High-level talent flow and its influence on regional unbalanced development in China

Yang Zhou[a,b,d], Yuanzhi Guo[a,b,c], Yansui Liu[a,b,d],*

[a] Institute of Geographic Sciences and Natural Resources Research, Center for Assessment and Research on Targeted Poverty Alleviation, Chinese Academy of Sciences, Beijing 100101, China
[b] Key Laboratory of Regional Sustainable Development Modelling, Chinese Academy of Sciences, Beijing 100101, China
[c] University of Chinese Academy of Sciences, Beijing 100049, China
[d] Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China

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ABSTRACT

Brain drain has long been a concern. However, little is known about the brain drain within a country. China is a developing country which is experiencing not only overseas brain drain but also a domestic cross-regional and cross-departmental flow. In this study, we investigate the flow of high-level talent (HLT) given the background of constructing world-class universities and disciplines (WCUDs) in China and its dynamic mechanisms, and then we discuss its potential implications. The results show that over the past four decades, eastern China has been a net-inflow area, and the northeastern and midwestern regions saw a net outflow. The eastern region shows more internal regional flow. Furthermore, a large amount of HLT has flowed from scientific research institutes to colleges and universities (CUs). Regional socioeconomic gaps, imperfect systems and inadequate management are the main reasons for the flow of HLT. Regional HLT flow is not as serious as expected, but irrational flow will probably aggravate the already interregional disparity in educational resources and human capital accumulation as well as regional unbalanced development. Therefore, some measures should be taken to fight irrational high-level talent flow.

1. Introduction

Brain drain, the diffusion of skilled human capital, is of concern to many countries and regions (Davenport, 2004; Pang, Lansang, & Haines, 2002). The term "brain drain" was first proposed by the British Royal Society, which referred to the migration of scientists and technologists from the United Kingdom to North American in the years after World War II (Cervantes & Guellec, 2002). Later, brain drain was used to refer to the mobility of the most highly skilled individuals in different regions, industries and occupation, including scientists, healthcare workers, engineers, and others with professional training (Bassioni, Adzaho, & Niyukuri, 2016; Gibson & Mckenzie, 2011).

High-skilled personnel tend to flow to areas with high levels of science and technology, liveable environments, sufficient funding for research and good salaries (Gibson & Mckenzie, 2011), which means that the developed countries (DCs) are the major destinations, while the less developed countries (LDCs) are major sources (Levy, 2003). Entering the 21st century, despite the existence of a new feature of global brain return and brain circulation (Lee & Kim, 2010; Mayr & Peri, 2009; Pellegrino, 2001; Saxenian, 2005), in which emerging economies are

particularly prominent (Grogger & Hanson, 2011; Kerr, Kerr, Özden, & Parsons, 2017; Saravia & Miranda, 2004; Zweig, 2006), the overall trend is still the same. Statistics from the World Bank show that there are approximately 28 million high-skilled migrants living in Organization for Economic Cooperation and Development (OECD) countries in 2010, an increase of nearly 130% since 1990 (Kerr, Kerr, Ozden, & Parsons, 2016). With the development of globalization and multi-polarization, the flow of skilled persons will be more common and becomes an important aspect of globalization (Docquier & Rapoport, 2011; Pellegrino, 2001).

Brain drain has a significant impact on source and recipient countries (Carrington & Detragiache, 1999). For the source countries, particularly developing countries, brain drain worsens the situation of stretched talent because of the long-existing limitations in society and economy and decreases the accumulation of human capital (Gibson & Mckenzie, 2011; Johnson, 2005; Okeke, 2013). The emigration of professional talent, no matter permanent or temporary, affects economic development and increases inequality in the global distribution of income (Beine, Docquier, & Rapoport, 2001; Kancs, 2011; Mountford & Rapoport, 2011; Wei, Yi, & Zhang, 2015; Wong & Chong, 1997), thus

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weakening a country's international competitiveness (Tung, 2008). This further exacerbates brain drain, causing a vicious circle. The universality of brain drain plays an important role in the young generation's intentions to migrate, giving impetus to the emigration of the young (Lisa et al., 2008). Meanwhile, many young students studying abroad do not intend to return home after completing their tertiary education, constituting a specific type of brain drain (Dako-Gyeke, 2015, 2016; Soon, 2009, 2012). However, because there are still many relatives in hometowns, skilled migrants have close ties with their home countries and send remittances to support families (Bollard, Mckenzie, Morten, & Rapoport, 2011; Gibson & Mckenzie, 2011), which increases the homeland's foreign exchange reserves. At the cross-country level, these professional migrants combine the market advantages of the source countries and the technological advantages of the recipient countries. They can contribute to industrial structure upgrading and local socioeconomic development (Gibson & Mckenzie, 2011; 2012; Saxenian, 2005). Additionally, by obtaining better training abroad, brain return becomes an important source of human capital formation and accumulation in source countries (Dustmann, Fadlon, & Weiss, 2011; Mayr & Peri, 2009). For the recipient countries, skilled people often have high comprehensive quality, age advantages, and educational attainment. Brain gain plays a positive role in improving the quality of the population and meets the demand for high-quality workers (Li, 2007; Oommen, 1989). There are serious issues with ageing populations and low birth-rates in recipient countries (Cromley, Wilson-Genderson, Christman, & Pruchno, 2015; Sobotka, 2009), skilled immigration helps to alleviate this situation, since most immigrants are young or middle-aged (Banerjee, 2010; Editoral, 2011; Mok & Han, 2016). In addition to global, cross-regional or cross-national mobility, the internal flow of talents within a region and country is also obvious, especially in the United States (George, Borjas, & Bronars, 1992; Ottaviano & Peri, 2012; Partridge, Rickman, Olfert, & Ali, 2012; Walker, Ellis, & Barff, 1992), British (Gagliardi, 2015), Germany (Parikh & Van Leuvensteijn, 2003), Austria (Tang, Rowe, Corcoran, & Sigler, 2014), Taiwan (Lan, 2011) and China (Fu & Gabriel, 2012; Han & Li, 2017; Liu & Shen, 2014; Liu, Shen, Xu, & Wang, 2017). Given the dominant position of the city in high-skilled employment, most migrants choose cities as their destinations (Tang et al., 2014). However, due to the cultural differences between source and recipient countries, brain migration likely brings new problems, i.e., racial discrimination and crime, which may hinder the social inclusion of immigrants and lead to social instability (Li, 2007).

