The spatial dispersion of economic activities and development trends in China: 1952–1985

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Abstract. This paper reviews and analyzes the spatial dispersion of economic activities in the Peoples' Republic of China for the period of 1952–1985. The purpose of the paper is to shed light on the future prospect of spatial development in China. Specifically, the paper examines the relationship between spatial dispersions of economic activities and the central government's policy for economic development in past decades.

1. Introduction

Historically, national development policies of the People's Republic of China have encouraged balanced development by sector and by region. China's future spatial development plans and policies, however, are not yet clear, particularly since China adopted a limited market economic system in the late 1970s, after decades of a centrally controlled economic system with a heavy emphasis on equity in the distribution of economic activities. In the Third Plenary Session of the Eleventh Central Committee in December, 1978, China adopted an open door policy on economic development, which resulted in rapid changes in economic growth in the coastal provinces in China. Because of this past tradition and new trends, China provides an interesting opportunity for an analysis of the impact of the central government's key economic policies on regional development and the spatial dispersion of economic activities (Li 1989a). China had implemented this equitable and balanced development policy since its liberation in 1949, but recently China has pursued a policy that focuses on readdressing spatial and/or sectoral disparities that have resulted from past centuries.

The purpose of this paper is to review and analyze the spatial distribution of economic activities in China to shed light on the effects of China's eco-

nomic development policies. More specifically, the paper examines the relationship between spatial dispersion of economic activities and the central government's policy for economic development in past decades. In addition, the paper examines the share of economic growth in seven coastal provinces (Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian and Guangdong) and two cities (Tianjin and Shanghai) before and after 1979 when the open-door policy was adopted.

The remainder of this paper is organized as follows. The following section presents a brief historical overview of economic development strategies in China. Section 3 describes the measure we used to analyze dispersion, the entropy measure, and two transformations thereof. Section 4 presents an analysis of spatial distribution of economic activities by sectors between the years 1952 and 1985. Section 5 presents a summary and conclusion.

2. Economic development strategies in China

China has implemented seven Five Year Economic Development Plans (FYEDP) since 1953. During the First FYEDP period (1953–1957), the plan emphasized the development of heavy industries. This strategy was based on Stalin's unbalanced development policy which held that the development of heavy industries will cause the development of light industries (Brodsgaard 1983). The focus on heavy industry was continued in the Second Five-Year plan (1957–1962), but this Plan was not carried out due to the Great Leap Forward movement. Several natural disasters in 1959–1961 and the withdrawal of Soviet technicians in 1960 made it impossible for Chinese planners to achieve the original growth targets (Liu and Wu 1986).

The three years between 1963–1965 are often called the Period of Readjustment and Consolidation. During this period, emphasis was given to restoring agricultural output and expanding it at a rate that would meet the needs of a growing population. As a means to revitalize agricultural production, small amounts of land were officially allowed to be privately owned. The Cultural Revolution prevented the Third Five-Year Plan (1966–1970) from being systematically prepared and implemented (Ma 1982). The radical Chinese leaders insisted that the most urgent task at hand was not to improve material well-being, but to continue the class struggle and to maintain spiritual purity. During the Fourth FYEDP period (1971–1975), the political environment for economic development was improved by exchanging diplomats with countries in the Western world.

The Fifth FYEDP (1976–1980) was severely hampered by political instability and natural disasters from the beginning. The Plan was revised in the Second Session of the Fifth National People's Congress in June, 1979, when Deng Xiao-Ping sought to stabilize political turmoil. During this period, emphasis was placed on price stability and balanced growth among industry sectors rather than the efficiency of economic growth. During the Sixth FYEDP period (1981–1985), an efficiency-first policy was implemented in order to achieve the national target of producing quadruple amounts in all sectors by the end of the century (Government of PRC 1983).

In April, 1986, the Fourth Session of the Sixth National People's Congress approved programs to be implemented during the seventh FYEDP (1986–1990) period. The plan was to achieve the following three goals: (1) to mod-

ernize the economic system by accommodating changes in consumer demand and industrial structure; (2) to facilitate the restructuring and expansion of existing industries through the adaptation of new technologies; and (3) to encourage the spatial dispersion of regional development through interregional coordination (Government of PRC 1986).

3. Entropy as a measure of spatial dispersion of economic activities

The concept of entropy originated in communication theory (Shannon and Weaver 1964), and has been used in a variety of applications including biology (Bowman et al. 1971), industrial organization (Horowitz 1971), mathematical geography (Wilson 1974), demography (Harsman and Quigley 1990) and transportation planning (Kim 1989, Kim 1990). In our analysis of the spatial distribution of economic activities, the concept of entropy is applied to data from 26 provinces in China. To illustrate our use of the entropy concept, consider a nation with k regions in which the activity, n, is distributed according to n_i; where the subscript i refers to the region i and the sum of n_i equals N. The entropy of activity n in the nation is found using the following equation:

$$H = -\sum_i [p_i * \ln(p_i)]$$

where,

H = entropy; and,

$p_i = n_i/N$.

As defined above, H provides a measure of the entropy or dispersion of the activity n. The value of H ranges from a minimum of 0, if $n_i/N = 1$ and $n_j/N = 0$ for all j not equal to i, to a maximum of $\ln(k)$, if $n_i = n_j$ for all i and j. The greater the value of H, the greater the dispersion the activity n.

Since the entropy H is a little known statistic with little intuitive appeal, it is useful to define the statistic F as follows:

$$F = \exp(H)$$

The F statistic is a monotonic transformation of H with more intuitive appeal. The F statistic represents the number of equal-sized regions necessary to generate the observed level of entropy or dispersion. The F statistic varies from a minimum of 1, when $H = 0$ and all activity n is concentrated in a single region, to a maximum of k, when $H = \ln(k)$ and n is uniformly distributed. The F statistic has been used extensively in industrial organization analysis and has been termed the numbers-equivalent of H (Horowitz 1971). We define a similarly useful statistic as follows:

$$G = H/\ln(k)$$

Again, G is a monotonic transformation of H with more intuitive appeal.

The G statistic represents the relative entropy of activity n. The G statistic varies from a minimum of 0, when $H = 0$ and n is concentrated into a single region, to a maximum of 1, and $H = \ln(k)$ when n is uniformly distributed (Garrison and Paulson 1973).

