The Interregional Migration of Human Capital: The Case of "First-Class" University Graduates in China

Can Cui[1] · **Yifan Wang[2]** · **Qiang Wang[3]**

Abstract

Human capital has been acknowledged as a key driver for innovation, thereby promoting regional economic development in the knowledge era. University graduates from China's "first-class" universities—the top 42 universities, included in the "double first-class" initiative, are considered highly educated human capital. Their migration patterns will exert profound impacts on regional development in China, however, little is known about the migration of these elite university graduates and its underlying driving forces. Using data from the 2018 Graduate Employment Reports, this study reveals that the uneven distribution of "first-class" universities and regional differentials largely shaped the migration of graduates from the university to work. Graduates were found aggregating in eastern first-tier cities, even though appealing talent-orientated policies aimed at attracting human capital had been launched in recent years by second-tier cities. Employing negative binomial models, this study investigates how the characteristics of the city of university and destinations affect the intensity of flows of graduates between them. The results showed that both jobs and urban amenities in the university city and destination city exert impacts on the inflow volume of graduates; whereas talent attraction policies introduced by many second-tier cities are found not to exert positive effects on attracting "first-class" university graduates presently. The trend of human capital migration worth a follow-up investigation, particularly given ongoing policy dynamics, and would shed light on the regional development disparities in China.

Keywords Human capital · University graduates · Migration · China

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Introduction

With the shift towards a knowledge-based economy, knowledge and innovation have become key elements for regional development (Acs et al., 2002; Romer, 1990). Human capital, as the main actor in knowledge creation and diffusion, as well as the driver for innovation, plays an increasingly pivotal role in accelerating regional economies (Florida & Mellander, 2018; Lao et al., 2021; Lucas, 1988). Realizing human capital as an economic incentive, second-tier cities in China, such as Wuhan, Xi'an, and Changsha, initiated a "war of attracting talent" in 2017, competing fiercely against each other to attract young talent (China Daily, 2017). To attract and retain people embodying valuable human capital, a series of policies has been implemented, including relaxing hukou registration[1] requirements, offering subsidies for home renting or buying, and providing a living allowance. Since 2019, the "war of attracting talent" has continued to heat up, and even first-tier cities such as Guangzhou and Shenzhen have launched policies to vie for talent (China Daily, 2019). The bid to attract talent has become a new paradigm of urban competition.

Human capital can be measured in various ways, i.e. skills, experience, and occupation, but the most common measurement is the level of education (Wright & Ellis, 2019). People with a bachelor's degree and above are usually thought to possess a high level of human capital, and therefore, university graduates are the main target of the "war of attracting talent" in Chinese cities. According to human capital theory (Faggian et al., 2017; Yue & Qiu, 2019), highly educated people are characterized by a high level of mobility. Regarding their migration motivation, there are two main viewpoints: classical migration theories hold that the primary motivation for migration is to acquire higher salaries (Faggian et al., 2006; Greenwood, 1975); however, another viewpoint claims that, unlike the general labor force, highly educated people are not only job-motivated but are more concerned about quality of life and prefer cities that offer a variety of amenities (Gottlieb & Joseph, 2006; Whisler et al., 2008). Researchers have been debating whether economic returns or amenities are the fundamental dimensions of the attractiveness of a location, especially for mobile university graduates (Darchen & Tremblay, 2010; Tang et al., 2014; Whisler et al., 2008).

The migration of university graduates is a typical sequential process involving two stages: from hometown to university and from university to work. Focusing on the second stage of migration from university to work, a number of studies have revealed that graduates' mobility is significantly affected by regional factors of university region (Krabel & Flöther, 2014; Timofeeva & Tesselkina, 2016; Venhorst et al., 2010). Particularly, in the context of China, there is a long history that education serves as a vital path for upward social mobility, which is usually accompanied

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[1] Hukou is a system of household registration used in mainland China. It officially identifies a person as a resident of an area and includes identifying information such as name, parents, spouse, and date of birth. The hukou system may impose constraints on the free flow of labor in China, because numerous social benefits, including access to public housing, education, and healthcare resources, are tied to the hukou system.

by geographical moves upward along the urban hierarchy. People make decisions regarding a place for study often with an intention to work there after graduation; in other words, the preference for city to work is already revealed during the choice in the first stage of migration from hometown to university (Sun & Pan, 2014). Or, alternatively, they assume the city of university as a springboard to jump from after graduation. In either way, the city of university serves as an important reference in the second stage of graduates' migration.

Given the emphasis on human capital as the driving force for economic development in the knowledge era, a considerable body of literature has emerged concerning university graduate migration in western countries (Faggian et al., 2009; Haussen & Uebelmesser, 2018; Kazakis & Faggian, 2017). However, relatively less is known about the migration of recent university students after graduation in China (Liu et al., 2017). Since 2015, Chinese central government has launched the "double first-class" initiative, including 42 "first-class" universities and 465 "first-class" disciplines, to promote a batch of high-level universities and disciplines to enter the world's top ranks (State Council, 2015). The migration of these university graduates would exert a profound impact on regional development in China. Are the cities with "first-class" universities able to retain this valuable human capital after their graduation, or merely serve as a springboard from which these graduates migrate to other places? Will the ongoing "war of attracting talent", initiated by second-tier cities, indeed stimulate more inflows of university graduates? Do urban amenities matter more to graduates than economic opportunities? This study aims to answer the above questions by conducting an empirical analysis of the migration of graduates from "first-class" universities in 2018.

Literature Review

Human Capital and Mobility

Earlier studies on human capital migration focused on revealing the migration patterns such as the migration rate, type, destination, and distance (Carrington & Detragiache, 1998; Franklin, 2003). The term "brain drain" was coined by the Royal Society of London to describe the phenomenon of a large number of British scientists migrating to the USA and Canada after World War II (Cervantes & Guellec, 2002). Later, this term was used broadly to refer to areas facing a net out-migration of human capital to other countries as well as to other regions within the country (Rérat, 2014). According to the human capital theory (Sjaastad, 1962), highly skilled individuals are more likely to benefit from migration and, therefore tend to be more mobile. A core issue regarding human capital migration is where they migrate to. Metropolitan areas, national and regional central cities, which are the most urbanized and developed regions, are believed to be the most popular destinations for human capital (Haapanen & Tervo, 2012; Wan et al., 2018).