Like other countries in the world, China is also a country with high brain drain (Tian & Fang, 2014), and it has attracted widespread attention. However, most of the studies only qualitatively describes the status of domestic talent flow (Li, 2005; Luo, Luo, & Wu, 2002; Zheng & Li, 2000; Zou & Dong, 2015), few studies have quantified the level and pattern of brain drain. Importantly, to enhance the comprehensive strength and international competitiveness of China's higher education system, the Chinese government introduced an overall plan to construct world-class universities and disciplines (WCUDs) on October 24, 2015.[1] This will lead to talent recruitment and talent flow among CUs across the whole country, and the CUs in midwestern and northeastern China have become a severely afflicted area of brain drain (Du & Tao, 2000). At present, an important criterion for Chinese WCUDs is largely measured by the amount of high-level talent (HLT).[2] The introduction of the "title-type" talents among CUs may form a vicious circle and exacerbate domestic brain drain. Thus, it is urgent that the talent distribution pattern and flow situation should be fully investigated to provide references for policymakers in China. Using a dataset of HLT over the

period of 1980–2016, this study explores the spatial pattern of high-level talent flow in China and reveals its mechanism and potential influences. These findings will provide a scientific basis to further guide the flow of talent and education development in China and beyond in the future.

2. Materials and methods

2.1. Materials

In China, there are various national talent projects, such as the National High-level Talents Special Support Programme, which is run by the Organization Department of the Central Committee of Communist Party of China (CPC), and the Chang Jiang Scholars Program, which is run by the Ministry of Education.[3] According to the programme length and nationwide recognition for high-level talents, we have included five types of talents in this study, i.e., the academicians of Chinese Academy of Sciences (CAS) and the Chinese Academy of Engineering (CAE), and candidates of the Ministry of Education's "Chang Jiang Scholars Program" (CJSP), the Thousand Talents Programme (TTP), the Ten-Thousand Talents Programme (TTTP) and the National Science Fund for Distinguished Young Scholars (NSFDYS). The electoral work of the academicians of CAS began in 1955, but the earliest selected year for the academicians who are still alive is 1980. The electoral work of the academicians of CAE began in 1994. The appointment of the YRAS, TTP, TTTP and NSFDYS began in 1998, 2012, 2008 and 1994, respectively. Therefore, the study period is 1980–2016, and this number excludes HLT who have deceased or committed a crime, academic misconduct or other actions that led to dismissal between 1980 and 2016.

The numbers of the academicians of CAS and CAE are collected from the CAS[4]and the CAE.[5] Since 1955, when the Faculty of Chinese Academy of Sciences (CAS) was established, and 1994, when the first batch of CAE's academicians was selected, there have been 2312 Chinese scientists and 162 foreign scientists been selected as academician, and there are 1562 Chinese academicians and 124 foreign academicians still alive. The data for the NSF for the Distinguished Young Scholars was available from the National Natural Science Foundation of China.[6] Excluding those who have deceased or emigrated, there are 3575 young scholars in China who have received the NSFDYS. The data on the "Chang Jiang Scholars Program", containing distinguished professors and chair professors, is accessible at the Ministry of Education of the People's Republic of China. Excluding those who have deceased or emigrated, there are 3050 professors enrolled in CJSP. The source for data for the Thousand Talents Programme and Ten-Thousand Talents Programme is the Organization Department of the Central Committee of the CPC. The recruitment of global experts has reached nearly 4000 since the implementation of the TTP in 2008, and the Chinese government has selected and supported 1936 HLT since the implementation of the TTTP in 2012.

2.2. Methods

In this study, we defined the irrational flow of talents as the flow that does not fully meet the needs of socioeconomic development, which leads to the imbalance of human capital and the inefficient use of human resources in different regions (Liu & Zhou, 2004). It is the result of the vicious competition between different regions or institutions and does not meet the needs of the development of the market economy (Liu & Zhou, 2004; Peng, 2015). For examples, the supply of talents is

[1] http://www.gov.cn/zhengce/content/2015-11/05/content_10269.htm.
[2] HLT include the academicians of Chinese Academy of Sciences (CAS) and Chinese Academy of Engineering (CAE), the candidates of the Ministry of Education "Chang Jiang Scholars Program", the Thousand Talents Program, the Ten-Thousand Talents Program and the National Science Fund for Distinguished Young Scholars.

[3] http://hr.ncut.edu.cn/rsc/50/20151230/110110205228112.html.
[4] http://casad.cas.cn/chnl/371/index.html.
[5] http://www.cae.cn/cae/jsp/qtysmd.jsp?ColumnID=135.
[6] http://www.nsfc.gov.cn/publish/portal0/tab315/.

greater than needed in China's developed areas such as Beijing, Shanghai and Guangzhou, while the demand for talent in its backward areas is far from being satisfied. Some colleges and universities in the developed areas will introduce the talents in underdeveloped areas with competitive conditions, e.g., high salary, professional title promotion and superior housing and teaching conditions.

China has 34 provincial administrative units. According to National Bureau of Statistics of China, in addition to Hong Kong, Macao and Taiwan, Chinese mainland can be divided into four parts based on the regional development difference, i.e., northeastern China, eastern China, western China and central China.[7] Based on the departmental nature, the work units can be divided into government, research institutes and colleges and universities (CUs). Thus, we focus on China's high-level talent flow at the provincial, regional and departmental levels. To study this phenomenon, there are two difficult problems with how to define HTL and calculate the flow scale. Due to the jurisdictions of different departments, the talent may have more than one title. In this case, only the earliest title is calculated. For example, if a scientist obtains the titles of NSFDYS and academician successively, the title of NSFDYS is included when calculating the number of HLT. Foreign academicians of CAS and CAE are not included in this study, unless they become a Chinese citizen, like Chen-Ning Yang. Additionally, we eliminate guiding technological entrepreneurship talents and famous teachers in the TTTP who are teaching in primary and secondary schools since they are relatively unengaged in scientific research and tracking their whereabouts is difficult due to the lack of relevant information.