4. Total material product

To analyze the spatial distribution of economic activity in China, we collected annual data on industrial output for five sectors (agriculture, industry, construction, transportation, and commerce) for each of 26 provinces for the period from 1952 to 1985 from ''Guomin Shouru Tongji Ziliao Huibian (Statistical Data Compilation of National Income): 1949–1985'' (State Statistical Bureau, 1987). The Total Material Product (TMP) of each region is measured by summing gross output in value terms produced in the five sectors (agriculture, industry, construction, transportation, and commerce). TMP refers to the transferred value of materials consumed during the process of production, including value added. TMP differs from Gross Regional Product (GRP) in that the income generated by services such as cultural, educational, and scientific activities is not included in calculation of TMP.

Among 29 existing provinces in China, Tibet, Guangxi, and Anhui are excluded from this analysis because data from these provinces were incomplete and thus not compatible with data from the other 26 provinces. Hainando was not separately considered since it only became an independent province in 1988. The names of the five industry sectors and the 26 regions are listed in Tables 1 and 2, respectively. Figure 1 shows the 26 provinces that were chosen for this analysis. All the data are presented in current RMB.

Table 1 presents the share of Total Material Products (TMP) in each industrial sector from 1952 to 1985. The last column of Table 1 presents the TMP from 1952 to 1985. According to Table 1, Chinese TMP has increased in real terms every year since 1952. Throughout these years, Industry and Agriculture remained the largest industrial sectors, contributing more than 80% of TMP in 1985, followed by Construction, Commerce, and Transportation. Since 1977, however, the share of Industry has been falling while the share of Agriculture has been rising. This restructuring of the Chinese economy is attributed in part to global restructuring, and also to government policies favoring foreign investment.

Table 2 presents the share of Total Material Products (TMP) in each region, and in the last column shows TMP from 1952 to 1985. As shown in Table 2, the distribution of Chinese TMP has varied. Throughout the past 34 years, the coastal regions remained the biggest contributors to TMP. In 1985, for example, the ten biggest contributing regions are Jiangsu (R_{10}), Shandong (R_{15}), Guandong (R_{19}), Liaoning (R_6), Shanghai (R_9), Sichuan (R_{21}), Henan (R_{16}), Hubei (R_{17}), Hebei (R_3), and Hunan (R_{18}), in that order. Six of these (the top five and Hebei) are coastal regions. In fact, all of the coastal regions combined (seven coastal provinces and two cities defined above) contributed more than half of the total 1985 TMP in China.

Although Table 2 provides a useful descriptive representation of the spatial dispersion of economic activity in China, the information is limited. It does not, for example, provide a summary statistic that captures the overall spatial distribution of economic activity, nor does it illustrate the spatial distribution

Fig. 1. Major provinces in China

of specific industries or provide a basis for hypothesis testing. To overcome these limitations we have added Table 3.

Table 3 presents the entropy measures for each industry and for the sum of industries for each year. Reviewing Table 3 provides a number of important insights. First, the dispersion of economic activity differed significantly[1] across industries. As shown in Fig. 2, Industry is the most concentrated sector, followed by Agriculture. Construction and Transportation are the most dispersed. Second, the dispersion of TMP is about the average of all dispersions. This suggests that variation in the dispersion of specific industries tends to be

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[1] The term "significantly" indicates that we have tested for significance at the 95% level. The test for significance, however, are subject to the caveats discussed in the Appendix.

Table 1. Shares of total material products by sector: 1952–1985

Year	Agri	Indu	Const	Trans	Comm	Total
1952	0.454	0.344	0.056	0.034	0.111	1015
1953	0.411	0.363	0.068	0.034	0.124	1241
1954	0.397	0.383	0.061	0.036	0.123	1346
1955	0.406	0.377	0.061	0.035	0.120	1415
1956	0.372	0.392	0.089	0.034	0.113	1639
1957	0.334	0.438	0.073	0.037	0.116	1606
1958	0.265	0.507	0.094	0.042	0.092	2138
1959	0.195	0.582	0.092	0.047	0.083	2548
1960	0.171	0.611	0.093	0.049	0.077	2679
1961	0.283	0.537	0.046	0.038	0.097	1978
1962	0.324	0.511	0.041	0.034	0.089	1800
1963	0.328	0.508	0.050	0.034	0.081	1956
1964	0.317	0.513	0.067	0.032	0.071	2268
1965	0.309	0.520	0.066	0.034	0.071	2695
1966	0.297	0.530	0.064	0.033	0.075	3062
1967	0.333	0.498	0.056	0.031	0.082	2774
1968	0.350	0.485	0.050	0.031	0.083	2648
1969	0.298	0.523	0.070	0.031	0.079	3184
1970	0.278	0.547	0.071	0.031	0.072	3800
1971	0.263	0.565	0.074	0.030	0.067	4203
1972	0.255	0.573	0.073	0.031	0.068	4396
1973	0.257	0.574	0.070	0.030	0.069	4776
1974	0.263	0.562	0.077	0.029	0.069	4859
1975	0.250	0.581	0.081	0.030	0.059	5379
1976	0.254	0.581	0.080	0.029	0.057	5433
1977	0.233	0.596	0.077	0.030	0.064	6003
1978	0.229	0.594	0.083	0.030	0.064	6846
1979	0.248	0.587	0.084	0.027	0.054	7642
1980	0.256	0.574	0.090	0.029	0.052	8531
1981	0.271	0.564	0.082	0.028	0.054	9071
1982	0.280	0.553	0.092	0.029	0.048	9963
1983	0.281	0.547	0.095	0.028	0.049	11125
1984	0.288	0.535	0.096	0.029	0.052	13167
1985	0.276	0.528	0.100	0.028	0.068	16587

Unit: 100 million RMB; *Agri*: Agriculture
Indu: Industry; *Const*: Construction
Trans: Transportation; *Comm*: Commerce

offsetting. Third, the Construction industry has consistently become more concentrated since 1977, while Transportation has consistently become more dispersed since 1969. The overall distribution of economic activity measured by TMP, however, has become more concentrated since 1970.