In the past decade, realizing that university graduates are important embodiments of human capital and owing to an increase in data availability, a considerable body of literature has emerged focusing on their interregional migration behavior in many

western countries, including the United Kingdom, the United States, Germany, and Italy (Di Cintio & Grassi, 2013; Faggian et al., 2006, 2009, 2014; Gottlieb & Joseph, 2006; Haussen & Uebelmesser, 2018). Faggian and McCann (2009a, 2009b) revealed that graduates in the UK tend to flow from northern regions to southern regions and in particular to the southeast and London, where the urbanization rate and the development levels are higher. The pattern of graduates migrating to more developed areas was also found in Italy (Di Cintio & Grassi, 2013), in the Netherlands (Venhorst et al., 2010) and Australia (Tang et al., 2014). Taking the university city as a geographical reference point, university graduates in European countries are rather immobile (Haapanen & Tervo, 2012; Kotavaara et al., 2018). In the UK, nearly 80% of university graduates stay in the university city for employment after graduation (HESA, 2018), and in Germany, this rate reached almost 50% (Krabel & Flöther, 2014). Comparatively, university graduates in the United States are inclined to "flow" across states owing to the country's highly mobile labor market (Bound et al., 2004).

In China, empirical studies demonstrate that university graduates migrate to the east coast regions, with first- and second-tier cities as their preferred destination for employment (He & Zhai, 2015; Wan et al., 2018). Nevertheless, in recent years, the proportion of graduates flowing into first-tier cities showed a downward trend, which can be attributed to skyrocketing housing prices, increasing work stress, and accelerating life pace (Ge et al., 2011; Zhu, 2015). "Escaping from Beijing, Shanghai, and Guangzhou" has been a heated topic in the media describing the loss of attractiveness of first-tier cities among young talent (Hu, 2013). Taking the university city as a reference point, the distribution of graduates' destinations presents a pattern centering on the university city, and the volume of flows decreases significantly with the increase in distance. In China, the migration behavior of university graduates is also shaped by the institutional context. Ma and Pan (2013) observed that graduates are relatively "immobile" due to the constraints of the hukou system.

Job-Versus-Amenity Debate on Human Capital Migration

Understanding the underlying driving forces of migration has been the core issue in the strand of literature on human capital migration. Regional differences at the macro-level are considered pivotal determinants of human capital migration, which derived from the theory of labor migration. Neoclassical economists claim that people migrate, first and foremost, because of differentials in wages and employment conditions between regions (Greenwood, 1975; Massey et al., 1993). Human capital theory also emphasizes that the differences in net economic advantages are the main driver for human capital migration (Khwaja, 2002). The above theories emphasize the importance of economic factors yet underestimate the impact of non-economic factors. The Tiebout hypothesis of "voting with one's feet" (Tiebout, 1956) highlights the role of public goods in affecting individual choices on where to live. More recently, with the prevalence of concepts such as the "consumer city" proposed by Glaeser et al. (2001) and "creative class" proposed by Florida (2003), urban amenities, quality of life, and quality of place have been recognized as attractors for human

capital, although no consensus has been reached regarding whether the pursuit of quality of life surpasses the importance of economic factors (Darchen & Tremblay, 2010; Faggian et al., 2009; Whisler et al., 2008).

The consumer city theory (Glaeser et al., 2001) asserts that the reason people choose a city to reside in is for consumption rather than for production, with the main function of cities gradually transforming to consumer centers (Clark et al., 2002; Glaeser & Gottlieb, 2006). Although some large cities in western countries have seen a substantial increase in living costs but a limited increase in wages over recent years, this does not prevent people from gathering in big cities (Glaeser et al., 2001). This indicates that when choosing somewhere to migrate to, people may not only regard the city as a place to acquire a high-paying job, but also consider the city as a place for consumption opportunities and for achieving a better quality of life. Therefore, places attract people by providing a range of lifestyle amenities (Gottlieb, 1995), which can be natural, such as air quality, average temperature, and precipitation (Liu et al., 2017; Zheng et al., 2019), and more importantly, can be socially constructed amenities, including public services, and cultural and recreational facilities (Li et al., 2019; Liu & Shen, 2014).

With a focus on talent and the creative class, Florida (2002a, 2002b, 2003) composed a series of indexes, such as a diversity index, gay index, coolness index, and bohemia index, and demonstrated their association with the distribution of talent. It is argued that diversity, or low entry barriers for talent, increases a region's ability to attract talent with a wider range of nationalities, race, ethnicity, and sexual orientation (Florida, 2002a, 2002b). Florida's creative class theory had been widely examined in varied settings, and the findings were mixed. Asheim and Hansen (2009) provided empirical evidence from Sweden to show a need to contextualize, unpack and refine the creative class thesis by incorporating the perspectives of differentiated knowledge bases. A case study on migration of creative class members in Germany partially supports Florida, but revealed that hard (economic) location factors are much more important than tolerance, openness or amenities (Vossen et al., 2019). In the Chinese context, interregional income differentials were found to be more of a determinant in driving skilled migration than regional variation in amenities (Liu & Shen, 2014).

As discussed above, most of the existing literature pays more attention to the features of destination cities in attracting human capital. According to the prospect theory (Kahneman, 2011; Kahneman & Tversky, 1979; Morrison & Clark, 2016), when making decisions, people often presuppose a reference standard according to their current situation/location, and then potential gains and losses are calculated based on this reference standard. In the case of graduates making migration decisions in China, hometown often serves as an important reference standard, as revealed by many studies (Sun et al., 2020; Yue & Qiu, 2019). Besides, the city of university is also an important hypothetical choice. First, people make decisions regarding a place for study often with an intention to work there after graduation (Sun & Pan, 2014). Second, in China, the 42 "first-class" universities are all located in provincial capitals or big cities and mostly in the eastern developed regions, where job opportunities are abundant, and amenities are favorable. In this sense, we argue that the city of university, as the starting point of the second stage of migration from

university to work, acts as an important reference, and the varied geographic contexts of the university city will shape the subsequent migration pattern of these elite graduates.