Overall, a total of 8151 HLTs are obtained after deleting the samples that are repeated and not in the scope of this study. If there is no talents flow, we just consider the natural growth of HLT. The human capital accumulation of HLT in each province was shown as the upper half line in Fig. 1. Due to the existence of flow, the accumulation of human capital in most provinces has changed (Fig. 1): 12 provinces have increased and 15 provinces have decreased. By comparing the current workplace and the original workplace where the scientist first won the title, if the two are inconsistent, we judge it to be a flow of talents. The same is true when a scientist obtains a part-time job in former unit. However, if the scientist is a chair professor or foreign expert from the beginning, then we do not judge it as flow. Thus, we calculate that 718 HLTs' workplaces have changed. We use ArcGIS 10.2 to reveal the spatial distribution of China's HLT and explore the possible mechanism.

3. Results

3.1. Flow of HLT at the provincial level

The flow of the HLT is bidirectional and widespread. After obtaining the title of talent, only Inner Mongolia does not have an inflow or outflow of HLT; even the flow within the province is non-existent. Among the 718 people representing HLT whose workplace has changed, 274 flowed within the province and 444 flowed out to other provinces (426 people), including Hong Kong, Macao and Taiwan (5 people), or other countries (18 people) (Table 1).

Statistics show that the top five provinces with internal HLT flow are Beijing, Shanghai, Jiangsu, Guangdong and Hubei, which had 121, 41, 15, 15 and 10 changes, respectively. Only nine provinces had HLT flow to other countries, and the total number was 18. The top three were Beijing, Shanghai and Jiangsu, which had 7, 3 and 2, respectively. The top five provinces for inter-provincial (Inter-P) HLT inflow were

Beijing, Shanghai, Jiangsu, Guangdong and Zhejiang, which had 106, 54, 42, 38 and 29, respectively, and those with HLT inter-provincial outflow were Beijing, Shanghai, Jiangsu, Guangdong and Shaanxi, which had 126, 42, 27, 26 and 23, respectively. Consequently, the top five provinces for HLT net inflow were Zhejiang, Jiangsu, Shanghai, Guangdong and Tianjin, with 20, 15, 12, 12 and 9, respectively, and the top five provinces for HLT net outflow were Beijing, Jilin, Liaoning, Gansu and Heilongjiang, with 20, 13, 13, 10 and 8, respectively (Fig. 2). These results demonstrate that the outflow problem in the eastern coast and northeastern China is obvious. The provinces in eastern coastal China, especially Beijing, Shanghai, Jiangsu and Guangdong, show more intra-provincial flow, while those in midwestern and northeastern China show varying degrees of outflow.

### 3.2. Flow of HLT at the regional level

Development in China has obvious regional characteristics (Qin, Zheng, & Zhang, 2013). Based on the differences in socioeconomic development and the need for regional policy-making (Li & Wei, 2010), Chinese Mainland can be divided into four economic regions: eastern China, central China, western China and northeastern China. In addition to the transnational flows and inter-provincial flows, we also analyse the flow of HLT at the regional level.

During the study period, the intra-regional flow of the eastern region, central region, western region and northeastern region was 378, 38, 28 and 23, respectively, which means the HLT flow within the eastern region is predominant. Meanwhile, eastern China is also predominant in the inter-regional flow. The HLT outflow from the eastern region to the central, western and northeastern regions was 31, 32 and 7 people, respectively, while the inflow from the central, western and northeastern regions to the eastern region was 50, 44 and 39 people (Fig. 3, left). The inter-regional inflow of the eastern region, central region, western region and northeastern region was 133, 42, 35 and 9, respectively, and the inter-regional outflow was 70, 54, 53, and 42, respectively. Thus, the inter-regional net inflow of the eastern region, central region, western region and northeastern region was 63, -12, −18 and −33, respectively. These results show that midwestern and northeastern China are major net-outflow regions for HLT and that the eastern coastal area is a net-inflow region, mainly because of its higher economic level and education quality as well as flexible employment policies.

3.3. Flow of HLT at the departmental level

This study includes three types of departments: governments, colleges and universities (CUs), and research institutions, which include specialized research institutions and research institutions that are established in enterprises. Both the HLT flow between different departments and that within departments are concentrated in the CUs. The number of HLT flowing between different CUs is 320, which far exceeds that between different governments (4) or research institutes (74). The outflow from CUs to research institutes and government sectors was 56 and 22 people, respectively, while that from research institutes to CUs and governments was 255 and 10 people, respectively. During the same period, the outflow of HLT in the CUs, research institutes and governments was 78, 235 and 7 people, respectively, while the inflow was 230, 58 and 32 people, and the net flow in the CUs, research institutes and governments was 152, -177 and 25 people (Fig. 3, right). This indicates that HLT in research institutes are the main target of headhunters for the CUs, implying a relatively poor environment in Chinese scientific research institutes. Further analysis demonstrated that the flow of most HLTs occurred in the public departments and the number of the flow reached 698 people. The number of HLT flow between the public and private department was 20 people, in which 18 people flowed from the private sector to public sector.
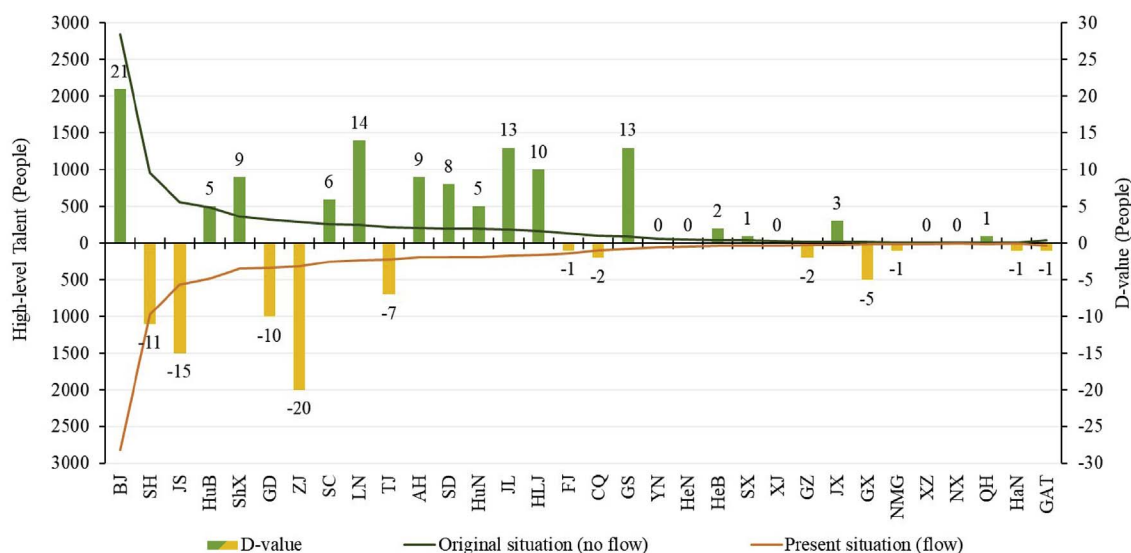
Notes: D-value = Value (original situation) — Value (present situation).