Information similar to that in Table 3 is provided in Tables 4 and 5. Table 4 presents the numbers-equivalent F statistics, defined by Eq. 2. As shown in Table 4, the entropy of total TMP in China could be equated with 18 to 21 of China's regions. Or, as shown in Table 5, the relative concentration of total economic activity in China, measured by Eq. 3, varies from about 88% to 92%, a significantly higher degree of concentration than in Indonesia (Knaap and Kim 1990). Statistics shown in Tables 1, 2, and 3 indicate that economic activities in China have been relatively evenly dispersed, although there has been some variation since the 1970s, as described before. In the following

Table 2. Shares of total material products by region: 1952–1985

Year	R1	R2	R3	R4	R5	R6	R7
1952	0.016	0.030	0.062	0.023	0.017	0.083	0.030
1953	0.020	0.033	0.054	0.023	0.018	0.087	0.029
1954	0.022	0.032	0.055	0.024	0.021	0.087	0.029
1955	0.022	0.030	0.055	0.024	0.019	0.082	0.026
1956	0.022	0.030	0.048	0.025	0.021	0.085	0.026
1957	0.021	0.031	0.044	0.025	0.014	0.083	0.025
1958	0.027	0.034	0.043	0.025	0.017	0.086	0.025
1959	0.031	0.036	0.045	0.027	0.018	0.092	0.025
1960	0.036	0.037	0.043	0.027	0.019	0.098	0.029
1961	0.033	0.030	0.043	0.025	0.019	0.071	0.027
1962	0.028	0.028	0.040	0.025	0.019	0.072	0.027
1963	0.027	0.028	0.035	0.025	0.022	0.073	0.029
1964	0.027	0.027	0.037	0.025	0.022	0.074	0.029
1965	0.026	0.028	0.040	0.025	0.020	0.075	0.027
1966	0.025	0.028	0.038	0.024	0.019	0.072	0.026
1967	0.023	0.025	0.039	0.022	0.016	0.058	0.023
1968	0.030	0.032	0.052	0.022	0.021	0.065	0.025
1969	0.034	0.033	0.051	0.023	0.018	0.078	0.027
1970	0.031	0.032	0.049	0.026	0.018	0.078	0.028
1971	0.029	0.031	0.047	0.026	0.018	0.078	0.029
1972	0.029	0.030	0.045	0.024	0.016	0.078	0.028
1973	0.029	0.031	0.046	0.024	0.017	0.079	0.029
1974	0.031	0.033	0.049	0.023	0.016	0.082	0.030
1975	0.031	0.032	0.049	0.022	0.016	0.077	0.029
1976	0.030	0.028	0.047	0.020	0.016	0.076	0.027
1977	0.034	0.031	0.057	0.026	0.018	0.080	0.029
1978	0.035	0.032	0.058	0.026	0.018	0.078	0.029
1979	0.034	0.032	0.056	0.027	0.017	0.075	0.029
1980	0.035	0.032	0.054	0.025	0.016	0.079	0.028
1981	0.034	0.031	0.050	0.026	0.016	0.076	0.028
1982	0.032	0.030	0.049	0.026	0.016	0.072	0.027
1983	0.034	0.030	0.051	0.027	0.017	0.073	0.029
1984	0.033	0.029	0.051	0.028	0.017	0.072	0.030
1985	0.032	0.029	0.051	0.027	0.017	0.072	0.028

R1 Beijing; *R2* Tianjin; *R3* Hebei; *R4* Shanxi; *R5* Inner Mongolia; *R6* Liaoning; *R7* Jilin

sections we present a more detailed description of the dispersion of activities in each sector.

4.1. Dispersion of agricultural activities

In 1981, about 857 million people (or about 86% of the total population) in China were employed in the agricultural sector. At the same time, about 10% of the total land area, 96 million hectares, were used for agricultural activities. Total production in the agricultural sector did not change significantly until 1977, when it increased from 285 kg per person in 1952 to 298 kg per person in 1977.

Beginning in the early 1950s, the Chinese government encouraged the establishment of a commune system for agricultural production. In 1950, only

Table 2. (continued)

Year	R8	R9	R10	R11	R12	R13	R14
1952	0.046	0.094	0.072	0.039	0.038	0.019	0.030
1953	0.048	0.105	0.067	0.036	0.054	0.018	0.025
1954	0.049	0.101	0.062	0.035	0.047	0.018	0.025
1955	0.047	0.091	0.062	0.034	0.062	0.019	0.025
1956	0.045	0.093	0.056	0.033	0.076	0.020	0.023
1957	0.043	0.089	0.055	0.034	0.101	0.018	0.023
1958	0.048	0.094	0.059	0.035	0.083	0.016	0.024
1959	0.049	0.106	0.056	0.034	0.068	0.016	0.022
1960	0.050	0.111	0.052	0.031	0.066	0.016	0.022
1961	0.048	0.104	0.054	0.035	0.110	0.016	0.026
1962	0.044	0.089	0.053	0.037	0.132	0.017	0.025
1963	0.045	0.091	0.053	0.035	0.138	0.016	0.024
1964	0.046	0.092	0.056	0.035	0.135	0.016	0.024
1965	0.047	0.091	0.057	0.033	0.129	0.015	0.024
1966	0.049	0.086	0.057	0.044	0.133	0.015	0.023
1967	0.049	0.079	0.051	0.048	0.175	0.014	0.022
1968	0.059	0.111	0.067	0.072	0.000	0.015	0.030
1969	0.055	0.103	0.063	0.074	0.000	0.016	0.030
1970	0.054	0.093	0.063	0.076	0.000	0.016	0.029
1971	0.052	0.090	0.068	0.082	0.000	0.016	0.029
1972	0.049	0.091	0.071	0.089	0.000	0.017	0.028
1973	0.048	0.091	0.072	0.092	0.000	0.016	0.026
1974	0.050	0.092	0.070	0.100	0.004	0.016	0.024
1975	0.049	0.086	0.068	0.112	0.004	0.015	0.023
1976	0.047	0.083	0.069	0.149	0.004	0.015	0.021
1977	0.053	0.095	0.082	0.000	0.004	0.018	0.026
1978	0.051	0.095	0.084	0.000	0.005	0.019	0.026
1979	0.049	0.091	0.087	0.000	0.004	0.020	0.027
1980	0.050	0.090	0.090	0.000	0.005	0.020	0.027
1981	0.049	0.088	0.091	0.000	0.006	0.022	0.026
1982	0.048	0.079	0.088	0.000	0.036	0.021	0.025
1983	0.049	0.077	0.093	0.003	0.003	0.021	0.025
1984	0.046	0.073	0.098	0.005	0.003	0.022	0.024
1985	0.042	0.071	0.103	0.004	0.002	0.023	0.024

R8 Herlongjiang; *R9* Shanghai; *R10* Jiangsu; *R11* Zhejiang; *R12* Anhui; *R13* Fujian; *R14* Jiangxi

10.7% of farmers joined the commune, but the rate grew to 50.7% by 1955. From the outset, however, the commune system had several major problems. Specifically, some special form of a management system was needed to coordinate the collective farming system. This led to the emergence of a leader, or group of leaders, who faced the serious problem of how to distribute the income on a fair and equitable basis.

