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Spatial-temporal patterns of China's interprovincial migration, 1985–2010

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Abstract: Migration plays an increasing role in China's economy since mobility rose and economic restructuring has proceeded during the last three decades. Given the background of most studies focusing on migration in a particular period, there is a critical need to analyze the spatial-temporal patterns of migration. Using bicomponent trend mapping technique and interprovincial migration data during the periods 1985–1990, 1990–1995, 1995–2000, 2000–2005, and 2005–2010 we analyze net-, in-, out-migration intensity, and their changes over time in this study. Strong spatial variations in migration intensity were found in China's interprovincial migration, and substantial increase in migration intensity was also detected in eastern China during 1985–2010. Eight key destinations are mostly located within the three rapidly growing economic zones of eastern China (Pearl River Delta, Yangtze River Delta and Beijing-Tianjin-Hebei Metropolitan Region), and they are classified into three types: mature, emerging, and fluctuant origins, while most key origins are relatively undeveloped central and western provinces, which are exactly in accordance with China's economic development patterns. The results of bicomponent trend mapping indicate that, in a sense, the migration in the south was more active than the north over the last three decades. The result shows the new changing features of spatial-temporal patterns of China's interprovincial migration that Fan and Chen did not find out in their research. A series of social-economic changes including rural transformation, balanced regional development, and labor market changes should be paid more attention to explore China's future interprovincial migration.

Keywords: China; spatial-temporal pattern; interprovincial migration; bicomponent trend mapping; economic and cultural factors

1 Introduction

The large-scale inter-regional migration is one of the most profound changes in China due to

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the economic transition since the late 1970s and the relaxation of migration control since the 1980s (Harry, 1994). A report on the country's 2010 population census stated that more than 260 million Chinese people are living away from where they are formally registered, and the majority of them (approximately 220 million) are rural migrants living and working in urban areas without formal urban household registration status (Peng, 2011). The intensity of China's interprovincial migration has quintupled over the past three decades: increasing from 11 million in 1985–1990 to 55 million in 2005–2010 (see Table 1). Internal migration has become an increasingly important determinant of demographic change at the provincial level in China.

Between 1980 and 2012, China's urbanization increased from 19.4% to 52.6%, unfortunately, China's urbanization has developed far ahead of its economic growth (Yang, 2013). China's rapid urbanization is much more complicated than the urbanization process that developed countries had experienced (Gu, 2012). The population aggregation from rural to urban areas in most developed countries was induced by agglomeration of manufacturing and service sectors. However, China's large-scale migration flow is the consequence of three factors including market, government, and individual (Ning, 1998). The role that government played in the urbanization process of China is more important than the developed countries. In the early stage, the urbanization was far behind the industrialization process, because the government decided most industrial distribution and the economic development in urban areas were not prosperous enough to absorb migrants. After 30 years, the present urbanization level is coordinated with economic development level (Lu *et al*., 2006). The problem is the quality of urbanization needs to be improved due to enormous rural migrant works are still at poor status in cities. China's urbanization process has its particularity, different with most countries in the Chenery's Model (Chen *et al*., 2013). It is both pulled by sustained and rapid economic growth and industrialization and pushed by huge migration flow of millions of surplus rural labors.

After the 1970s, much research has been devoted to studying the interprovincial migration in China (Shen, 1999, 2011; Johnson, 2003; Fan, 2005). However, due to the low mobility until recent decades and lack of detailed and accurate migration data, studies of China's interprovincial migration lagged behind many other nations, and most of them were often focused on net migration of a certain time period instead of on the spatial structure of the migration and its changes over time. It should be noted that some studies paid attention to different aspects of China's interprovincial migration, including differences between permanent and temporary migration (Yang, 2000), floating population's household strategy (Zhu, 2003; Liang and Ma, 2004), settlement intension of floating population (Zhu and Chen, 2010), and changing patterns and determinants of interprovincial migration (Shen, 2011). Some scholars tried to employ conventional migration models (e.g. gravity model) to estimate the impacts of determinants on the whole provincial migration in China (Pannell, 1997; Yan, 1998; Shen, 1999; Fan, 2005). However, due to the new circumstances for population movements after the reforms and availability of systematic and national-level data on migration in China after the 1980s, advances in identifying changes over time in the spatial patterns and in the understanding of the mechanisms that drive these changes are needed.

Generally speaking, there are two widely accepted regional division systems in China (Figure 1). One is the so called "three regions," also referred to as the "three economic belts": Eastern, Central, and Western Regions, reflecting a conceptualization popularized by the 7th Five-Year Plan (1985–1990) that dictated each of the regions should focus on its

Table 1 Interprovincial migration in China (1985–1990 to 2005–2010)

Province	1985–1990		1990–1995		1995–2000		2000–2005		2005–2010	
	In	Out	In	Out	In	Out	In	Out	In	Out
Beijing	672,662	132,148	676,368	114,059	1,989,158	183,537	2,245,358	329,811	3,827,760	405,950
Tianjin	244,607	72,194	217,404	60,293	517,874	109,768	908,453	106,717	1,497,120	213,360
Hebei	520,387	645,704	490,036	405,684	810,432	918,116	611,849	989,509	924,090	2,017,390
Shanxi	307,026	218,472	154,287	136,559	402,874	351,126	210,189	345,208	498,210	793,680
Inner Mongolia	254,306	303,129	268,054	242,047	342,621	464,274	394,038	417,057	827,680	647,590
Liaoning	541,375	294,996	423,704	191,397	794,547	399,863	673,811	416,453	1,171,870	685,420
Jilin	237,293	355,532	145,910	287,145	267,326	557,168	217,811	532,453	338,420	853,890
Heilongjiang	367,428	607,485	218,475	597,666	317,053	989,284	195,245	1,019,849	321,850	1,463,210
Shanghai	665,526	132,562	707,147	118,929	2,281,926	171,516	3,025,057	375,094	4,900,490	401,010
Jiangsu	791,110	620,478	943,642	437,828	2,008,789	1,306,295	3,290,717	1,327,774	4,887,290	1,893,540
Zhejiang	335,886	632,323	453,509	500,847	2,857,611	1,020,842	5,062,189	1,041,132	8,372,910	1,339,400
Anhui	337,763	533,388	151,267	724,972	329,958	3,045,221	670,642	3,835,774	822,140	5,525,590
Fujian	251,044	238,387	335,359	213,897	1,417,095	657,400	1,933,962	802,038	2,449,910	1,113,660
Jiangxi	224,865	293,772	121,851	499,289	248,347	2,821,684	499,170	2,475,849	698,350	3,483,280
Shandong	609,432	534,842	513,218	371,691	951,663	924,421	923,472	1,123,019	1,335,580	2,014,990
Henan	477,833	589,626	262,794	720,881	494,632	2,430,484	279,547	3,433,358	429,660	5,430,370
Hubei	431,121	346,274	263,476	371,691	638,137	2,326,526	501,132	2,714,868	843,470	3,804,200
Hunan	271,802	528,614	209,417	685,621	381,726	3,432,863	501,057	3,327,849	688,420	4,591,910
Guangdong	1,257,508	250,494	1,896,636	215,164	12,106,389	461,053	11,996,377	1,715,170	13,874,400	1,612,900
Guangxi	142,505	588,889	116,494	539,419	302,589	1,934,884	397,208	2,123,094	597,790	2,820,530
Hainan	150,101	105,977	101,105	99,351	229,126	136,411	190,792	157,962	337,710	235,900
Chongqing	–	–	–	–	471,326	1,161,189	427,170	1,437,434	735,590	1,844,060
Sichuan	469,876[a]	1,316,049	384,938	1,419,262	620,632	4,626,874	763,245	3,940,755	1,052,830	4,988,090
Guizhou	190,408	312,786	148,053	391,074	275,211	1,296,758	531,094	1,765,660	591,930	2,680,750
Yunnan	250,264	277,432	201,332	235,326	771,305	419,095	469,132	600,906	620,880	1,089,070
Tibet	–	54,582	34,968	27,273	74,411	37,211	25,434	31,396	91,970	62,490
Shaanxi	314,588	362,349	158,865	257,632	445,253	757,179	254,868	826,943	734,020	1,347,490
Gansu	199,196	280,715	135,878	244,580	214,358	590,337	117,736	494,340	260,200	1,046,860
Qinghai	115,819	102,141	50,065	74,513	80,958	129,632	73,585	85,358	182,540	149,980
Ningxia	91,912	56,609	47,533	52,987	135,600	92,021	74,566	67,774	239,030	150,660
Xinjiang	341,718	277,412	551,205	145,910	1,202,295	228,189	577,434	181,736	839,800	286,690
Total Inter-provincial migration	11,065,361		10,382,989		33,981,221		38,042,340		54,993,910	