Letters BJ, SH, JS, HuB, ShX, GD, ZJ, SC, LN, TJ, AH, SD, HuN, JL, HLJ, FJ, CQ, GS, YN, HeN, HeB,

SX, XJ, GZ, JX, NMG, XZ, NX, QH, HaN and GAT respectively refer to Beijing, Shanghai, Jiangsu, Hubei,

Shaanxi, Guangdong, Zhejiang, Sichuan, Liaoning, Tianjin, Anhui, Shandong, Hunan, Jilin, Heilongjiang,

Fujian, Chongqing, Gansu, Yunnan, Henan, Hebei, Shanxi, Xinjiang, Guizhou, Jiangxi, Guangxi,

Neimenggu (Inner Mongolia), Xizang (Tibet), Ningxia, Qinghai, Hainan and Hong Kong, Macao, Taiwan.

Fig. 1. Human capital accumulation of HLT in different situations.

3.4. Driving forces

Brain drain, a complicated social phenomenon, is essentially a type of population migration, usually involving a permanent or long-term change of residence (Henry & Louis, 1982). The relevant theories to explain this phenomenon include the push-pull theory (Lee, 1966), the human capital theory (Schultz, 1961), the dual labour market theory (Doeringer & Piore, 1970) and the age-mobility model (Rogers, 1978). The flow of talents is driven by a variety of factors (including subjective or external and objective or internal) (Haas, 2010; Lee, 1996). The external dynamics involve demographic, social, economic, cultural, political system (Beechler & Woodward, 2009; Haas, 2009, 2010), and physical environmental aspects (Czaika & Parsons, 2017; Warner, Hamza, Oliver-Smith, Renaud, & Julca, 2010), while the internal factors include personal income (Grossmann & Stadelmann, 2013), self-development and self-realization (Halman & Müller, 2006) and promotion (Devaro & Brookshire, 2007).

These factors also affect the flow of the HLTs in China. Specifically, regional socioeconomic gaps in household conditions and teaching facilities, which affect family and personal utility, are the root causes of brain drain (Tian, 2006). Since the reform and opening-up, owing to the implementation of the strategy of gradient development, regional society and economies in China have gone from a state of low-level relative equality to one of higher-level inequality (Lu, 1987, 2001). The spatial difference is increasingly obvious (Fig. 4). The eastern coastal area, especially the Pearl River Delta, Yangtze River Delta and Beijing Tianjin region, have become growth centres, gathering a large amount of resources, but other areas have experienced massive resource losses. Furthermore, interregional wage differentials and better career prospects, rather than amenities, play a dominant role in attracting skilled labour (Liu & Shen, 2014). The eastern region has relatively superior material conditions for HLT and can provide higher quality educational opportunities for their children than the central and western regions can. Perfect system (i.e., income distribution, professional title

evaluation and promotion) and adequate management in recipient are more propitious to the development of their career. There is a relatively flexible and workable system guarantee for HLT in eastern China. Cultural value deviation is another deep reason for brain drain. The universities of the eastern region have a better academic atmosphere and are in close contact with international communities. Meanwhile, the need for access to self-development, high quality educational conditions for their children and family living capital also promote the flow of HLT (Guo, Zeng, & Wang, 2016). Furthermore, in addition to the general driving forces, the flow of HLT is also influenced by other factors, such as the need for people to realize their own value and to repay hometowns (Ioannidis, 2004; Soon, 2009, 2010). Besides, because of the particularity of the Chinese system, administration is ubiquitous in CUs and research institutions; thus, the adjustment of administrative positions is also an important cause of the flow of HLT, which is especially prominent for Beijing.

4. Discussion

Brain drain is a global issue (Pang et al., 2002; Stolz & Baten, 2012). Most countries in the world have or are experiencing this issue, and it will be permanent due to the imbalance between different countries, hindering the development of backward areas (Banerjee, 2010; Beechler & Woodward, 2009; Docquier, Lohest, & Marfouk, 2007; Stark, 2003). Previous studies mainly focused on the international talent flow from developing countries to developed countries (Docquier et al., 2007; Levy, 2003; Wang, Mao, Wang, Peng, & Hou, 2013) and from developed countries to other developed countries (Arrieta, Pammolli, & Petersen, 2017; Veugelers, 2017), revealing the impact of migration on the source and recipient countries, with a lack of attention to talent flow within a country (Hansen, Ban, & Huggins, 2003; Ioannidis, 2004; Liu et al., 2016). China is still a developing country. Because of the gaps between regions, China's movement of skilled persons from less-developed regions to developed regions will continue.

Table 1
Statistics for HLT flow in China.