A contracted farming system was introduced in 1960 to overcome some of the problems associated with the commune system. Under the contracted farming system, farmers were able to rent a plot of farm land with the promise that a certain amount of production would be paid as rent. Whatever surplus the farmers produced beyond the contracted amount would belong to the farmers (Putterman 1987). The contracted farming system, which was severely criticized in the late 1960s by the Communist Party, was revived in the late 1970s. The system was officially recognized by the Party in late 1981. In Jan-

Table 2. (continued)

Year	R15	R16	R17	R18	R19	R21	R22
1952	0.076	0.049	0.039	0.040	0.049	0.058	0.014
1953	0.064	0.047	0.038	0.036	0.056	0.056	0.013
1954	0.067	0.048	0.032	0.034	0.059	0.062	0.013
1955	0.067	0.047	0.037	0.036	0.056	0.064	0.013
1956	0.063	0.043	0.041	0.033	0.053	0.065	0.014
1957	0.056	0.043	0.041	0.036	0.053	0.070	0.014
1958	0.059	0.045	0.040	0.035	0.051	0.064	0.014
1959	0.057	0.043	0.040	0.034	0.049	0.061	0.013
1960	0.049	0.042	0.037	0.034	0.046	0.062	0.012
1961	0.048	0.037	0.033	0.032	0.051	0.067	0.013
1962	0.049	0.035	0.040	0.035	0.055	0.061	0.013
1963	0.047	0.033	0.042	0.033	0.058	0.061	0.012
1964	0.045	0.032	0.040	0.034	0.057	0.061	0.013
1965	0.047	0.035	0.041	0.034	0.053	0.062	0.014
1966	0.047	0.035	0.045	0.033	0.050	0.061	0.013
1967	0.052	0.038	0.043	0.034	0.051	0.056	0.012
1968	0.068	0.044	0.047	0.041	0.057	0.054	0.014
1969	0.059	0.044	0.044	0.039	0.057	0.059	0.011
1970	0.061	0.046	0.044	0.040	0.055	0.062	0.014
1971	0.061	0.047	0.045	0.040	0.052	0.061	0.015
1972	0.061	0.047	0.045	0.042	0.052	0.059	0.013
1973	0.059	0.048	0.045	0.043	0.053	0.057	0.011
1974	0.047	0.049	0.043	0.038	0.055	0.054	0.010
1975	0.057	0.047	0.047	0.039	0.054	0.054	0.011
1976	0.062	0.041	0.042	0.037	0.057	0.048	0.010
1977	0.073	0.055	0.049	0.043	0.065	0.064	0.013
1978	0.071	0.052	0.049	0.043	0.060	0.069	0.014
1979	0.073	0.053	0.052	0.046	0.059	0.071	0.014
1980	0.076	0.054	0.051	0.045	0.062	0.070	0.013
1981	0.079	0.055	0.052	0.045	0.068	0.070	0.013
1982	0.077	0.051	0.051	0.044	0.068	0.069	0.014
1983	0.082	0.054	0.053	0.045	0.069	0.071	0.014
1984	0.084	0.053	0.055	0.043	0.071	0.070	0.015
1985	0.083	0.055	0.054	0.043	0.075	0.070	0.014

R15 Shandong; *R16* Henan; *R17* Hubei; *R18* Hunan; *R19* Guangdong; *R20* Guangxi*; *R21* Sichun; *R22* Guizhou
* Data not available

uary, 1980, only about one percent of all production teams in China changed to the individual farming system, called as the household responsibility system. This grew to 14.4% by December 1980, 28.2% by July, 1981, and 45.1% by October, 1981. By the end of 1983, about 97.7% of production teams, or 94.2% of households in China, operated under the household responsibility system. The effects were dramatic. Per capita production increased from 298 kg in 1977 to 378 kg in 1983, an increase of more than 30% from 1952.

The dispersion levels of agricultural activities shown in Tables 3, 4, and 5 reflect the effects of the above changes well. Figure 2 shows that the dispersion level has been fairly constant from 1952 to 1974. The peak in 1961 was the highest level of decentralization in agricultural production activities in China until 1985. This was the year when the Great Leap Forward Movement began. Overall dispersion levels indicate, however, that the Agricultural pro-

Table 2. (continued)

Year	R23	R25	R26	R27	R28	R29
1952	0.018	0.020	0.018	0.002	0.002	0.015
1953	0.020	0.022	0.016	0.002	0.002	0.013
1954	0.021	0.024	0.017	0.003	0.002	0.014
1955	0.021	0.023	0.017	0.003	0.002	0.015
1956	0.021	0.026	0.018	0.004	0.002	0.015
1957	0.021	0.022	0.017	0.004	0.002	0.014
1958	0.020	0.022	0.016	0.004	0.002	0.013
1959	0.019	0.022	0.016	0.005	0.002	0.015
1960	0.019	0.023	0.014	0.005	0.002	0.016
1961	0.019	0.025	0.011	0.004	0.003	0.017
1962	0.020	0.023	0.013	0.003	0.002	0.014
1963	0.019	0.021	0.015	0.003	0.002	0.015
1964	0.019	0.020	0.016	0.003	0.002	0.014
1965	0.020	0.022	0.017	0.003	0.002	0.014
1966	0.019	0.022	0.015	0.003	0.002	0.013
1967	0.019	0.020	0.015	0.003	0.002	0.012
1968	0.016	0.019	0.018	0.004	0.002	0.014
1969	0.020	0.025	0.018	0.004	0.003	0.012
1970	0.020	0.026	0.020	0.004	0.003	0.012
1971	0.019	0.028	0.020	0.004	0.003	0.012
1972	0.021	0.027	0.019	0.004	0.004	0.010
1973	0.021	0.026	0.019	0.004	0.003	0.010
1974	0.020	0.025	0.020	0.004	0.004	0.009
1975	0.018	0.024	0.020	0.004	0.004	0.010
1976	0.015	0.022	0.019	0.004	0.003	0.010
1977	0.019	0.026	0.021	0.004	0.004	0.011
1978	0.020	0.026	0.020	0.005	0.004	0.012
1979	0.020	0.026	0.018	0.004	0.004	0.011
1980	0.019	0.024	0.017	0.004	0.003	0.012
1981	0.020	0.023	0.016	0.004	0.003	0.012
1982	0.020	0.023	0.015	0.004	0.003	0.012
1983	0.020	0.023	0.016	0.004	0.003	0.013
1984	0.020	0.023	0.015	0.004	0.003	0.013
1985	0.019	0.023	0.016	0.004	0.003	0.013