Sources: Tabulation on the 1990 Population Census of the People's Republic of China (1993);
Tabulation on the 1995 National 1% Sample Survey (1996);
Tabulation on the 2000 Population Census of the People's Republic of China (2002);
Tabulation on the 2005 National 1% Sample Survey (2006).
– No data
[a] The data of Chongqing in the first two sets were included in the data of Sichuan

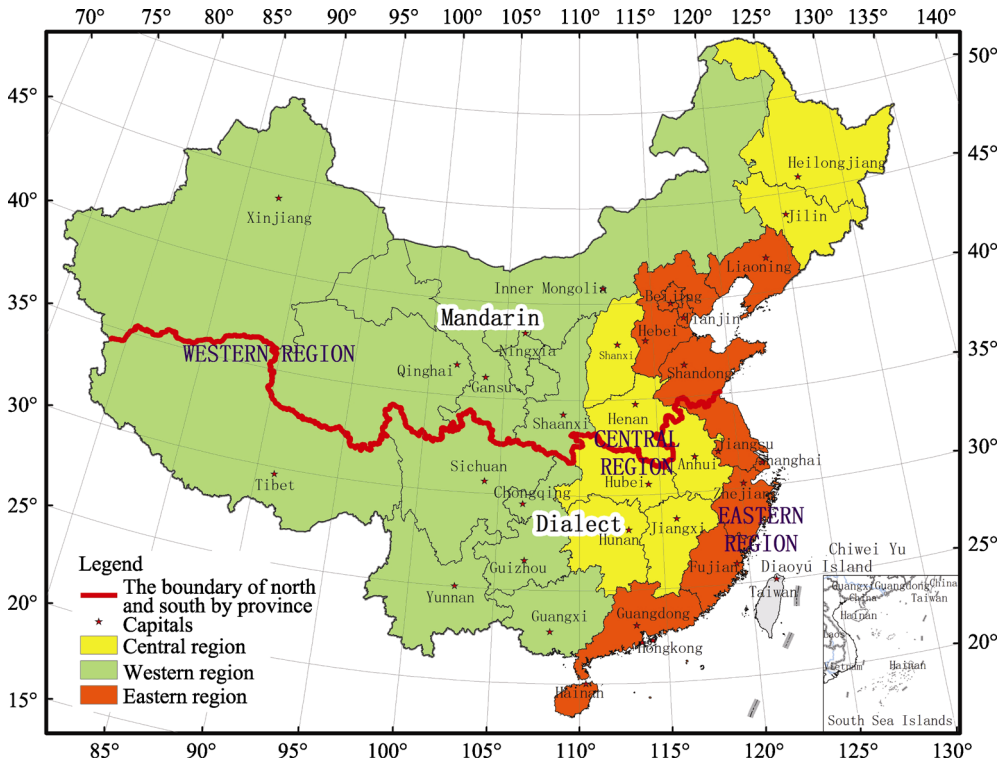

Figure 1 Two regional division systems in China

comparative advantage. They constitute a convenient regionalization scheme to describe the level and changes of regional inequality, which are important for understanding the spatial patterns of China's internal migration. The other well-known division system is North-South China as shown in Figure 1. The entire China is divided into two parts (the North and the South) by a red line, which is drawn based largely on provincial boundaries considering the provincial level we study on here. Besides different natural environments including climate, topography, soil, and food, the long-term cultural heritage and precipitation also greatly affected China's North-South diversity. The northerners are said to be more forthright and staid; on the other hand, the southerners are relatively more euphemistic and speculative. All these discrepancies between them are likely to work on their decision-making process before they migrate. The above two regional divisions we mentioned are of great value to comprehending the spatial patterns of China's internal migration.

The purpose of this paper is to understand the dynamics of interprovincial migration over the last three decades so as to explore potential future interprovincial migration patterns. The specific aims are (1) to analyze the spatial variations of migration intensity at the provincial level (2) to demonstrate the temporal change of interprovincial migration using a method called bicomponent trend mapping, and (3) to discuss the policy implication of spatial-temporal patterns of interprovincial migration in order to achieve regional sustainable development.

2 Data and methodology

2.1 Data

Migration volume is commonly defined as the number of people who changed residence or

crossed certain administrative boundaries between two specific points in time. The migration data used in this research are derived from 1990 National Population Census, 1995 1% Population Sample Survey, 2000 National Population Census, 2005 1% Population Sample Survey, and 2010 National Population Census, respectively. The first two data sets cover all the 30 provincial-level jurisdictions in China in 1985–1995 (including 5 autonomous regions and 3 cities directly under the central government, Beijing, Tianjin, and Shanghai); the latter three cover all the 31 provincial-level jurisdictions in China from 1995 to 2010 (including 5 autonomous regions and 4 cities directly under the central government, Beijing, Tianjin, Shanghai, and Chongqing, where Chongqing was upgraded from a city in Sichuan Province in 1996). The in-migration data of Tibet were absent in 1990 census. In addition, we use the term "province" for all types of provincial-level administrative regions of China for the sake of simplicity. In sum, the migration data used here is the migration flows among the 31 provincial regions during the periods of 1985–1990, 1990–1995, 1995–2000, 2000–2005 and 2005–2010. Table 1 shows in-migration and out-migration of the 31 provincial regions in the five periods.