	BJ	SH	JS	GD	SD	FJ	ZJ	TJ	HeB	HuB	AH	HuN	HeN	SX	ShX	SC	GS	CQ	GZ	YN	NX	GX	XZ	LN	JL	HLJ	HaN	JX	QH	XJ	GAT	OC	Inter-P outflow	Total
BJ	121	17	16	11	5	4	7	5	1	6	8	5		1	9	7	1	3	1	1				2	2		1	1	1		4	7	126	247
SH	10	41	5	5		1	8	2		3			1			1	1							2	2		1	1		1		3	42	83
JS	11	2	15	1	2		3	1	1				2				1	1											1			2	27	42
GD	10	1	2	15	1	4	1	2				1				1		1				1		1	1						1		26	41
SD	4	4	2	1	4	1							1						1	1				1		1						1	12	16
FJ	4	3	1	1		1						1			1										1						1	1	10	11
ZJ	4			2			5			1	1														1							1	9	14
TJ	3		1				3	3	1		1				1																		6	9
HeB	1	1						1	0			1			1																		4	4
HuB	9	1	3	5			1			10	2	1	1	1	1	1												1			1		22	32
AH	7	3		1				1		2	8	5	1				3					1		1							1	1	19	27
HuN	5	3	2	1						1	1	5	5																			1	15	20
HeN	1	1			1		1						5		1						1												5	10
SX	2	1												3																			3	6
ShX	7	5	5	1		1	2			1					2	1								1									23	25
SC	5	1	2	1		1		1		1	1	1			1	6	3	2						1				1				17	23
GS	3		1	1			1			1					4	1	3	1															12	15
CQ	1		1	1												3		1															6	7
GZ	1	1								1									0												1		3	4
YN	1																	1		0	1												3	3
NX												1									1												1	2
GX				1																		1											0	1
XZ	1																						1										0	1
LN	6	3	2	1	1		2	1		2				1					1					8	8		1				1		20	28
JL	7	2	1	1			2	1	1										2					2	5	5	1						17	22
HLJ	3	1		3	1																				8	8							8	16
GAT	1	2	1	3						1							1										1	1		1	1	8	8	9
Inter-P inflow	106	54	42	38	13	12	29	15	3	16	12	9	5	2	17	15	2	8	1	1	0	2	0	7	4	0	1	5	1	1	5	18	444	
Total	227	95	57	53	17	13	34	18	3	26	20	14	10	5	19	21	5	9	2	1	1	3	0	15	9	8	1	5	1	1	6	18		718

Notes: Letters BJ, SH, JS, GD, SD, FJ, ZJ, TJ, HeB, HuB, AH, HuN, HeN, SX, ShX, SC, GS, CQ, GZ, YN, NX, GX, XZ, LN, JL, HLJ, HaN, JX, QH, XJ, GAT and OC respectively refer to Beijing, Shanghai, Jiangsu, Guangdong, Shandong, Fujian, Zhejiang, Tianjin, Hebei, Hubei, Anhui, Hunan, Henan, Shanxi, Shaanxi, Sichuan, Gansu, Chongqing, Guizhou, Yunnan, Guangxi, Xizang (Tibet), Liaoning, Jilin, Heilongjiang, Hainan, Jiangxi, Qinghai, Xinjiang, Hong Kong, Macao, Taiwan and other counties. The horizontal row indicates HLT outflow to the provinces or counties, and the vertical column indicates the inflow of HLT from different provinces or counties.
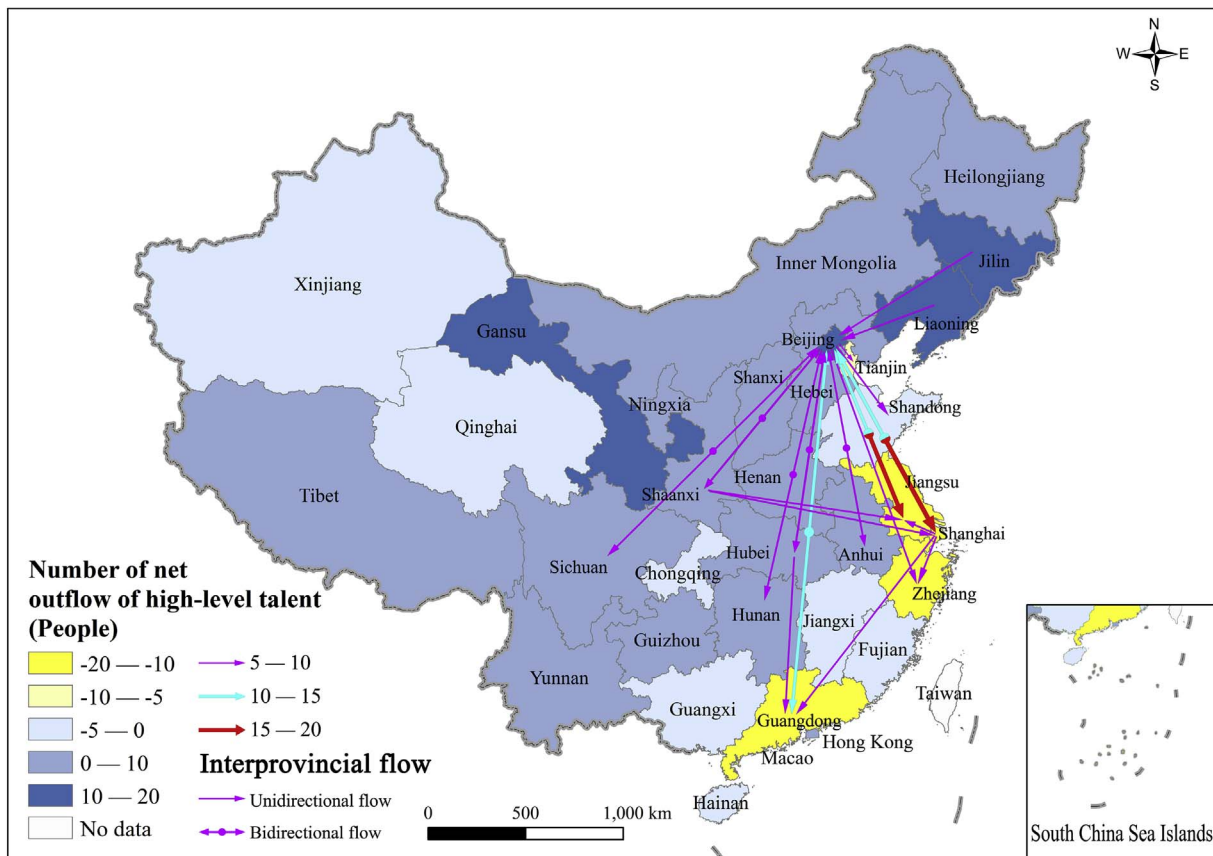
Notes: Only high-level talent flow of five or more are presented.
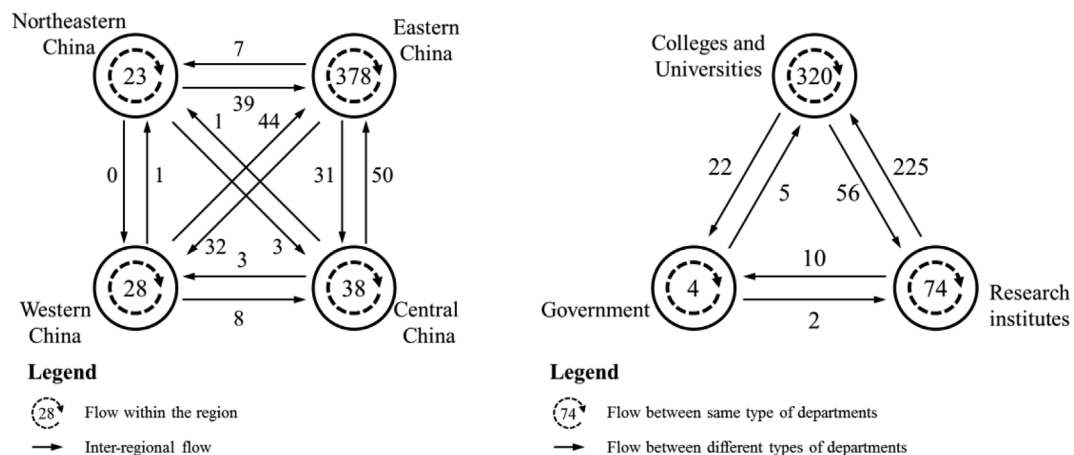
Fig. 2. High-level talent flow in China.