It has been acknowledged that human capital constitutes the primary driver of regional development. Meanwhile, they exhibit high rates of spatial mobility (Landolt & Thieme, 2018; Liu et al., 2017; Venhorst et al., 2010). The literature on the migration of university graduates in China is still limited compared with corresponding literature in European countries and the US (Faggian & McCann, 2009a, 2009b; Haussen & Uebelmesser, 2018; Wright & Ellis, 2019). Particularly, given the heated "war of attracting talent" which began from 2017, it is unknown whether the migration pattern of those targeted talent has been reshaped. This study, focusing on graduates of "first-class" universities in China, aims to provide an overall picture of the migration pattern of these elites. Furthermore, we employ negative binomial models to explore how the characteristics of cities affect the intensity of flows of graduates.

"First-Class" Universities in China

The expansion of Chinese higher education since 1998 has created a large pool of human capital. The admission rate has risen from 9.8% in 1998 to 48.1% in 2018, and the number of university graduates reached 7.53 million in 2018 (NBSC, 2018). With the expansion of higher education, China entered the stage of higher education popularization. In the meantime, the structure of the higher education system became vertically differentiated (Liu & Wang, 2010; Luo et al., 2018). The "211 Project" and "985 Project" were implemented in 1995 and 1998, respectively, which aimed to designate 112 universities as national flagships and 39 universities as among the top universities in the world (MOE, 2008, 2011). Substantial financial support was allocated by the central government to facilitate the development of these universities. In 2015, in a bid to increase the global recognition of China's university system, the central government initiated the "double first-class" initiative to promote a group of high-level universities and disciplines to enter the world's top ranks (State Council, 2015). Two lists, including 42 "first-class" universities and 465 "first-class" disciplines (from 137 universities), were released by the Ministry of Education in 2017.

The list of 42 "first-class" universities includes all 39 of the former "Project 985" universities and three universities from the former "Project 211". Situated at the top-tier of the hierarchical higher education system, the enrollment quotas of these 42 universities are very limited. In 2018, only 2.22% of Gaokao (the National College Entrance Examination) participants could be enrolled in a "first-class" university. Although the distribution of "first-class" universities covers a broader geographical spread, 22 of them are clustered in major cosmopolitan areas in the eastern region of China, seven in the central, nine in the western, and four in the northeast[2]

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[2] Following the division adopted by the National Bureau of Statistics of China, there are four regions in China: eastern, central, western, and northeast. The eastern region includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. The central region includes

Fig. 1 The distribution of "first-class" universities in China

(Fig. 1). The 42 "first-class" universities are unevenly located in 24 cities, including four municipalities directly under the Central government, 16 provincial capitals, and four other cities. Beijing topped the chart with eight "first-class" universities, followed by Shanghai with four "first-class" universities, and Changsha with three "first-class" universities. Some cities have two "first-class" universities, such as Nanjing, Wuhan, Guangzhou, Chengdu, and Xi'an. The rest of the cities have only one "first-class" university.

Data

The primary data of this study was collected from 2018 Graduate Employment Reports released by 39[3] "first-class" universities. In this study, we focus exclusively on graduates with a bachelor's degree, considering that the migration pattern and mechanism are quite different between graduates with a bachelor's degree, a

Footnote 2 (continued)

Shanxi, Anhui, Jiangxi, Henan, Hubei, and Hunan. The western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. The northeast region includes Liaoning, Heilongjiang, and Jilin.

[3] There are 42 "first-class" universities in total, but there is no available or qualified data for three of them, Xinjiang University, Ocean University of China, and National University of Defense Technology.

master's degree, and a doctor's degree. Furthermore, we focus on graduates who entered the labor market, so graduates pursuing postgraduate degrees were excluded from our analysis. When data in 2018 was unavailable, we used the data from the Graduate Employment Report of 2015–2017 as a supplement.[4] Other statistical data concerning cities' feature was obtained from official statistical yearbooks and research reports released by several Chinese research institutions (China Index Academy, 2018).

The Graduate Employment Reports released by each university do not adopt a unified format. Some reports reveal graduates' destination at the city level, but many reports only publish the province that graduates migrated to. However, graduates from "first-class" universities, as the elite, were most likely to migrate to provincial capitals and the most developed cities. As claimed in many universities' Graduate Employment Report, nearly 80% of their graduates went to municipalities, provincial capitals, and designated sub-provincial level cities ("*jihuadanlieshi*")[5] in 2018. Hence, this allows us to approximately locate graduates' migration destination at the city level. In addition to four municipalities and 27 provincial capitals, six developed cities (Ningbo, Xiamen, Dalian, Shenzhen, Qingdao, and Suzhou) were recognized as destinations with large inflows of graduates.

As the focus of this paper is to examine how the features of cities affect the volume of flows of graduates between cities, we converted the original data at the university level to the city level by aggregating the number of graduates from different universities but in the same city into the total number of graduates from that city. In this way, migration flows between 22 cities[6] with "first-class" universities and destination cities could be generated. However, some Graduate Employment Reports excluded certain destinations, to which very few graduates migrated. Therefore, 562 migration flows could be obtained for the following analysis.

Migration Pattern of "First-Class" University Graduates

Figure 2 demonstrates the migration pattern of "first-class" university graduates, departing from 22 cities with "first-class" universities to 31 destination cities. The thickness of the curves indicates the volume of migration flows, and the curves go clockwise from the departure city—where students graduated from—to the destination after graduation. As expected, a large number of graduates migrated eastwards. Guangzhou and Shenzhen, Beijing, and Shanghai are, unsurprisingly, the top three

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[4] More than half of the data of Peking University, Fudan University, Shanghai Jiao Tong University, and East China Normal University was supplemented by the data from 2015–2017. A small amount of data of other universities, such as Xiamen University, Lanzhou University, and Wuhan University was supplemented by the data during 2015–2017.