In this paper, we captured the number of migrants based on the question that "the current place of residence on the date of enumeration was different from their permanent residence 5 years ago" at a provincial level, and the current place of residence was considered as the usual residence of the migrants if they had left their place of household registration for more than one year. For interprovincial migrants, their origin and destination province were identified. Based on the way we captured the interprovincial migration volume from the five enumerations (1990, 1995, 2000, 2005 and 2010), we can study five-year migration flows for the five census and survey periods.

2.2 Indices

Since migration intensity derived from census transition data represents probability rather than rate (van Imhoff and Keilman, 1991), here we employ crude migration probability (*CMP*), which is obtained by dividing the number of migrants from area *a* to area *b* by the total number of inhabitants in area *a* at the beginning of the five-year period. Moreover, we analyze crude net-migration probability (CM_nP), crude in-migration probability (CM_iP), and crude out-migration probability (CM_oP), which can be expressed as follows respectively.

$$CM_nP_a = \frac{M_i - M_o}{P_a}$$

$$CM_iP_a = \frac{M_i}{P_a}$$

$$CM_oP_a = \frac{M_o}{P_a}$$

where M_i is the volume of in-migration, M_o is the volume of out-migration, and P_a is the total population of province *a*.

Insights into variation of interprovincial crude migration probabilities across space and time are gained from an analysis of the key destinations and origins, which are identified using in-, out-, and net-migration probabilities for each provincial region.

2.3 Bicomponent trend mapping (BTM)

The spatial-temporal patterns of migration reflect migration flows that differ in size across

many places and times. However, the relationship between size, space and time is complicated which makes it hard to determine the spatial-temporal patterns. Conventional approaches to visualizing spatial-temporal patterns use a series of maps to separately depict only one of two important aspects: the way spatial distributions change over time, or the way temporal behaviors vary spatially, but rarely both (Andrienko and Andrienko, 2006). In this paper, we adopted the Bicomponent Trend Mapping (BTM) method to effectively illustrate the dynamics of spatial patterns of China's interprovincial migration. Bicomponent trend mapping depicts multiple forms of trend variation simultaneously on one map by combining the techniques of principal component analysis (PCA) and bivariate choropleth mapping (Schroeder, 2009; Sander, 2010).

As illustrated in Figure 2, the bicomponent trend map consists of three elements: a map, a bicomponent matrix, and a component loading chart. PCA here is used to reduce the number of variables from five (one for each census and survey, as shown in the five maps on the top) to a smaller number of components that capture the region-specific level and the change over time. The PCA thus uses the migration intensity values from a series of five maps as input, and we selected the first two components PC1 and PC2 as shown in the left bottom loading chart, due to the nature of migration data, which can capture two main things: PC1 for the level of net-migration intensity and PC2 for its trend. The resulting scores of PC1 and PC2 for each province were divided into three quantiles, respectively. Color shadings of provinces in the map thus correspond to different combinations of component scores. For example, provinces covered by orange have high scores for both PC1 and PC2, which means this province had a high level and an increase trend of migration intensity in five periods.

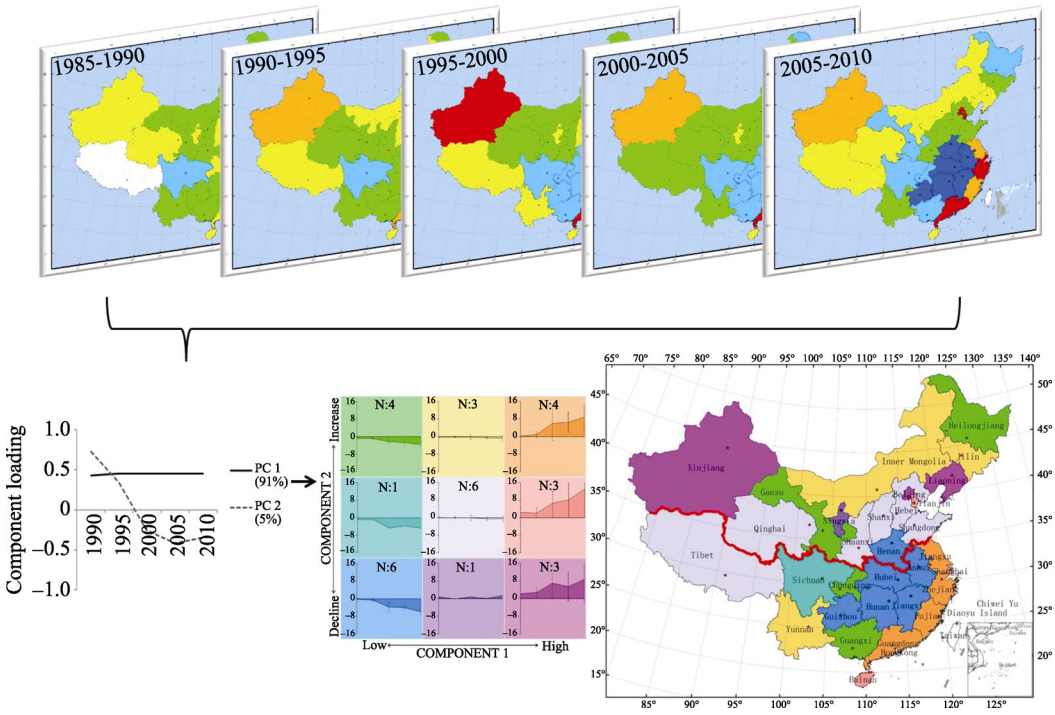

Figure 2 Schematic diagram of bicomponent trend mapping

3 Analysis to the result

The volume of internal migration in China has been increasing since the economic reform in the late 1970s and relaxation of migration control during the 1980s (Harry, 1994; Fan, 2005; Shen, 2011). There were 11.06 million interprovincial migrants in 1985–1990, and the number rose up to 54.99 million in 2005–2010 (see Table 1). The direction has also shifted from east-to-west migration in the pre-reform period to west-to-east migration in the reform period (Shen, 1996; 2011; Fan, 2005; Liu, 2011). Comparing five-year internal migration intensities between countries, we can see from Table 2 that, China had an intensity of 3%, close to that of Mexico, both of which are developing countries. Despite of different zonal system and number of regions, China's internal migration intensity was still low compared to that of the developed countries, like the USA and Australia.