Fig. 3. HLTs flow at the level of regions or departments.

However, due to the institutional barriers, the HLT flow is abnormal and irrational, aggravating regional imbalances (Dan, 2017).

Brain drain is not a new problem (Liu & Shen, 2014). Since the 1980s, interregional talent flow in China has been obvious. With superior natural conditions, regional and economic advantages as well as preferential policies, the eastern region has attracted talent from the midwestern region. Facing a shrinking pool of HLT in recent years, China has taken some measures to tackle the brain drain or unreasonable flow, while simultaneously encouraging a "brain gain" for the midwestern region. Despite these measures, most provinces of the midwestern region still undergo massive talents outflow (Liu & Shen, 2014). Worse still, the striving to construct world-class universities and

discipline (WCUDs) will promote the inter-regional flow of talent and exacerbate the brain drain in midwestern China. By virtue of various advantages, such as perfect public service facilities and good prospects for development (Guo et al., 2016; Ni & Zhang, 2010), CUs in eastern coastal regions are in a favourable position when competing for HLT with CUs in midwestern and northeastern China. Therefore, this will exacerbate the irrational flow of talent, vicious competition and the imbalance of the distribution of educational resources (Ma, 2016). Those CUs that have not been selected for inclusion in the list of WCUDs will face more serious brain drain. On the other hand, the allocation of a large number of elements, including funds and public services, improves the level of hardware and software, providing important
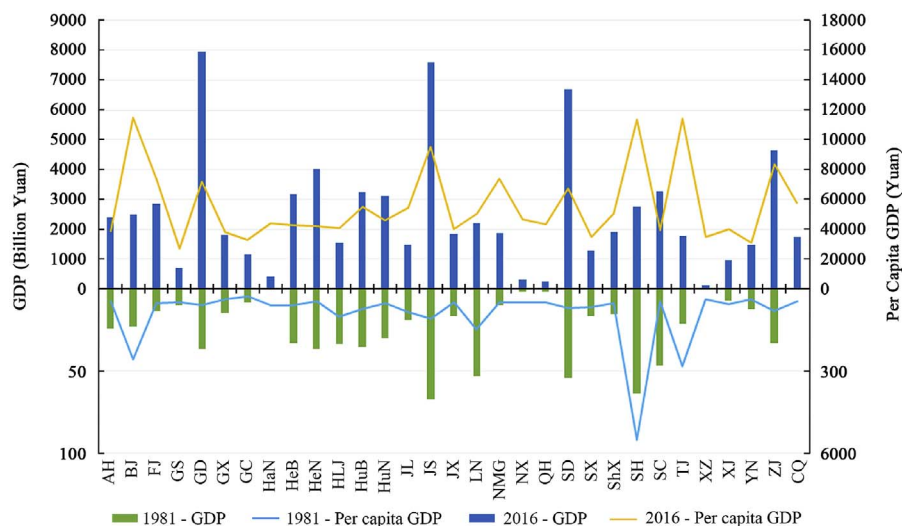
Notes: In 1981, Hainan (HaN) and Chongqing (CQ) belonged to Guangdong (GD) and Sichuan (SC) respectively, so there was no GDP, but the per capita GDP was based on data from Guangdong (GD) and Sichuan (SC), respectively.

conditions for brain return and prompting the accumulation of human capital (Mayr & Peri, 2009). It is inevitable that though foreign talent will take midwestern China into consideration, as a whole, eastern China is the major distribution area for brain return. Taking a young overseas high-level talent introduction plan as an example, the proportions of talent distributed in eastern China, central China, western China and northeastern China are 70.33%, 16.99%, 9.84% and 2.84%, respectively,[8] which means that the Matthew Effect becomes more remarkable and poses a negative impact on the development of CUs.