[5] Five cities in China are designated to enjoy a sub-provincial level status ("*jihuadanlieshi*") for their open economic atmosphere and important position in regional economic development, namely Dalian, Qingdao, Ningbo, Xiamen, and Shenzhen.

[6] Two cities, Qingdao and Urumqi, were not included because no data was available for Xinjiang University and Ocean University of China.
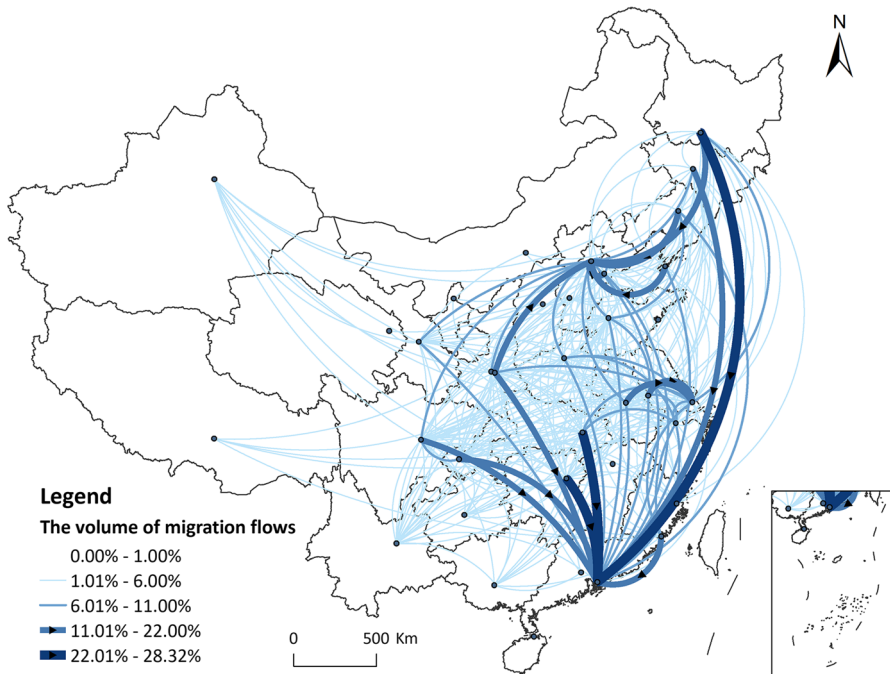
Fig. 2 The migration pattern of "first-class" university graduates in 2018

receiving areas. Guangzhou and Shenzhen, in particular, attracted a large number of graduates from both nearby cities and distant cities, which accounted for 12.80% of the graduates on average from each departure city. Beijing and Shanghai followed, receiving 8.03% and 5.93% of graduates, respectively, but with a greater proportion from nearby cities. Beijing was favored among graduates from the north and northeast of China, with 17.6% of graduates from Shenyang, 16.24% of graduates from Harbin and 15.79% from Tianjin migrating to Beijing. Shanghai, as the center of the Yangtze River Delta region, has significant advantages in attracting university graduates from this region, with 12.06% graduates from Nanjing, 11.90% from Hefei and 9.60% from Hangzhou migrating to Shanghai. Economically developed areas have a magnetic attraction for human capital.

Changing the focus from destination cities to departure cities, we used a local retention rate index to measure a city's capacity of retaining local graduates. The index refers to the ratio of the number of graduates who stayed in the city after graduation to the total number of graduates in this city. As shown in Fig. 3, regional differences in terms of retention capacity were observable. Cities in the eastern region, comparably, had higher local retention rates, among which Shanghai was the highest, reaching 70%, followed by Hangzhou (65%) and Guangzhou (50%). The central region appeared to have two subgroups. The local retention rates for Hefei and Zhengzhou were moderate (over 40%). However, only 25% and 20% of local graduates stayed in Wuhan and Changsha, respectively. A large proportion of them migrated from Wuhan (27%) and Changsha (28%) to Guangzhou and Shenzhen. As
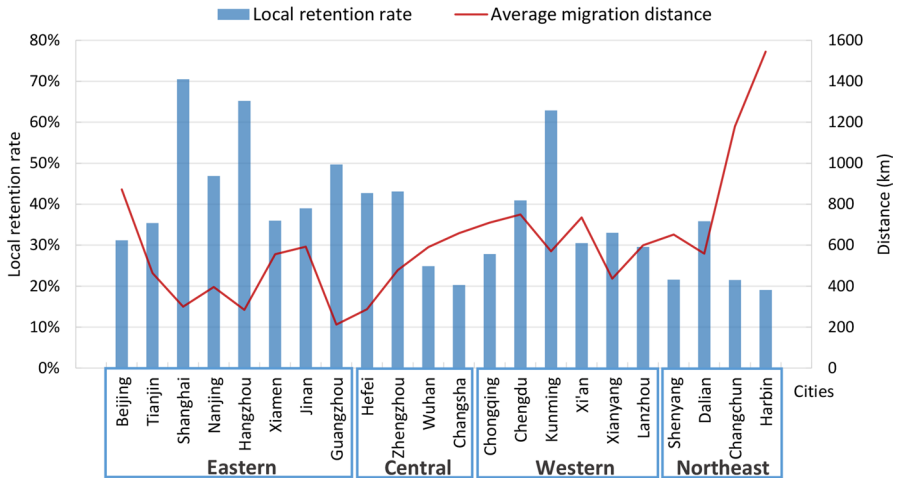
Fig. 3 Loal retention rate and average migration distance of "first-class" university graduates in 2018

expected, cities in the western region had a lower capability of retaining graduates, except for Kunming (over 60% of local graduates chose not to move). The northeast region used to be an important base for heavy industry in China's planned economy period, but since economic reforms, this region has been facing economic recession as well as a population decrease (Qi et al., 2017). It appeared that job opportunities for the higher levels of human capital were limited. The local retention rates for these four northeast cities were all lower than 36%, with Harbin (19%) the lowest.