R23 Yunnan; *R24* Tibet*; *R25* Shaanxi; *R26* Gansu; *R27* Qinghai; *R28* Ningxia; *R29* Xinjiang
* Data not available

duction has shown a consistent trend toward centralization since 1975. In fact, the most centralized production activity in three decades occurred in 1985. This trend clearly indicates the increase of agricultural productivity in some regions due to the practice of the popular contracted farming system accelerated by official recognition of the Party in 1979.

4.2. Dispersion of construction activities

The Construction industry in China includes all construction, expansion, transformation, and restoration projects as well as the purchase and installation of equipment. It includes construction for industry, geological resources, agriculture, transportation, telecommunication, commerce, and all other

Table 3. Spatial dispersion of total material products by sector: Entropy measures for 1952–1985

Year	Agri	Indu	Const	Trans	Comm	Total
1952	2.927	2.705	2.857	2.931	2.873	2.953
1953	2.944	2.691	2.883	2.929	2.863	2.948
1954	2.938	2.729	2.928	2.957	2.884	2.957
1955	2.938	2.760	2.973	2.973	2.912	2.969
1956	2.947	2.749	3.009	2.980	2.918	2.979
1957	2.930	2.766	2.936	2.996	2.930	2.971
1958	2.933	2.791	2.993	3.030	2.954	2.969
1959	2.945	2.812	3.033	3.025	2.976	2.964
1960	2.943	2.817	3.034	3.022	2.991	2.956
1961	2.952	2.818	2.988	3.015	2.983	2.974
1962	2.941	2.827	2.969	3.020	2.990	2.986
1963	2.929	2.824	3.020	3.026	2.980	2.982
1964	2.937	2.826	3.067	3.017	2.972	2.980
1965	2.934	2.834	3.044	3.012	2.967	2.982
1966	2.915	2.854	2.991	3.003	2.943	2.983
1967	2.925	2.861	2.993	3.003	2.961	2.989
1968	2.925	2.779	3.044	2.989	2.927	2.965
1969	2.922	2.837	2.998	2.981	2.964	2.978
1970	2.932	2.881	3.002	2.992	2.982	2.992
1971	2.933	2.894	3.029	2.988	2.994	2.996
1972	2.927	2.891	3.050	2.994	2.997	2.992
1973	2.930	2.890	3.060	2.999	2.983	2.987
1974	2.950	2.872	3.068	2.997	2.988	2.985
1975	2.947	2.898	3.057	3.005	2.974	2.987
1976	2.930	2.872	3.039	2.996	3.002	2.972
1977	2.926	2.905	3.031	3.000	3.004	2.979
1978	2.931	2.914	3.061	3.013	3.007	2.984
1979	2.911	2.920	3.062	3.007	2.986	2.981
1980	2.905	2.908	3.044	3.011	2.946	2.970
1981	2.908	2.903	3.021	3.008	2.959	2.966
1982	2.900	2.919	3.023	3.016	2.965	2.973
1983	2.899	2.926	3.016	3.026	2.968	2.973
1984	2.902	2.926	3.016	3.027	2.961	2.970
1985	2.887	2.927	3.009	3.034	2.953	2.965

means-supporting production. It also includes the construction of residential buildings, public institutions, and public facilities, especially cultural and educational facilities.

The Third Plenary of the Eleventh Central Committee of the Communist Party held in December, 1978, was the most dramatic turning point for the socialistic structure in the history of China. Individual ownership was allowed and individual freedom in economic activities was recognized. Special export districts were established in Shenzhen, Zhuhai, and Shantou (all in Guangdong Province); and in Xiamen (Fujian Province) in the late 1970s (Phillips and Yeh 1987). By 1985, Shenzhen, once a small village of 20,000 people, became a city of 300,000. In 1984, 14 other port cities were designated as special export districts (Li and Qu 1989).

Government investment in these districts was enormous. In the Shenzhen district alone, 49.9 million Yuan was invested in 1979, which grew to 124.9

Table 4. Spatial dispersion of total material products by sector: Number-equivalent F statistic for 1952–1982

Year	Agri	Ind	Const	Trans	Comm	Total
1952	18.68	14.96	17.40	18.74	17.69	19.17
1953	18.99	14.74	17.88	18.71	17.51	19.07
1954	18.88	15.32	18.70	19.24	17.88	19.25
1955	18.87	15.80	19.56	19.55	18.39	19.48
1956	19.06	15.63	20.27	19.69	18.50	19.67
1957	18.72	15.90	18.84	20.00	18.73	19.51
1958	18.78	16.30	19.95	20.70	19.17	19.47
1959	19.02	16.64	20.75	20.59	19.62	19.38
1960	18.97	16.72	20.78	20.53	19.91	19.22
1961	19.14	16.74	19.84	20.40	19.76	19.56
1962	18.94	16.89	19.47	20.48	19.89	19.80
1963	18.71	16.84	20.49	20.61	19.69	19.73
1964	18.85	16.87	21.48	20.43	19.54	19.70
1965	18.81	17.01	21.00	20.33	19.43	19.73
1966	18.46	17.35	19.91	20.15	18.97	19.76
1967	18.63	17.47	19.94	20.14	19.32	19.86
1968	18.64	16.10	20.99	19.88	18.67	19.39
1969	18.57	17.07	20.04	19.71	19.38	19.65
1970	18.77	17.83	20.12	19.92	19.73	19.92
1971	18.79	18.06	20.68	19.85	19.97	20.00
1972	18.67	18.01	21.12	19.97	20.02	19.92
1973	18.84	18.00	21.32	20.06	19.74	19.83
1974	19.11	17.68	21.50	20.02	19.85	19.79
1975	19.05	18.15	21.27	20.18	19.56	19.83
1976	18.74	17.68	20.88	20.00	20.12	19.53
1977	18.65	18.26	20.72	20.08	20.17	19.66
1978	18.74	18.43	21.35	20.35	20.22	19.77
1979	18.37	18.54	21.38	20.24	19.81	19.71
1980	18.26	18.31	20.99	20.31	19.03	19.48
1981	18.33	18.24	20.52	20.24	19.28	19.40
1982	18.17	18.52	20.56	20.41	19.40	19.54

million in 1980, 270.4 million in 1981, 632.7 million in 1982, and 885.9 million Yuan in 1983 (Renmin Ribao, March 29, 1984).