Talent flow is a double-edged sword (Beine, Docquier, & Rapoport, 2006; Docquier et al., 2007). Moderate mobility of talents is conducive to the rational allocation of resources and personnel structure optimization, which contributes to the formation of competitive incentive mechanisms and the accumulation of high-end human capital in the receiving regions (Mckenzie & Rapoport, 2011). However, brain drain is also a drag on economic development for outflow regions (Docquier et al., 2007). First, unidirectional flows of skilled people from less-developed regions to well-developed regions may aggravate the already interregional disparity in educational resources and human capital, which is not conducive to the coordinated development of regional society and economies, especially in the poverty-stricken areas in the midwestern regions of China (Fu & Gabriel, 2012). The HLT shows a distinct regional disparity, with a decrease from the eastern region to central and western regions (Fig. 5), indicating the unbalanced distribution of China's educational resources. Furthermore, Elsevier Ltd, a world-leading provider of information solutions, has released a list of the most cited Chinese researchers for three consecutive years since 2014. A total of 1802 scholars from China's universities and research institutes between 2014 and 2016 are included in this list (Fig. 6). The list has gradually become a symbol of recognition and measurement of whether a scientist has influence in his field of research or not. Many people worry that these scholars will likely become new targets for head-hunters.

Second, non-informal job-hopping of researchers does not play a role in scientific research but seriously disrupts the normal order of scientific research and teaching and has a bad influence on students and young scholars, causing a serious waste of funds and resources. Third, higher education plays an irreplaceable role in national or regional development, particularly in midwestern and northeastern China,

where the CUs serve as regulators of national security and frontier stability and are a power source of regional economic-social development. Finally, the CUs also provide a platform of multicultural communication. If the disorderly flow of HLT cannot be stopped in time, midwestern and northeastern China will face an unprecedented crisis of brain drain. It is not hard to estimate the damage that the brain drain will cause to the midwestern region. This is not only an educational problem but also a political, economic and social issue. This study only considers specific HLT. When defining flow, the starting point and the ending point are the focus of attention, with a lack of attention on the process of the HLT flow. Furthermore, we did not consider the imbalance of educational resources that affect the level of economic development, location, the number of universities and so on (Zhang, Wang, & Wang, 2013). In future studies, different levels of talent, such as lecturers and technical talent, should be counted to fully understand China's brain drain. The process of brain drain in China also deserves further attention.

5. Conclusions and policy implications

Talent flow is an inevitable phenomenon of social development and is also an inevitable result of a market economy. The development prospects of a country or region partly depend on its innovation ability, which is mainly determined by HLT (Agrawal, Kapur, Mchale, & Oettl, 2011). China is one of the largest brain drain countries at the global level, and experiences serious domestic talent flow. In this study, we quantitatively estimate the flow of high-level talent among different provinces, regions and departments in China, then explore the spatial-temporal pattern of the HLT, and finally reveal the mechanism behind the brain drain. The results indicate that the main direction of HLT flow is from the inland to the eastern seaboard, which has made eastern China a net-inflow region and northeastern and midwestern China net-outflow regions. China's HLT tend to flow from scientific research institutes to colleges and universities. Further analysis suggests that socioeconomic differences in salary, system construction and public service facilities are the main driving forces of HLT flow. The HLT flow often occurs between the underdeveloped and the developed countries (Beechler & Woodward, 2009; Docquier, Lowell, & Marfouk, 2009; Freeman, 2017; Gibson & Mckenzie, 2012; Kerr et al., 2016; Sardana, Zhu, & Veen, 2016), but irrational flow within a region may be more common in China due to the lack of market regulation mechanism of
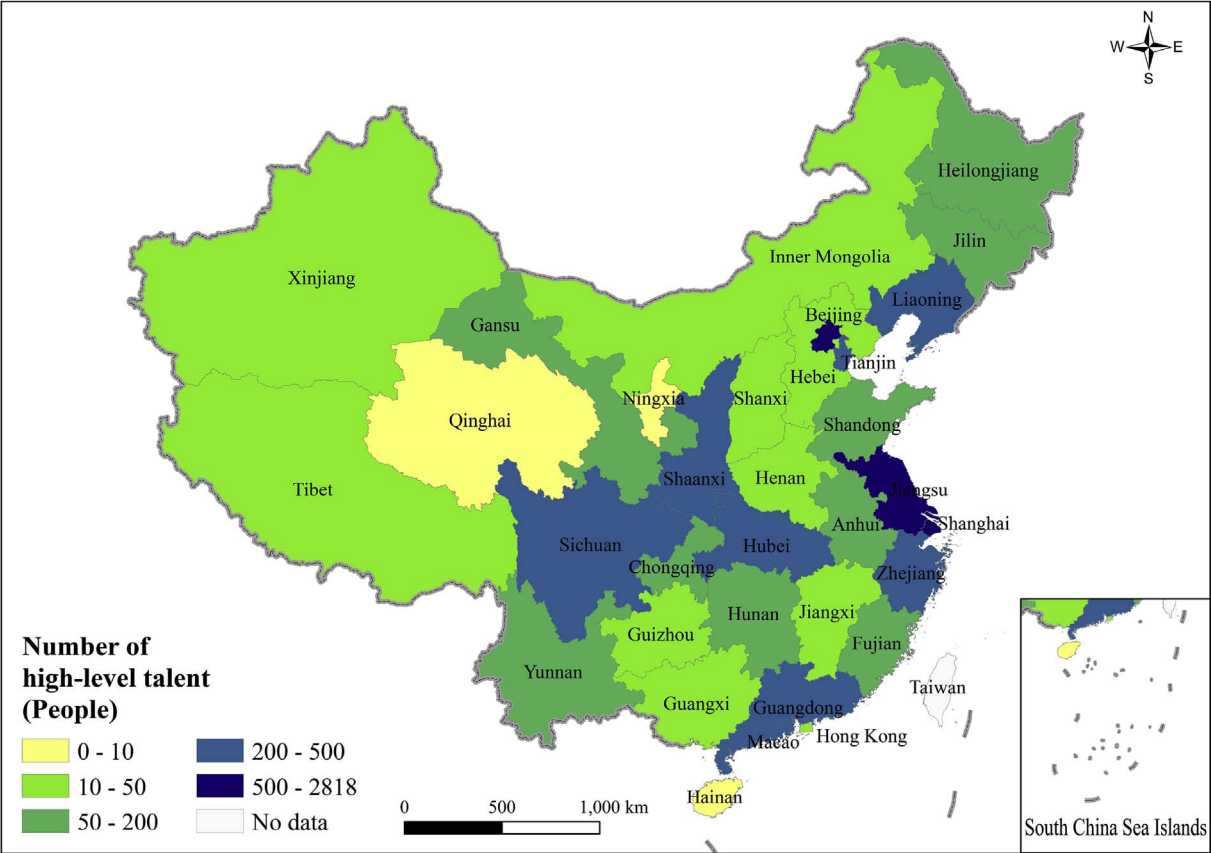
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[8] http://www.1000plan.org/qrjh/section/2.