In Fig. 3, red lines represent the average migration distance of graduates from each city. The more graduates who stay in their university city, the shorter the migration distance will be. The peak of migration distance occurred in Harbin in the northeast region, and the migration distance in Changchun in the same region was also much higher than in other cities. Graduates from these two cities were not only found to be more mobile but also more likely to make long-distance movements to other regions, particularly to the eastern region. Similarly, many graduates from the western region also migrated to the eastern, resulting in longer average migration distances. The migration distances of graduates from eastern cities were mostly below the average (610 km) because nearly 77.9% of graduates in the eastern region remain in this region for subsequent employment. In this way, the eastern region has formed an internal circulation of human capital as well as attracting inter-regional migration.

Cities with "first-class" universities generate outflows and also receive inflows. Combining these two flows, we could categorize these cities into four types: large outflows and large inflows; large outflows and small inflows; small outflows and small inflows; and small outflows and large inflows (Fig. 4). Beijing is a typical city falling into the first category. As the national capital, as well as the birthplace of the Chinese higher education system, Beijing has up to eight "first-class" universities. After graduation, nearly 70% of "first-class" students chose to leave Beijing, but Beijing is not short of human capital because it receives an influx of
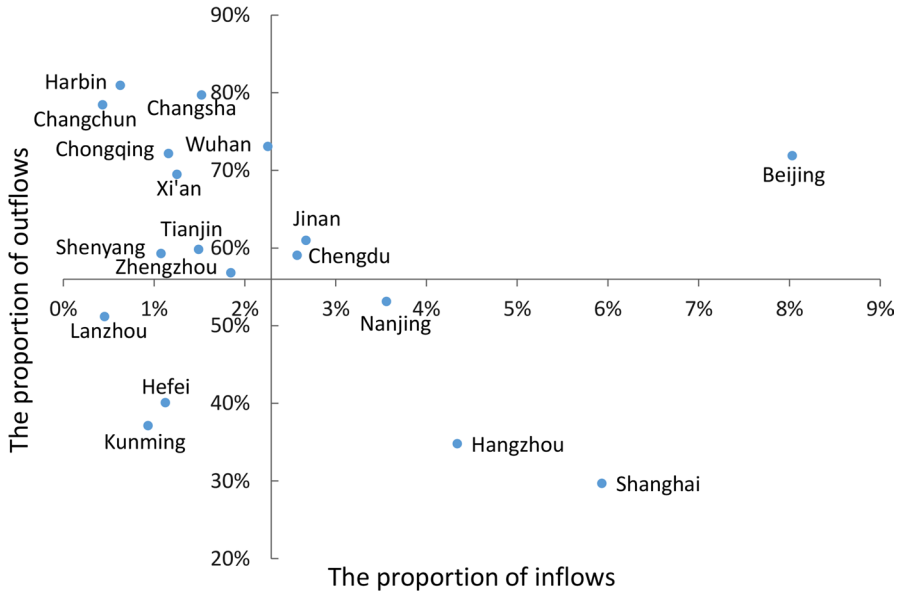
Fig. 4 Categorization of cities based on outflows and inflows of "first-class" university graduates in 2018

graduates from Tianjin, Harbin, Shenyang, Xi'an and other cities. A representative of the second category, with large outflows and small inflows, Xi'an is sometimes labelled as a city with many higher education institutions but has a poor capability of retaining the human capital that it cultivates and attracting human capital from elsewhere, and thereby is facing a severe problem of brain drain (Shi, 2018). Regarding the third category, small outflows and small inflows, these are cities comparatively segregated in terms of labor mobility. Lanzhou is the most representative city, with more than half of graduates remaining there, but less than 1% of graduates moving in. The fourth category, small outflows and large inflows refers to cities most attractive to local graduates to stay in, and for graduates from elsewhere to migrate to. Shanghai and Hangzhou fall into this category.

Explaining the Migration of Human Capital

The gravity model of migration, derived from Newton's law of gravity, has been extensively used to estimate and forecast population mobility. The classical gravity model (Eq. 1) assumes that the migration flows M_{ij} between the location i and location j increases with P_i and P_j, which represent the population of location i and location j, respectively, and decreases with the geographical distance between the two locations d_{ij} (Delisle & Shearmur, 2010; Shen, 2012).

$$M_{ij} = k\frac{P_i{}^{\beta_1} + P_j{}^{\beta_2}}{d_{ij}{}^{\beta_3}} \tag{1}$$

To estimate the gravity model described in Eq. (1), one solution is to linearize the model by taking the natural logarithm of each side, and then estimates by ordinary least squares (OLS), as shown in Eq. (2):

$$\ln M_{ij} = \beta_0 + \beta_1 \ln P_i + \beta_2 \ln P_j - \beta_3 \ln d_{ij} + \in_{ij} \tag{2}$$

in which $\in_{ij}$ is assumed to be an independent random variable which is normally distributed with zero mean. However, three serious problems may arise: (1) the bias caused by the use of the logarithmic transformation, (2) the failure of the assumption that all error terms have equal variance, and (3) the incapability of handling dependent variables with the value of zero (Cullinan & Duggan, 2016; Dotti et al., 2013). In view of these problems, Poisson models and negative binomial models provide alternate solutions (Cullinan & Duggan, 2016; Flowerdew & Aitkin, 1982). Whereas, in most cases, the dependent variable is over-dispersed, which means the data can hardly conform to the Poisson distribution, and the conditional variance is often higher than the conditional mean. Employing a negative binomial regression could control for the bias caused by over-dispersion (Delisle & Shearmur, 2010; Faggian & Franklin, 2014).