Table 2 Five-year internal migration intensities between countries

Country	Zonal system	Number of regions	Census year	Intensity (%)
China	Province	31	2005	3.00
Mexico	State	32	2005	2.70
USA	State	51	2005	8.94
Australia	Division (SD)	61	2006	10.39

Source: Martin Bell and Salut Muhidin. 2009. Human Development Research Paper. Cross-National Comparisons of Internal Migration

In this section, we will examine the migration intensity by crude net-, in-, and out-migration probabilities in China from 1985–1990 to 2005–2010 in order to provide an overall view of migration spatial-temporal patterns for the last three decades. We introduce bicomponent trend mapping (BTM) to translate the three-dimensional image containing space, time, and spatial indicator into a two-dimensional map. Therefore, the results of the analyses are represented by three bicomponent trend maps. The patterns and trends over time for crude net-, in-, and out- migration probabilities are illustrated by the following three maps.

3.1 Net-migration

In Figure 3, considerable net-migration gains (above 2%) are detected mainly in two regions: one is coastal areas, including Shanghai (25.31%), Beijing (22.25%), Guangdong (13.34%), Zhejiang (14.36%), Tianjin (12.31%), Fujian (3.78%) and Jiangsu (4.01%), which are located within the three most developed economic zones of eastern China (Pearl River Delta, Yangtze River Delta and Beijing-Tianjin-Hebei Metropolitan Region) initially formed since reform and opening-up policy in the late 1970s; while, the other one is Xinjiang (2.75%) in northwest China due to the support Xinjiang construction policy as well as its vast land and abundant resources. Moderate and great losses of net-migration are identified mainly in central and western provinces during 2005–2010, such as Anhui (–7.69%), Jiangxi (–6.46%), Hunan (–6.17%), Guizhou (–5.60%), Henan (–5.33%), Hubei (–5.18%), Sichuan (–4.79%), Guangxi (–4.77%) and so on. Therefore, the spatial distribution patterns of net-migration represent a "low in the center, high in the periphery" structure, which means the central areas were losing people, while the periphery regions, especially the southeastern coastal areas, were gaining people. Namely, the internal migration is reshaping China's population distri-

bution with enhancing the agglomeration of population in coastal areas and narrowing the population density gap between western and central regions.

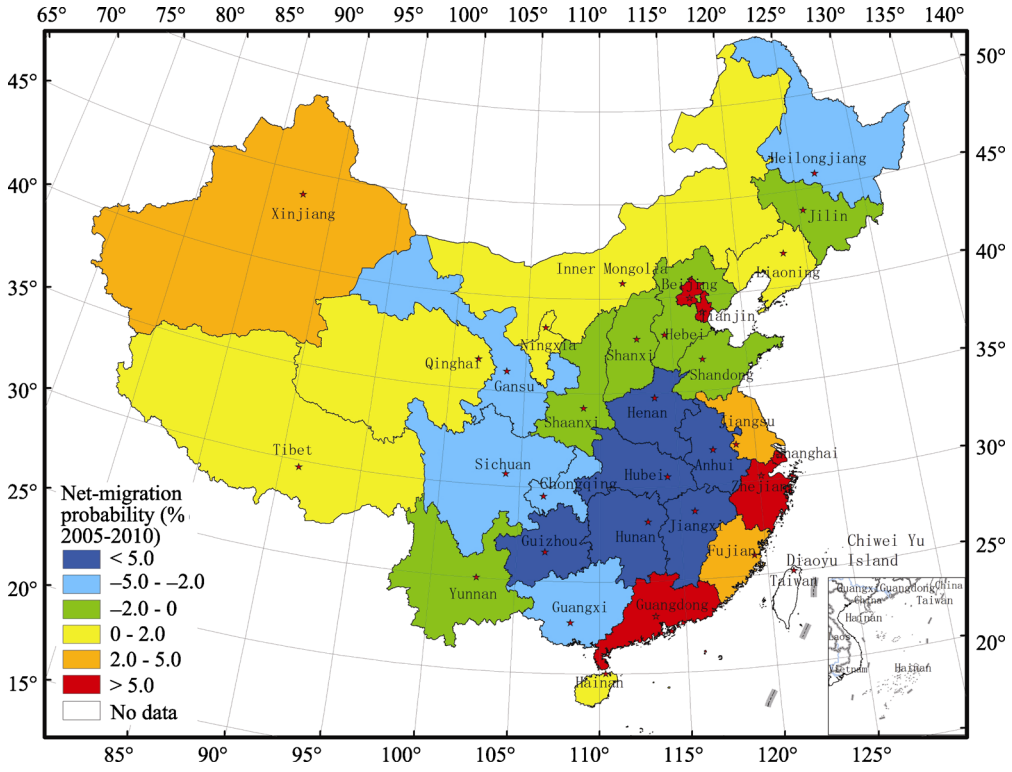

Figure 3 Crude net-migration probabilities by province in China (2005–2010)

To be specific, the key origins of migrants, which are defined as provinces with net-migration probabilities below –4% in 2005–2010 here, include eight provinces: Anhui, Jiangxi, Hunan, Hubei, and Henan in central China; Guangxi, Sichuan, and Guizhou in western China.

Among them, Anhui was the province with the largest loss of population followed by Jiangxi, Hunan, and Guizhou in 2005–2010, which are all located in close proximity to the most developed regions of southeastern coastal provinces.

The other provinces with negative net-migration probabilities are listed as follows:

Western China: Chongqing, Gansu, Shaanxi, and Yunnan;

Central China: Heilongjiang, Jilin, and Shanxi;

Eastern China: Hebei and Shandong.

Five provinces were the key destinations for migrants with a net migration probability above 12% in 2005–2010: Shanghai, Beijing, Zhejiang, Guangdong, and Tianjin, which are all located in eastern China and three most developed economic belts. Jiangsu, Fujian, and Xinjiang came after them with the net-migration probability above 2% but lower than 5 in 2005–2010. Among them, Jiangsu locates itself in proximity to Shanghai in the Yangtze River Delta economic zone, and Fujian is a province in the southeastern coastal areas of China near Guangdong and Zhejiang, while the only noticeable exception is Xinjiang, which lies in western China and has below-average economic development level as a result of its

cotton industry and cross-border trade with the Central Asian Republics (Pannel, 1997; Loughlin, 2001), and certain supporting Xinjiang construction migration policies implemented by Chinese government for its place and role in geopolitics.