The dispersion of construction activities in China exhibits a wide range of centralization and decentralization patterns as shown in Fig. 2. The trends indicate cyclical ups and downs, progressing toward decentralization during the first half of each planning period and toward centralization during the second half of each planning period. The trend since 1978, however, is clearly downward, indicating that construction activities have been centralized. This trend is probably a result of the establishment of the special export districts described above.

4.3. Dispersion of industrial activities

Figure 2 shows that the dispersion levels of Industrial activities in China have generally been increasing, except during the period of the Third FYEDP. The

Table 5. Spatial dispersion of total material products by sector: Relative measures for 1952–1985

Year	Agri	Indu	Const	Trans	Comm	Total
1952	0.89	0.82	0.87	0.89	0.87	0.90
1953	0.89	0.82	0.87	0.89	0.87	0.89
1954	0.89	0.83	0.89	0.90	0.87	0.90
1955	0.89	0.84	0.90	0.90	0.88	0.90
1956	0.89	0.83	0.91	0.90	0.89	0.90
1957	0.89	0.84	0.89	0.91	0.89	0.90
1958	0.89	0.85	0.91	0.92	0.90	0.90
1959	0.89	0.85	0.92	0.92	0.90	0.90
1960	0.89	0.85	0.92	0.92	0.91	0.90
1961	0.90	0.86	0.91	0.91	0.91	0.90
1962	0.89	0.86	0.90	0.92	0.91	0.91
1963	0.89	0.86	0.92	0.92	0.90	0.90
1964	0.89	0.86	0.93	0.92	0.90	0.90
1965	0.89	0.86	0.92	0.91	0.90	0.90
1966	0.88	0.87	0.91	0.91	0.89	0.91
1967	0.89	0.87	0.91	0.91	0.90	0.91
1968	0.89	0.84	0.92	0.91	0.89	0.90
1969	0.89	0.86	0.91	0.90	0.90	0.90
1970	0.89	0.87	0.91	0.91	0.90	0.91
1971	0.89	0.88	0.92	0.91	0.91	0.91
1972	0.89	0.88	0.93	0.91	0.91	0.91
1973	0.89	0.88	0.93	0.91	0.91	0.91
1974	0.90	0.87	0.93	0.91	0.91	0.91
1975	0.89	0.88	0.93	0.91	0.90	0.91
1976	0.89	0.87	0.92	0.91	0.91	0.90
1977	0.89	0.88	0.92	0.91	0.91	0.90
1978	0.89	0.88	0.93	0.91	0.91	0.91
1979	0.88	0.89	0.93	0.91	0.91	0.90
1980	0.88	0.88	0.92	0.91	0.89	0.90
1981	0.88	0.88	0.92	0.91	0.90	0.90
1982	0.88	0.89	0.92	0.92	0.90	0.90
1983	0.88	0.89	0.92	0.92	0.90	0.90
1984	0.88	0.89	0.92	0.92	0.90	0.90
1985	0.88	0.89	0.91	0.92	0.90	0.90

trends indicate how firmly local governments in China have been committed to the development of industries. In contrast to Agriculture and Construction activities, the levels of dispersion of Industrial activities have shown strong trends toward decentralization, even after the establishment of special export districts in 1980. However, the rate of decentralization decreased after 1979. Pannell (1988) reports that gross industrial output generally decentralized after the First FYEDP, even though specific industries have displayed different spatial patterns.

Looking at Fig. 2, it becomes apparent that the Cultural Revolution, which occurred during the Third FYEDP period, caused Industry activities to become centralized. The major focus of the Third FYEDP was the establishment of a sound economic base through an increase of agricultural production and an increase in industrial technology. The sudden change in trend from decentralization to centralization of Industrial activities during this period may also have been caused by the fact that only limited areas were able to produce during the Cultural Revolution era.
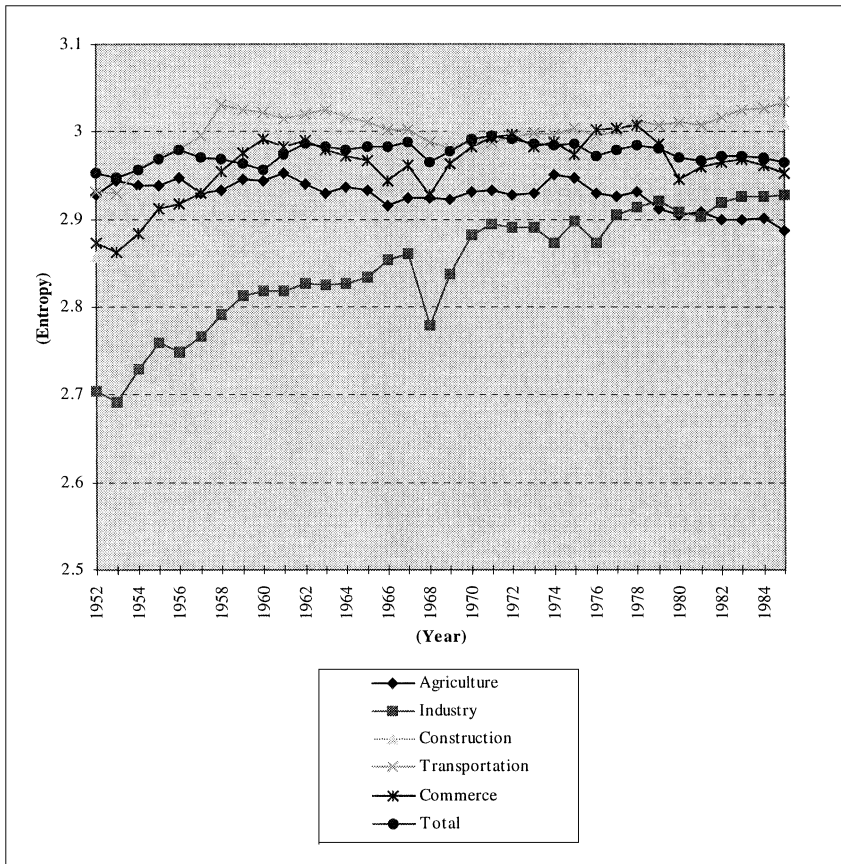
Fig. 2. Dispersion of economic activities in China by sector entropy measures for 1952–1985

