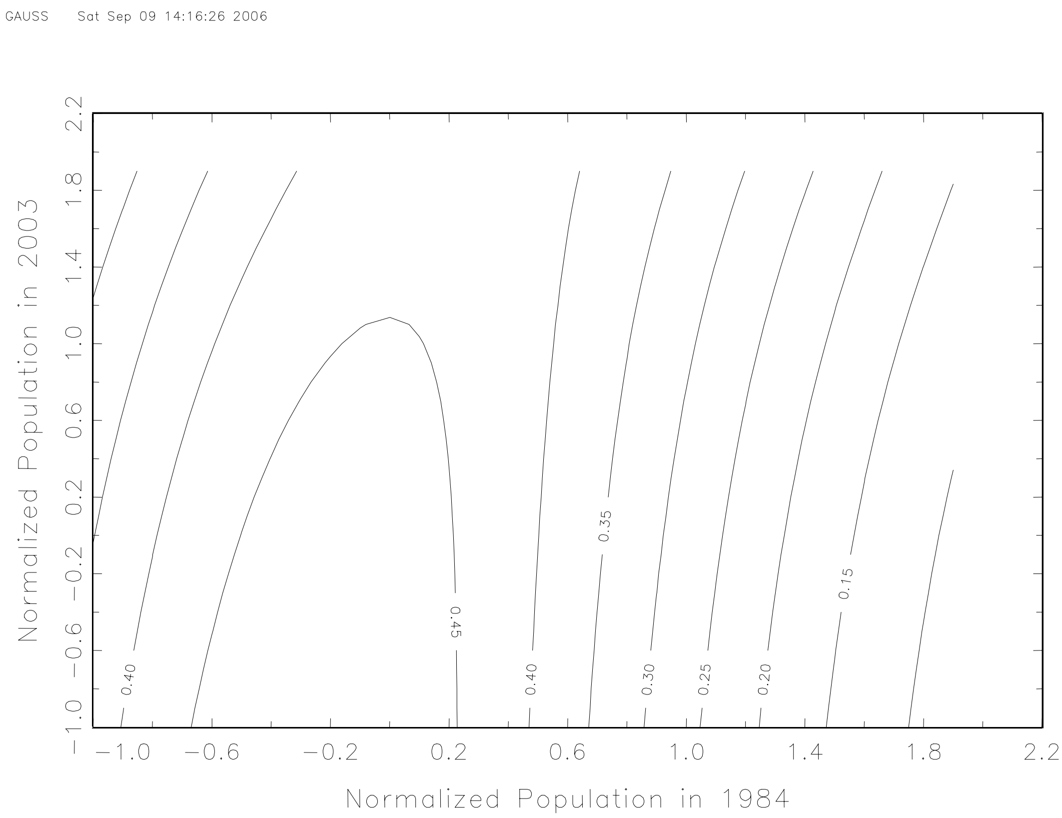

Figure 6: Contour Plot of Conditional Density for Population Size of Chinese Cities, 1984-2003 (Source: China Statistics Yearbooks, 1985 & 2004)