In eastern China, Liaoning, Hainan, Shandong, and Hebei had net-migration probabilities close to zero (1.15%, 1.23%, –0.73%, and –1.60% respectively). Liaoning is one of the three northeastern provinces of China (the other two are Jilin and Heilongjiang) known as the traditional industrial base, and the 11th Five-Year Plan (2006–2010) highlighted the role of the northeastern regions, proposing economic restricting and reforms of state-owned enterprises for it. Apparently, none of the three provinces can be the migrants gainer, and the further north, the more population loss for all four periods (Heilongjiang, –2.99% < Jilin, –1.90% < Liaoning, 1.15%, 2005–2010). Hainan Province is an island located in the southernmost China, demarcating its north boundary with Guangdong by Qiongzhou Strait. Thus, relatively isolated geographic location makes its attractiveness for interprovincial migrants not as strong as most of the provinces in eastern China. Although Shandong is one of the most developed provinces in terms of its GDP ranking second to Guangdong in 2005, it is the third most populous provinces of China for five periods after Sichuan and Henan. Hebei belongs to Beijing-Tianjin-Hebei Capital Economic Zone, which is unlike the Pearl River Delta and Yangtze River Delta Economic Zones, lack of fully developed cities around, only Beijing and Tianjin dual core center cities, made Hebei comparatively weak and lost population (58.27% outflow of Hebei flowed into Beijing and Tianjin in 2005–2010).

Changing trend of crude net-migration probabilities by provinces is shown in Figure 4. The provinces are sorted by western, central, and eastern China and then by their net-migration probabilities in 2005–2010. We can also see that most provinces in eastern China experienced significant increases in net-migration probability, except Hainan, Liaoning, Shandong and Hebei we mentioned above. However, provinces in central and western China manifested moderate net-migration probabilities and relatively slight changes over time.

Eight key destinations had net-migration probabilities above 2% in 2005–2010, and four of them experienced a significant and continuous rise in net gains or a change from net losses to net gains over time: Shanghai, Zhejiang, Fujian, and Jiangsu in eastern China. The net-migration probabilities of Beijing and Tianjin maintained increase stamina, except there was slight decline during 1990–1995 for both of them, and 2000–2005 for Beijing. The net-migration probabilities of Guangdong and Xinjiang kept stable rise in the previous three periods, but lowered in the fourth period (2000–2005). However, 2005–2010 period saw another rising trend; the increase rate has been obviously slowed down compared to the previous periods. The provinces with the net-migration probabilities lower than zero usually recorded the decline trend. That is to say, these provinces lost people due to migration, and this effect increased over time.

The bicomponent map (Figure 5) shows a systematic shift of net-migration over time, and it confirms our earlier findings. Four provinces covered by orange had high net-migration gains and experienced a dramatic increase during 1985–2010, all of which are southeastern coastal provinces (Jiangsu, Zhejiang, Fujian, and Guangdong). There are six provinces shadowed by blue means these provinces experienced high net-migration losses, and had undergone a sharp decline over time, i.e. increasing population losses. In addition, five of them are located in central China (Henan, Anhui, Hubei, Hunan and Jiangxi), and one is in western China (Guizhou).

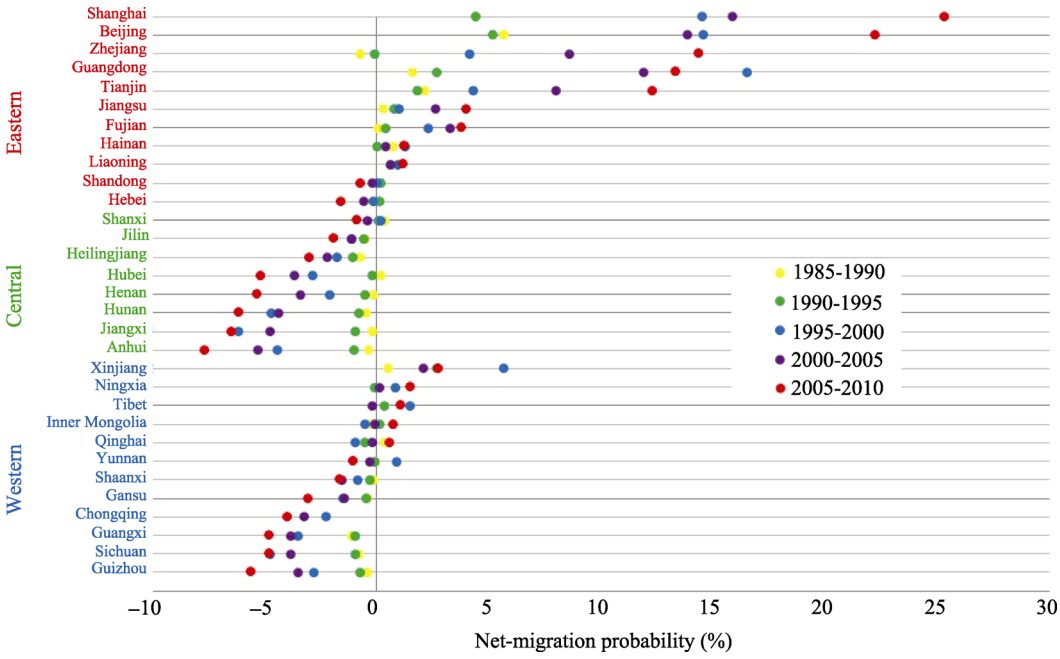

Figure 4 Net-migration probabilities by provinces (1985─1990 to 2005─2010)

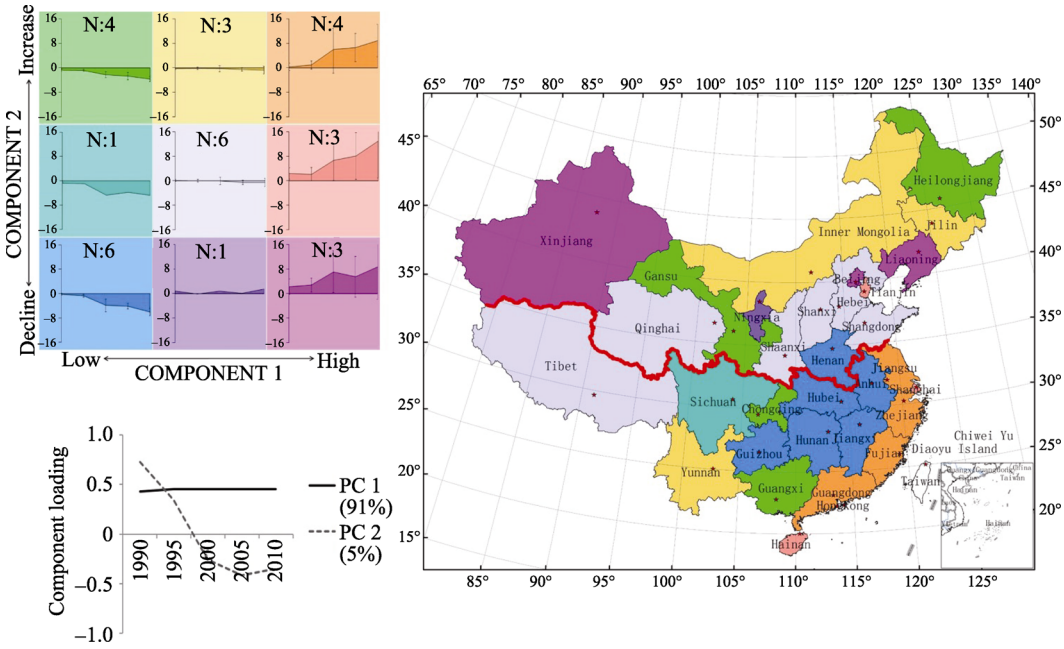

Figure 5 Bicomponent trend of net-migration probabilities (1985─1990 to 2005─2010)