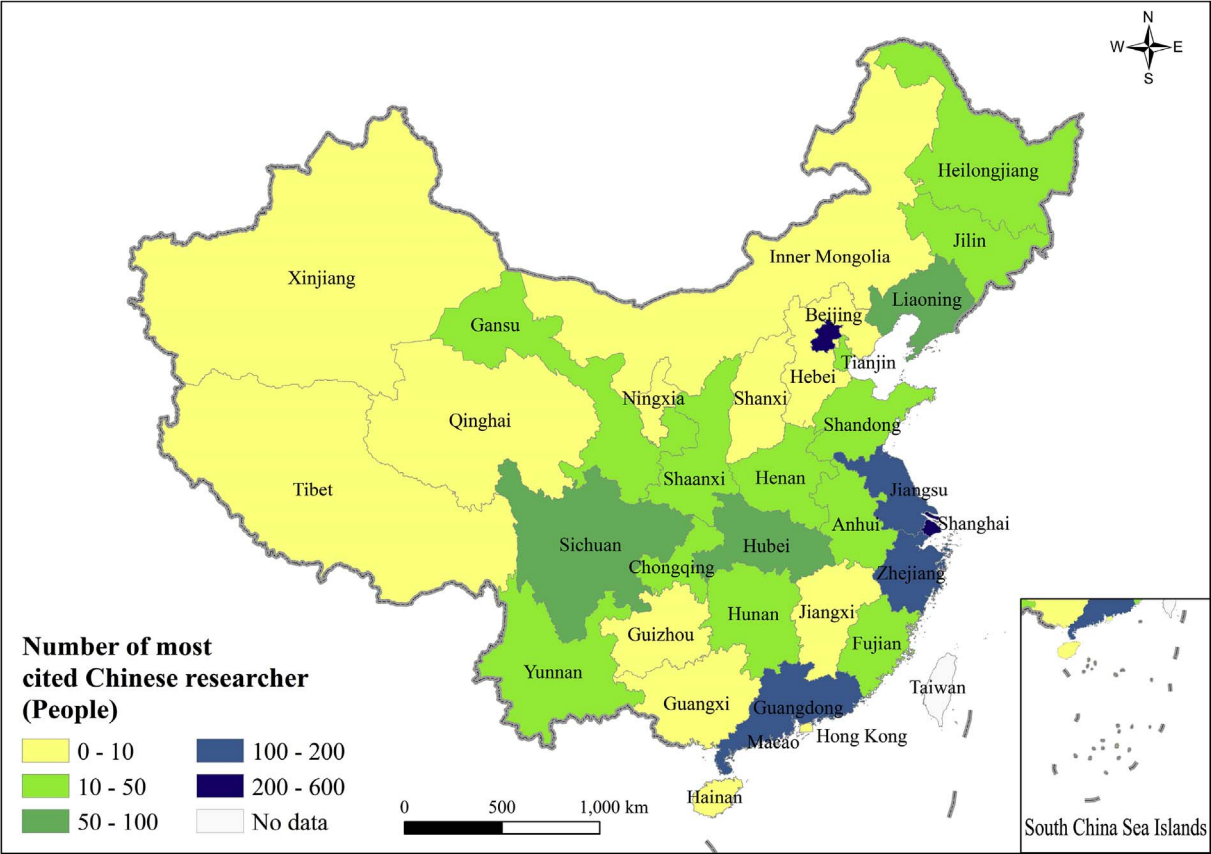**Fig. 5.** Distribution of HLT in China.

Fig. 6. Distribution of the most cited Chinese researchers.

talent flow (Liu & Zhou, 2004; Peng, 2015). The irrational flow of high-level talent may exacerbate the unbalanced development of education and the economy.

Influenced by resources endowment, regional uneven development strategy and urban-rural dualistic structure (Lu, 1987, 2001), there are obvious regional and urban-rural differences in China, which makes HLT concentrated in the eastern coastal areas and regional central cities, causing a situation of oversupply in certain areas. While the demand for HLT in Midwest is often not satisfied, which slows down the regional socioeconomic development. Vicious competition between different regions aggravates the irrational flow of talents. The Matthew effect of the irrational HLT flow needs to take targeted measures. First, China should establish a reasonable salary distribution system and a unified national compensation management system to promote the balanced distribution of teachers' incomes and avoid the vicious competition of talents in different regions. Constructing a scientific and reasonable talent flow order is also an urgent need. Second, policy support, capital allocation and talent gain should be tilted to favour the midwestern and northeastern regions, which should be given preferential policies to create an excellent university and to cultivate and introduce the HLT as well as make them stable. The reform of the university teacher salary system should fully consider the natural conditions in the underdeveloped western areas and increase the intensity of central transfer payments. Third, it is necessary to accelerate the transformation of evaluation mechanisms for measuring the comprehensive strength of a university, which is mainly based on the number of HLT. This will reduce eastern universities' willingness to hunt for talent from the midwestern and northeastern regions. Fourth, the country should slow down the pace of construction of WCUDs and avoid blindly pursuing WUCD construction; instead, it should optimize its regional pattern and brain gain policy, and set up an objective and reasonable evaluation system for the comprehensive strength of the higher education system and the talented. Midwestern China should also develop its initiatives fully with respect to the talented and create a favourable working and living environment for them to realize their own value. Finally, preventing brain drain in midwestern China should prompt a national strategy related to the rejuvenation of the central and western regions and regional balanced development as soon as possible.

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