After conducting the test which shows that the variance is much higher than the mean, this study employs the negative binomial regression to analyze the factors affecting the volume of flows of graduates between the city of university and the employment destination. A series of characteristics of both the city of university and destination (X_i and X_j) are added into the regression as follows:

$$M_{ij} = \exp\left(\beta_0 + \beta_1 \ln P_i + \beta_2 \ln P_j - \beta_3 \ln d_{ij} + \sum \beta_4 X_i + \sum \beta_5 X_j\right) + \varepsilon_{ij} \tag{3}$$

Based on the literature review, the debate centers on whether jobs/economic opportunities or a range of amenities play a dominant role in attracting human capital (Florida, 2002a, 2002b; Liu & Shen, 2014). In the context of China, the recent "war of attracting talent", in which cities launched various talent-oriented policies to retain and attract human capital, could exert profound effects on the migration pattern of university graduates. Therefore, in this study, the characteristics of cities comprise three sets of factors: economic characteristics, amenity-related facilities and talent policy.

The descriptive statistics, measurements as well as data source of the independent variables are given in Table 1. To capture a city's economic characteristics, two widely used indicators (Dotti et al., 2013; Liu et al., 2017), the average wage and unemployment rates, were chosen. As we focus on highly educated labor forces, cities with an innovative spirit would be more attractive for them (Faggian & McCann, 2009a, 2009b). Previous studies often consider the number of patents per 1,000,000 inhabitants as an important indicator of scientific and technological output as well as knowledge creation (Guo & Yang, 2018), thus, it was also utilized in this study to assess the innovation capacity of a city.

Table 1 Description of independent variables in the models

Variable	Mean	SD	Description
Economic factors			
$WAGE_i$	8.623	1.980	Average annual wage in the university city in 2017[a]
$WAGE_j$	8.376	1.770	Average annual wage in destination city in 2017[a]
$UNEMP_i$	2.806	0.725	Urban unemployment rate in the university city in 2017[b]
$UNEMP_j$	2.821	0.680	Urban unemployment rate in destination city in 2017[b]
$INNO_i$	24.051	12.176	Number of patents per 1,000,000 inhabitants in the university city in 2017[a]
$INNO_j$	19.836	13.685	Number of patents per 1,000,000 inhabitants in destination city in 2017[a]
Amenity related facilities			
$CINEMA_i$	13.183	3.828	Number of cinemas per 1,000,000 inhabitants in the university city in 2017[d]
$CINEMA_j$	13.385	3.568	Number of cinemas per 1,000,000 inhabitants in destination city in 2017[d]
$TEMP_i$	15.271	4.878	Annual average temperature in the university city in 2017[e]
$TEMP_j$	15.267	5.191	Annual average temperature in destination city in 2017[e]
$HOSP_i$	0.356	0.315	Number of hospitals per 1,000,000 inhabitants in the university city in 2017[a]
$HOSP_j$	0.337	0.184	Number of hospitals per 1,000,000 inhabitants in destination city in 2017[a]
$PUBTRA_i$	8.183	2.358	Number of public transport vehicles per 1,000,000 inhabitants in the university city in 2017[a]
$PUBTRA_j$	8.462	2.825	Number of public transport vehicles per 1,000,000 inhabitants in destination city in 2017[a]
$INCLUS_i$	1.229	0.221	Inclusiveness index (the ratio of the total population to the hukou-registered population) in the university city in 2017 [a]
$INCLUS_j$	1.238	0.196	Inclusiveness index (the ratio of the total population to the hukou-registered population) in the destination city in 2017 [a]
Talent policy			
$TALPOL_i$	3.452	1.687	Talent policy index in the university city in 2017[f]
$TALPOL_j$	3.144	1.689	Talent policy index in destination city in 2017[f]
DIS_i	12.272	6.601	The Euclidean distance between the origin and the destination city
POP_i	1.200	0.700	Total population in the university city in 2017[b]
POP_i	0.946	0.677	Total population in destination city in 2017[b]
$HUMCAP_i$	23.339	9.605	The percentage of population with college degree and above in the university city in 2015[g]
$HUMCAP_j$	20.827	8.285	The percentage of population with college degree and above in destination city in 2015[g]

Data source: [a]China City Statistical Yearbook, 2018; [b]Statistical Communiqué on the 2017 National Economic and Social Development; [c]National Bureau of Statistics of China; [d]Maoyan App; [e]China Statistical Yearbook, 2018; [f]The attractiveness index of talent-oriented policies by China Index Academy, 2018; [g]2015 national 1% population sample survey

In terms of urban amenities, Glaeser et al. (2001) summarizes them into four categories: services and consumer goods, aesthetics and physical setting, public

services, and speed of communication and transportation. Based on his categorization, four variables were incorporated into the models, namely, the number of cinemas per 1,000,000 inhabitants, the annual average temperature, the number of hospitals per 1,000,000 inhabitants, and the number of public transport vehicles per 1,000,000 inhabitants. Besides, an inclusiveness index, measured by the ratio of the total population to the hukou-registered population, was included in the model. It has been verified in various contexts that inclusiveness (also referred to as diversity) increases a region's ability to compete for talent because low entry barriers can mobilise and enable a wider spectrum of people and talent to interact, thereby nurturing novel ideas, promoting creativity, and enhancing a sense of belonging (Florida, 2003; Stren, 2001).

As discussed in the introduction, to retain and attract human capital, the "war of attracting talent" was initiated by some second-tier cities in China, and these cities were later joined by a wide range of other cities. However, whether talent-orientated policies exert an influence on graduates' migration behavior is unclear. To examine their effects, we included an index measuring the attractiveness of talent-oriented policies of each city, which is issued by the China Index Academy (2018). This index comprehensively evaluates the talent policies of Chinese cities from three aspects: the breadth of the population that the policies target at, the amount of subsidies provided, and the implementation of these policies (detailed information is shown in the Appendix).