Another interesting finding is that most provinces in north China belong to the stable column (grey), while most ones in the south belong to increase or decline groups, which implied that the migration in the south was more active than that of in the north.

3.2 In-migration

From Figure 6 we can see that, the migrants' choice of destination has been changing in China during the past 30 years, especially the substantial increase in in-migration in most of the eastern provinces. The in-migration probabilities of the most provinces in central and western China has been low and recorded a stable or slight increase trend since 1985, except some western provinces recorded a decrease trend in in-migration probability.

In light of the level and the change over time of crude in-migration probabilities, key destination provinces can be divided into three groups (see Table 3):

The "mature" destinations with in-migration probabilities over 20% in 2005–2010 had very strong and increasing net gains, including Beijing and Shanghai, which is China's

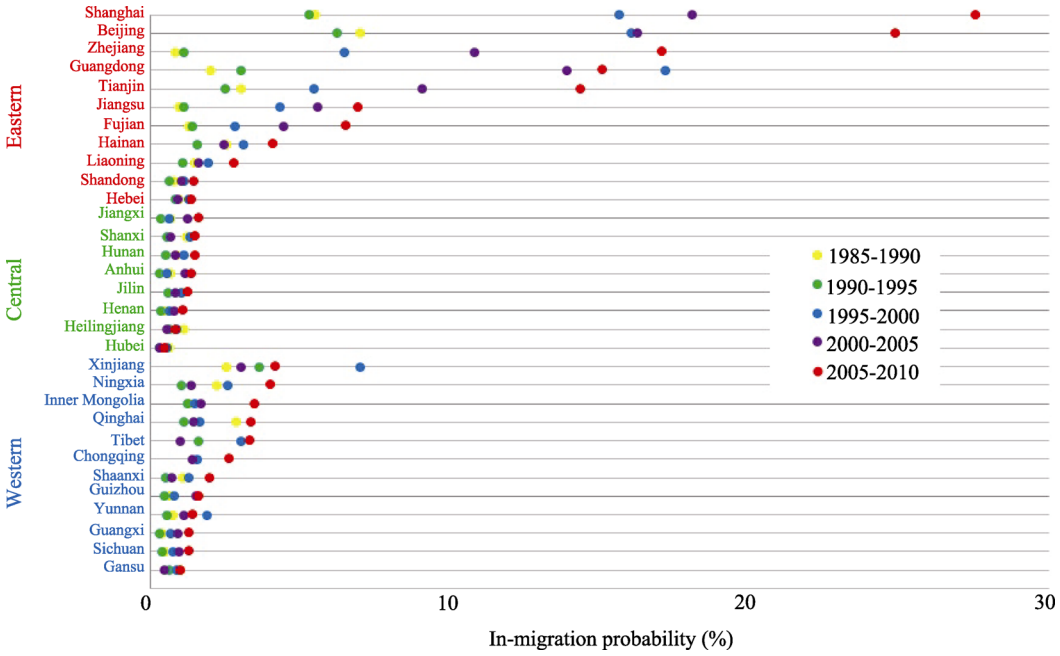

Figure 6 In-migration probabilities by provinces (1985─1990 to 2005─2010)

Table 3 Crude in-migration probabilities (1985–1990 to 2005–2010), and destination type (only provinces with a net-migration probability above 4% in 2005–2010 are shown)

Province	In-migration probability (%)					Mature	Fluctuant	Emerging
	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010			
Shanghai	5.469	5.289	15.662	18.071	27.562	X		
Beijing	7.007	6.228	16.042	16.247	24.888	X		
Zhejiang	0.833	1.088	6.443	10.824	17.095			X
Guangdong	2.011	2.989	17.170	13.881	15.091		X	
Tianjin	3.027	2.459	5.434	9.075	14.354			X
Jiangsu	0.925	1.104	4.318	5.572	6.930			X
Fujian	1.273	1.394	2.810	4.424	6.538			X
Xinjiang	2.511	3.605	6.998	3.000	4.178		X	

political and economic core, respectively. They attract migrants from all of the country with their rich cultural heritage and booming economy.

The "fluctuant" destinations with increasing in-migration at the beginning but obvious decrease and increase over time include Guangdong and Xinjiang. Both of their in-migration probabilities increased in the first three periods, then declined at least by 3 percentage points in the fourth period, and rose a little in the last period. As the gateway of reform, Guangdong is prone to be affected by the external financial environment. Due to the particular geopolitical position of Xinjiang, its in-migrants are mainly from Sichuan, Henan, and Gansu owing to the supporting Xinjiang construction and western development policies. Two provinces manifested fluctuant in-migration probabilities because they are relatively more sensitive to the external financial environment and government policy.

The "emerging" destinations are those provinces that showed a tremendous rise in in-migration (Zhejiang, Tianjin, Fujian, and Jiangsu). The in-migration probability of Zhejiang ranked the last one in the first period, but ascended to the top three in-migrants gainers right after Shanghai and Beijing in 2005–2010, overpassing Guangdong.