4.4. Dispersion of transportation activities

One of the major barriers to the modernization of China has been the lack of social infrastructure, particularly the lack of transportation and telecommunication facilities. Since the opening of the market, the government invested heavily in the construction of roads, ports, railroads, and telecommunication systems.

As shown in Fig. 2, the dispersion of transportation services has been increasing since 1969. This consistent increase indicates a trend toward decentralization and therefore an increase in accessibility. By 1986, all of China (except Tibet) was connected by railroads totaling 52,100 km in length, of which about 9% were electric. During the Seventh FYEDP period, about 3,600 km of railroads were planned for installation, 3,300 km were to be expanded to a double track system, and 4,000 km were to be electric.

By 1985, the total length of national roads was 942,400 km, about half of which were not paved. A highway system connecting Beijing and Tianjin has
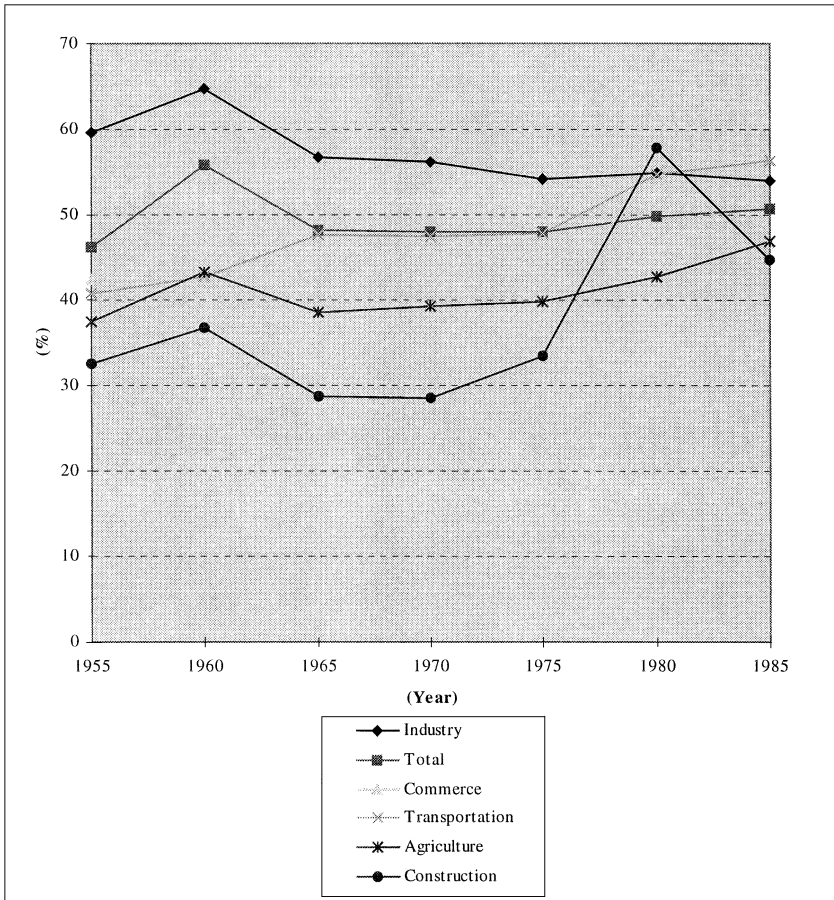
Fig. 3. Share of economic activities by 7 coastal provinces plus Tianjin and Shanghai

been planned for the future. An inland waterway system was extended to a total of 109,100 km by 1987, although about one-third of the system can not be used during winter. By 1982, China had 10,600,000 dwt ships and the current plan includes increasing that number to 20,000,000 dwt by the year 2,000. Air coverage extended to 324,340 km total by CAAC, which includes 107,575 km of international routes.

4.5. Economic activities in the coastal region

As discussed earlier, it is evident that the coastal regions of China provide the largest contributions to TMP and to many of the five industrial sectors as well. To examine this further we present in Fig. 3 the share of economic activities represented by the coastal region – defined as the seven coastal provinces plus coastal cities of Tianjin and Shanghai – for each year of the study period. As shown in the figure, the coastal region has been the focus of

China's economic development, particularly since the 1970s. This region produced more than 45% of all economic activities in China in 1985.

The contribution of the coastal region to the Agriculture sector increased from 37% in 1955 to 46% in 1985, with a particularly rapid increase after 1975. The share of industrial activities decreased from the peak of 65% in 1960 to about 55% in 1985, while the share of construction activities increased rapidly from about 33% in 1955 to 57% in 1980 and to about 44% in 1985. The share of transportation activities increased from about 41% in 1955 to about 56% in 1985. The share of commercial activities also increased from about 42% in 1955 to 46% in 1985.

Despite variation in the share of particular sectors, the of TMP in the coastal region remained high but relatively constant between 1952 and 1985. And though the share of Industry fell, the share of Commercial and Transportation activities increased rapidly, especially after 1970. If the Commercial and Transportation represent the leading sectors of China's economy, then the overall share of economic activity in the coast region is likely to increase further over the next several decades.

5. Summary and conclusion

The measures of economic dispersion presented above reveal a strong trend toward centralization in Agriculture, Commerce, and Construction activities and a general trend toward the centralization of TMP, especially since the early 1970s. Measures of the dispersion of activities in the Industrial sector, however, reveal a strong tendency toward decentralization for most of the study period. This trend, however, has slowed since 1979 displaying a constant degree of dispersion since the early 1980s. The dispersion of Transportation activities shows a general trend toward decentralization indicating the nationwide increase of accessibility.