Lastly, three variables of gravity model—the total population of the origin and destination, as well as the distance between them—were included in the models. In addition, the stock of human capital measured by the percentage of people with a college degree, which has been found to exert impacts on migration of human capital (Arauzo-Carod 2013; Gu et al., 2020a, 2020b; Salas-Velasco 2020), was added in the models.

Table 2 reports the results of three negative binomial models, in which three sets of independent variables—economic characteristics, amenities, and talent policy enter the models stepwise. After eliminating 22 migration flows where the university city and employment city are the same, the number of observations in the models reduces to 540. As shown in Model 1, the impacts of economic characteristics are prominent. Higher wage in the destination city is positively associated with the inflows of graduates. Also, the effect of a city's innovation level is significant. A city with higher innovative level attracts larger inflows of university graduates and loses fewer graduates. However, the influence of unemployment rates in the city of university and the employment destination are insignificant.

In Model 2, variables of amenity-related facilities were added. Cities with more cinemas witness more inflows and less outflows of graduates, which suggests the graduates' preference for amenities concerning consumer services and entertainment opportunities. Temperature, a proxy for climatic comfort, is found to be related with the choice of employment destination, as graduates are more inclined to migrate to a warm and cozy place for working and living. The number of hospitals in the city of university is positively related to the retention of graduates while unexpectedly exert insignificant effects on attracting graduates from elsewhere. Given that the subject of this study—university graduates—are at the early stage of their life

course, healthcare facilities may not be their primary consideration to make a movement. The effect of public transportation in university city and the destination are both positive. The results also confirm the important role of inclusiveness of a place in attracting human capital. In Chinese cities, the ratio of the total population to the hukou-registered population could reflect a city's openness to non-locals as well as act as an indicator of population diversity in the city. The more inclusive and diverse the city, the more graduates flow in. It can be noted that, after adding the amenity variables, the coefficient of wage in the university city and unemployment rate in the destination city became significant, while innovation level in the university city became insignificant. Besides, the pseudo R^2 has increased considerably. These all indicate that solely considering economic factors is not capable of explaining the flows of talent. Furthermore, to some extent, amenities compete with the economic factors in affecting graduates' migration decision-making. Nevertheless, seen from the magnitude of these coefficients, wage differentials are still an important driving force underlying migration, even for the talent.

Model 3 considers ongoing talent policies. However, disappointingly, it appears that those talent policies are not effective, and even have an opposite impact on attracting an inflow of graduates. This can be explained by the paradox that cities with less competitiveness are more eager to launch favorable talent attraction policies to make up for their lack of attractiveness to talent, whereas cities with higher levels of competitiveness (such as Beijing and Shanghai), on the contrary, are facing large inflows of labor forces, including highly educated human capital, and thus are reluctant to loosen their hukou policies even for talent. The implementation of talent attraction policies, at least for now, has not changed the migration pattern of highly-educated human capital. However, it cannot be denied that the impact of such an implementation will show up over a longer period, which is worth a follow-up investigation.

Conclusions and Discussion

Individuals with high human capital have been widely acknowledged as key drivers of regional economic development (Faggian et al., 2017). In the past decade, researchers have become increasingly interested in the interregional migration of highly skilled migrants, but studies have mainly focused on developed countries (Haussen & Uebelmesser, 2018; Imeraj et al., 2018; Wright & Ellis, 2019). This empirical study enriches previous research by illustrating the migration pattern of recent university graduates in China, particularly in the context of the implementation of the "double first-class" initiative as the national strategy and cities' "war of attracting talent". To further unravel the driving forces underlying the migration pattern of graduates, the present study assesses the impact of economic factors versus amenities at the city level. It has been found that, unlike China's floating population who are predominantly job-motivated (Liu et al., 2015), highly educated people are also concerned about quality of life and prefer cities that offer a variety of amenities, which is in line with the findings of some previous studies (Fan, 2005; Liu et al., 2019; Michael & Gary, 1989). However, disappointingly, the talent policies

Table 2 Results of negative binomial models (robust standard errors in parentheses)

Variable	Model 1	Model 2	Model 3
Economic factors			
$WAGE_i$	− 0.035 (0.032)	− 0.092*** (0.035)	− 0.094** (0.040)
$WAGE_j$	0.162*** (0.020)	0.139*** (0.025)	0.106*** (0.027)
$UNEMP_i$	− 0.014 (0.065)	0.025 (0.057)	0.022 (0.056)
$UNEMP_j$	− 0.004 (0.057)	− 0.140** (0.061)	− 0.129** (0.061)
$INNO_i$	− 0.009** (0.006)	− 0.001 (0.006)	− 0.001 (0.007)
$INNO_j$	0.045*** (0.005)	0.010** (0.005)	0.015*** (0.005)
Amenity related facilities			
$CINEMA_i$		− 0.043*** (0.011)	− 0.044*** (0.011)
$CINEMA_j$		0.040*** (0.011)	0.027** (0.012)
$TEMP_i$		− 0.020** (0.008)	− 0.020** (0.009)
$TEMP_j$		0.024*** (0.009)	0.032*** (0.009)
$HOSP_i$		− 0.181* (0.103)	− 0.185* (0.101)
$HOSP_j$		0.305 (0.300)	0.157 (0.311)
$PUBTRA_i$		0.072*** (0.022)	0.073*** (0.024)
$PUBTRA_j$		0.060** (0.024)	0.067*** (0.025)
$INCLUS_i$		− 0.311 (0.261)	− 0.321 (0.267)
$INCLUSj$		0.495** (0.208)	0.376* (0.211)
Talent policy			
$TALPOL_i$			− 0.001 (0.028)
$TALPOL_j$			− 0.077*** (0.022)
DIS_{ij}	− 0.308*** (0.065)	− 0.526*** (0.058)	− 0.538*** (0.057)
POP_i	0.049 (0.093)	0.203** (0.089)	0.210** (0.092)
POP_j	0.195*** (0.057)	0.385*** (0.075)	0.383*** (0.077)
$HUMCAP_i$	0.004 (0.005)	0.001 (0.004)	0.002 (0.004)
$HUMCAP_j$	− 0.029*** (0.004)	− 0.015*** (0.005)	− 0.016*** (0.005)
Constant	0.003 (0.415)	0.379 (0.474)	1.019** (0.517)
Observations	540	540	540
AIC	1689.317	1524.425	1522.116
Pseudo R^2	0.234	0.319	0.322

***p < 0.01, **p < 0.05, *p < 0.1

launched by cities in the "war of attracting talent" do not exert an effective impact, at least for now.