Figure 7 shows that the significant spatial-temporal variations in in-migration probabilities have played a more important role than out-migration for shaping the spatial-temporal pattern of net-migration probabilities across provinces. The bicomponent trend matrix shows that, among provinces with high in-migration probability (the right column), four provinces experienced a rise (N=4: Jiangsu, Zhejiang, Fujian, and Guangdong), whereas four (Beijing, Xinjiang, Hainan, and Qinghai) experienced a decrease and two (Shanghai and Tianjin) were stable. All of the provinces with a low in-migration level experienced an increase (N=7: Jiangxi, Anhui, Hunan, Guizhou, Guangxi, Sichuan, and Chongqing), except only one decline (N=1, Heilongjiang). Eight provinces had low and stable in-migration probability (turquoise and grey field). The provinces with stable in-migration levels were located spatially in the central and western parts of China, none of which was an attractive destination according to the earlier findings. It is confirmed by the bicomponent map that southeastern coastal provinces experienced dramatic growth of in-migration probabilities (orange field). As we anticipated, the orange field, covering the provinces with high-level in-migration probability and an increasing trend, contains the 'emerging' destinations of Fujian, Zhejiang, and Jiangsu. Moves to the 'mature' destinations (Shanghai) were positive and slightly increased over time (pink field). The regions with increase high level in-migration were concentrated spatially in the southeastern coastal part of China. However, most inland provinces experienced low, declined or stable in-migration trend over time. Moreover, an interesting finding is that all provinces with increase trend (first row) in in-migration probability are located in South China, and provinces with decline trend (third row) are in North China. Another special finding is that, there's only one province classified into blue field, with low value and decline trend for both bicomponent trend map of in-, and out-migration probability, which indicate that the general increasing trend of China's internal migration.

3.3 Out-migration

Distinctive characteristics can be clearly identified here for out-migration probabilities (see Figure 8). The out-migration probabilities and the in-migration probabilities are complementary, i.e. the out-probabilities of coastal provinces with high in-migration probabilities were relatively low, while the out-migration probabilities of central China with low

in-migration probabilities were relatively high. Out-migration probabilities for most provinces in central and western China showed high level and steadily increasing trend over time, while the most eastern provinces experienced relatively low-level and low increase out-migration probability.

In the bicomponent map of out-migration probability (Figure 9), we identify the top five sender provinces (Henan, Hubei, Anhui, Hunan, and Jiangxi) in the orange field – high and

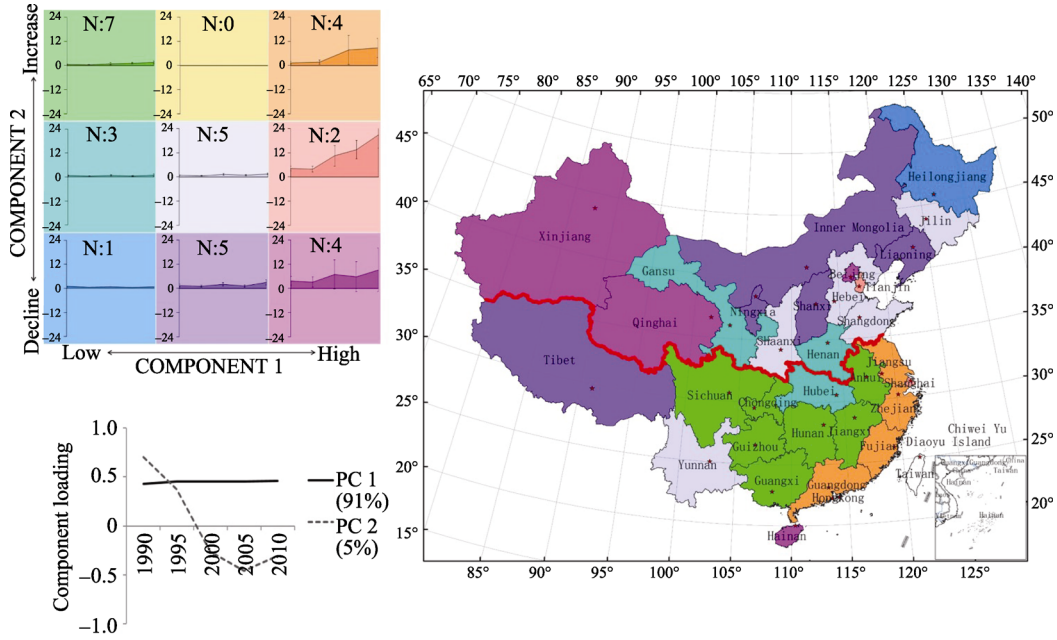

Figure 7 Bicomponent trend of in-migration probabilities (1985─1990 to 2005─2010)

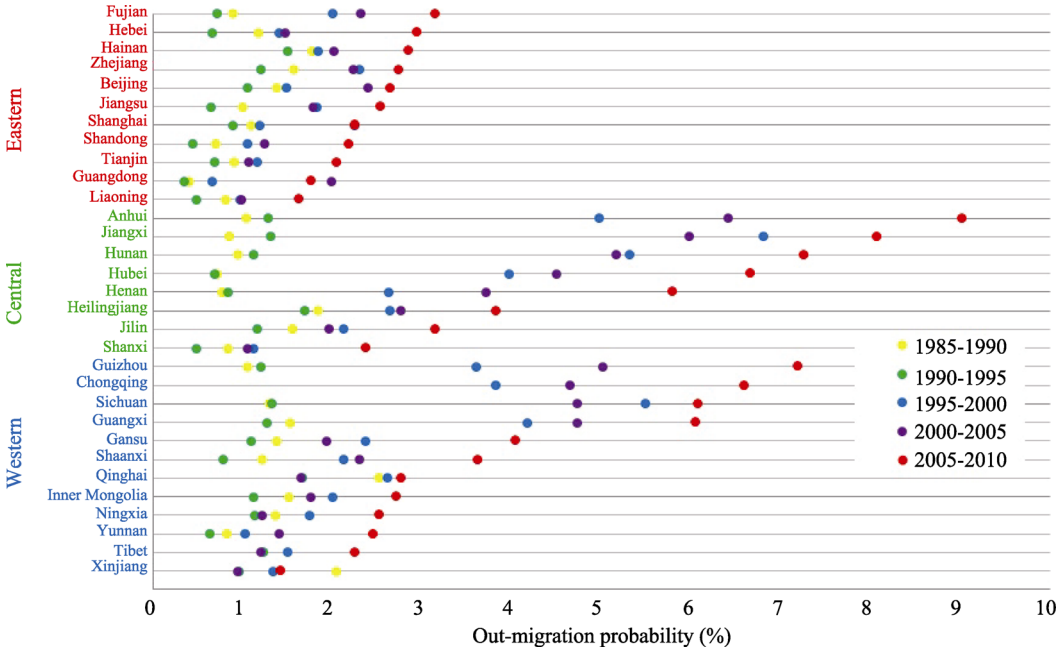

Figure 8 Out-migration probabilities by provinces (1985─1990 to 2005─2010)