Despite the Central Government's commitment to balanced growth, the coastal regions produced nearly half of the TMP in the 1980s, supporting the observations of centralization trends indicated by the measurement of dispersion of economic activities described above. These findings are consistent with results reported by Tsui (1991) in his study on China's regional inequality using the same data, but a different method of analysis.

The results have significant implications for China's current development policies. First, the results suggest that there are powerful economic forces leading to the concentration of certain sectors of China's economy. Second, these powerful forces were strong enough to overcome state policies that favor decentralization. Finally, the tendency toward growth in the coastal region of China has been evident since at least the mid 1970s and is not the result of recently adopted changes in state economic development policies.

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Apendix A

A.1. Hypothesis testing using entropy statistics

As defined above, the H, F, and G statistics are purely descriptive. Each one describes an observed dispersion of the activity n on a different scale. For analytical purposes, however, it is useful to think of these statistics on probabilistic terms. The value p_i represents the probability of activity n located in region i, and n_i/N represents an estimate of p_i. If the n_i represents a large sample drawn from a multinomial population, then H is a maximum-likelihood estimate of the true entropy $\mathbf{H}$ (Theil 1971). Further, the estimated

H has been shown to follow a normal distribution with a mean $\mathbf{H}$ and the variance given in equation 4 (Bowman et al. 1971).

$$\text{var}(H) = \sum_i \{[p_i \ln(p_i)^2 - H^2]/n\} + (k-1)/2n^2 \tag{4}$$

Viewing H as a normally distributed function of random variables makes the standard statistical tools of inference such as hypothesis testing applicable. Assuming the n_i/N are distributed according to a multinomial random distribution, we can conduct simple hypothesis tests for the equality of entropy across different activities n and across time. These tests are analogous to tests for the difference of means under the assumption that sample means are normally distributed, based on Eq. 5.

$$(H_1 - H_2)/(\text{var}(H_1) + \text{var}(H_2))^{1/2}$$

H_1, H_2:   Estimated entropy values for sectors (categories) 1 and 2.

$\text{var}(H_1), \text{var}(H_2)$: Variances for estimated entropy values of sectors (categories) 1 and 2.

Selected hypothesis tests produced the following results:

1. The levels of dispersion of Total Material Products of Regions between the years 1955 and 1965, and between 1965 and 1975, remained fairly constant ($t = 0.8$ and $t = 0.73$, respectively). However, TMP became significantly concentrated ($t = -3.29$) between the years 1975 and 1985.
2. The levels of dispersion of Agriculture between the years 1955 and 1965 remained fairly constant ($t = -1.04$). However, the Agriculture sector became significantly dispersed between the years 1965 and 1975 ($t = 2.61$). In contrast, it became significantly concentrated between the years 1975 and 1985 ($t = -8.62$).
3. The levels of dispersion of Industry outputs between the years 1955 and 1965 remained fairly constant ($t = 1.6$). However, the Industry sector became significantly dispersed between the years 1965 and 1975 ($t = 2.82$), and 1975 and 1985 ($t = 4.3$).
4. The levels of dispersion of Construction between the years 1955 and 1965, and 1965 and 1975 remained fairly constant ($t = 0.75$ and $t = 0.4$, respectively). However, TMP became concentrated ($t = -1.67$) between the years 1975 and 1985.
5. Although the trends in Transportation are consistently dispersed, the differences between years 1955 and 1965, 1965 and 1975, and 1975 and 1985 are not significant ($t = 0.21$, $t = -0.09$, and $t = 0.41$, respectively).
6. In 1985, the levels of dispersion of all sectors are significantly different except between Transportation and Construction ($t = 0.67$).
7. In the year 1985, the Agriculture sector ($H = 2.888$) was more concentrated than Industry ($H = 2.927$, $t = -4.13$).
8. In the year of 1985, the Industry sector was more concentrated than Commerce ($H = 2.93$, $t = -1.22$), but the difference is not significant.

10. In the year 1985, the Commerce sector was more concentrated than Construction ($H = 3.01$, $t = -2.24$).
11. In the year 1985, the Construction sector was more concentrated than Transportation ($H = 3.03$, $t = -0.67$), but the difference is not significant.

A.2. Caveats

The approach we use to conduct hypothesis tests is taken from Garrison and Paulson (1973). As stated, the approach takes a probabilistic view of entropy. In this view, the dispersion of economic activity is a stochastic process that reflects unobserved, underlying parameters. As such, the p_i represent the true probability of region i attracting activity n. Thus, if the n_i are drawn from a multinomial distribution, the n_i/N represent maximum-likelihood estimates of the p_i, H is a maximum-likelihood estimate of the true entropy $\mathbf{H}$, and the standard statistical tools of inference are applicable. As N approaches infinity, second, third, and higher-order moments can be approximated similar to the variance in equation 4. When N is small, adjustments must be made to eliminate bias in the estimates of the moments. In our case, N is not small (small requires $N < 5k$, see Bowman et al. 1971).

Problems of bias are minor compared to more troubling problems concerning necessary assumptions about the distribution of the n_i. For the application of statistical inference, the n_i must be distributed according to discrete multinomial probability functions. Unfortunately, it is not clear that they are. In our case, the n_i represent RMBs of TMP in region i; N represents the total RMBs of TMP in all regions. To employ statistical inference, each RMB must be viewed as a sample observation from a population with the p_i as underlying parameters. This perspective raises two issues: are the n_i stochastic random variables, and what constitutes the size of the sample?

The first issue concerns the nature of the sample. Since the sum of $n_i (\sum n_i)$ constitutes the entire population of RMBs, it is not clear that the n_i can be considered a sample. The second issue concerns the size of the sample. Since the variance is a function of the sample size n (as in Eq. 4), the size of the sample is critical in determining the variance, as well as the dispersion of the estimated entropy around its true value. However, since we are using monetary units as the sample unit, the size of the sample unit is dependent on the choice of monetary unit (in the U.S. for example, dollars versus pennies). The first moment, the mean entropy, is independent of the sample unit; but the second moment, the variance, is dependent on the sample unit.

These issues raise serious questions concerning the appropriateness of statistical inference. Since the entropy statistic is independent of the sample unit, except for the bias adjustment, we present the entropy statistics with confidence concerning their descriptive properties. But since the variance of the entropy statistic depends on the size of the sample unit, over which we can exercise discretion, we present the hypothesis tests as preliminary.