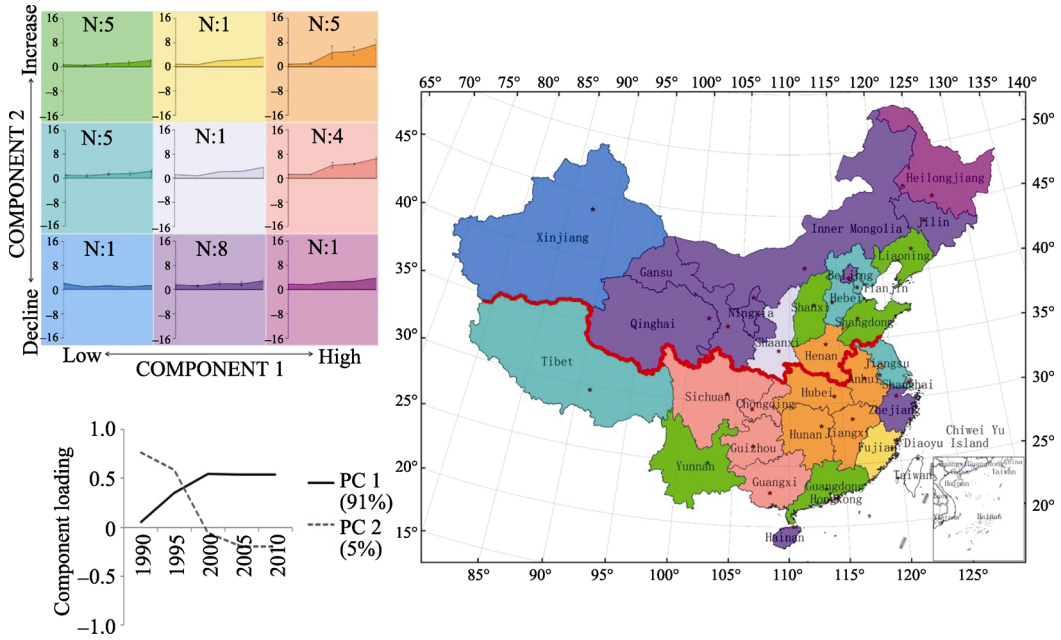

Figure 9 Bicomponent trend of out-migration probabilities (1985–1990 to 2005–2010)

increase pattern, all located in central China, and close to economic developed areas. They were important source of migrants in China, whereas those provinces which are far away from the major economic zones recorded descend trend in out-migration probabilities, including Xinjiang, Qinghai, Heilongjiang, Inner Mongolia, etc. The provinces with high and increase out-migration probabilities covered by orange or pink were mainly located in the South, while the provinces with low and decline out-migration probabilities covered by purple and grey were mostly located in the North, which indicates that the northerners are more reluctant to leave their residences, the southerners are more dynamic.

4 Conclusions and discussion

4.1 Conclusions

This study is concerned with the spatial-temporal patterns of China's interprovincial migration. Using BTM technique, both the spatial and temporal dimensions were examined through analysis of variables net-migration, in-migration, and out-migration intensities in the periods 1985–1990 to 2000–2005. In general, the BTM works well for China's interprovincial migration and it can highlight changes over time in the spatial structure of migration. Conclusions of the research are summarized as follows:

(1) Eight provinces with net-migration probabilities over 2% in 2005–2010 are detected as the key migration destinations in China. Among them, three types were identified. Beijing and Shanghai belong to "mature" destinations having the strongest and relatively increasing net gains of migration. Zhejiang, Tianjin, Fujian, and Jiangsu are "emerging" destinations recording a substantial rise in net gains, while Guangdong and Xinjiang had unsteady in-migration, thus, are entitled "fluctuant" destination.

(2) The spatial distribution patterns of net-migration represent a "low in the center, high in the periphery" structure, which means the central areas were losing people, while the periphery regions, especially the southeast coastal areas, were gaining people. That is to say, the internal migration is reshaping China's population distribution with enhancing the agglomeration of population in coastal areas and narrowing the population density gap between western and central regions over time.

(3) The in-migration probabilities and the out-migration probabilities are complementary, i.e. the out-probabilities of coastal provinces with high in-migration probabilities were relatively low, while the out-migration probabilities of central China with low in-migration probabilities were relatively high. In-migration probabilities increased largely in most of the provinces in Eastern China, like Zhejiang, the in-migration probabilities of which increased from 0.83 in 1985–1990 to 17.10 in 2005–2010, whereas most of the provinces in western China recorded a comparatively low increase in in-migration during the five periods. The in-migration probabilities of provinces in Central China were low and stable or slight decrease, like Henan, the in-migration probabilities of which declined from 0.62 in 1985–1990 to 0.46 in 2005–2010. On the contrary, out-migration probabilities increased greatly in the central and southwestern China, which are close to the economic growth centers.

(4) Migration manifests itself diversely in South China and North China. BTM helps us to identify that the migration in the south was more active and dynamic than that of in the north in our study period from 1985 to 2010.

(5) A clear picture of China's interprovincial migration over the last two decades has been drawn by the analysis of net-, in-, and out- migration intensity and BTM technique. Due to an increasing mobility and economic growth gap between coastal and inland regions, the scale of migration rapidly increased in the period 1985–2010, from 11 million in 1985–1990 to almost 55 million in 2005–2010, which proves Ravenstein's statement (1885) migration is mostly due to economic causes. Some fast growing regions in Eastern China has become new destinations because of the effects of "pull" factors in these regions – they attract people adjacent to these economic zones migrated to these provinces. This phenomenon reveals that the "pull-push" theory of migration (Bogue, 1959; Lee, 1966) fits well for China.

(6) The spatial pattern of China's interprovincial migration is consistent with the "Core and Periphery Theory" in spatial economy field (Fujita, 1999). The spatial overlap of major destinations and economic centers confirmed the concentration of huge migration flow is a consequence of economic agglomeration. The fast-growing mobility implies that massive temporary migrants are still at poor status due to their low education level and rural *hukou* identity. This bifurcation is very common in urban areas of eastern China, suggested by the labor market segmentation theory (Fan, 2002).

4.2 Discussion

This study improved traditional methods for studying spatial-temporal patterns of migration by BTM technique. The innovation is that both the spatial pattern and changing trend are demonstrated in one single chart. The notion that the migration of South China was more active than that of North China was confirmed by the BTM technique. Nevertheless, focusing on migration at the provincial level cannot reflect all the characteristics of China's internal migration. The difficulty in accessing to investigate migrants of different ages, wages,

sexes, and education levels and the lack of migration data among counties and cities in one province lead to some limits for this study to describe migration process at micro level. This could be done in specific regions in further research, due to mass data and a lot of data processing work.

As China is entering into a new era with fast economic growth, regional development discrepancy, relaxed migration control, and improved technology, a comprehensive connection between migration and social-economic factors would receive more attention from government and researchers (Fan, 2008; Shen, 2011). This connection has been confirmed by the research on the spatial-temporal patterns of China's interprovincial migration in the period 1985–2010. Besides, a series of social-economic changes including rural transformation, balanced regional development, and labor market changes would be new factors impacting China's future interprovincial migration. A greater understanding of the connection between migration and regional development would be important to explore what lies ahead for future interprovincial migration in China.

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