The 42 "first-class" universities included in the "double first-class" initiative are unevenly distributed and mainly clustered in metropolitan areas in Eastern China. After graduation, those human capital further cluster in the most developed areas; Guangzhou and Shenzhen are the most popular destination, attracting graduates from both nearby and distant cities, followed by Beijing and Shanghai attracting graduates mostly from neighboring provinces. The general spatial pattern of graduates migrating to developed regions is similar to that revealed for the general labor

force (Liu & Gu, 2020; Liu et al., 2014; Shi & Liu, 2019). Cities with "first-class" universities exhibit varied retention capabilities. In general, cities in the eastern region are more capable of retaining local graduates, among which Shanghai takes the lead, with 70% of the local graduates remaining in Shanghai. Conversely, cities in western and northeast regions, particularly Xi'an, Harbin, Changsha, and Chang-chun, serve as a "springboard", from which a large number of graduates migrate to other places. We further categorize those cities into four types based on their volume of outflows and inflows of "first-class" university graduates. Some cities suffer from large outflows and small inflows of graduates, such as Xi'an and Changsha. It can be noted that it is these cities which have introduced appealing talent-orientated poli-cies, because they are facing the brain drain problem, but this problem has not been fixed by introducing talent policies, at least not yet. Conversely, some cities receive large inflows and experience small outflows, such as Shanghai and Hangzhou, which will undoubtedly consolidate and enhance their advantage in assembling human capital. This "Matthew effect", in the form of agglomeration of human capital, will further widen regional disparities (Li & Wei, 2010).

A central debate concerning human capital's migration is whether job opportuni-ties or urban amenities constitute the fundamental dimension of the attractiveness of a location affecting the flows of migration (Faggian et al. 2006; Haussen & Uebelm-esser, 2018; Whisler et al., 2008). Scholars have argued that skilled individuals migrate in search of a higher "quality of life" in addition to better job opportunities. However, previous studies have mainly focused on the features of destination cities, neglecting the role played by departure cities in the migration process. Our empirical study, situated in the Chinese context, joins the job-versus-amenity debate and takes into account the characteristics of both the departure and destination cities. It has been found that both jobs and amenities are significant considerations for graduates from "first-class" universities when choosing the destination to work. Furthermore, both the features of the university city and destination city shape the subsequent migration pattern of graduates. Inclusiveness of the destination city, measuring the diversity of the population, has also been found to be a crucial determinant, which confirms Florida's assertion that the creative class can be attracted by cities with social tolerance (Florida, 2003). Nevertheless, for developing countries like China, economic factors still play a central role, even for talents.

Another contextual factor that may exert an impact on human capital's mobil-ity is the ongoing "war of attracting talent" in China, which started in 2017. Many second-tier cities have launched various policies to attract talent, including relax-ing hukou registration requirements, offering subsidies for home renting or buying, and providing a living allowance. However, our study shows that these policies did not work, at least for attracting "first-class" university graduates in 2018. A para-dox exists here in that cities facing the problem of the brain drain are more likely to introduce talent-orientated policies to make up for their lack of attractiveness. Nevertheless, these policies may not serve as a solution, since human capital may inevitably be concentrated geographically; however, it is too early to draw this con-clusion. First, graduates may be in wait-and-see mode, and it takes time for these policies to be implemented and then exert effects. Second, labor migration in China used to be constrained by the hukou system (Gu et al., 2020a, 2020b). As a core

element of talent policies, relaxing the hukou registration requirement is expected to eliminate impediments placed by the hukou system in the longer term.

Finally, it is acknowledged that this study is subject to several limitations. First, the data drawn from Graduate Employment Reports is aggregated at the city/province level. The differences at the individual level cannot be captured in this study. Second, the data does not allow us to trace back to graduates' birthplace, which means we could only focus on the university-to-work transition and the influence of hometown cannot be taken into account in this study. The first stage of graduates' migration from domicile to university is highly shaped by the allocation system of university enrolment quotas (Hamnett et al., 2019), and therefore the analytic framework would be substantially different from that of the second stage of migration from university to work. We hope, in the future, that with the wider availability of data, we will be able to track the entire migration path from their domicile, to university and to work, which will deepen our understanding of human capital's migration in an integrated way.

Appendix

See Tables 3 and 4.

Table 3 The indicator system of the attractiveness of talent-orientated policies (source: China Index Academy, 2018)

Dimension	Related indicators	Description
The breadth of the population that the policies target at	The target of the policies	If only targeting high-end talents, the overall strength of the policies is weak, and if targeting talents at all levels, the strength of the policies is strong
	The scale of talents to be imported	If the city has issued specific talent import goals and the number of talents to be imported is large, then the policy would have greater impact
Policies facilitating talents' settlement	Hukou registration policies	The easier it is to register one's hukou, the more attractive the policies
	Housing subsidies	The more subsidies for home renting or purchase, the more attractive the policies
	Living allowance	The more living allowances, the more attractive the policies
The implementation of policies	Frequency of the policies that have been issued	The more frequent the policies that have been issued, the more likely the policies will be implemented
	Financial support for implementing policies	When the policies explicitly mention that the government will provide financial support, the more likely the policies will be implemented
	Organizational framework	The more established the organizational framework, the more likely the policies will be implemented

Table 4 The categorization of cities based on the attractiveness of talent policies

Ranking	Level	Cities
1st to 15th	5	Zhengzhou, Xi'an, Hefei, Changsha, Nanchang, Fuzhou, Haikou, Chengdu, Wuhan, Tianjin, Nanjing, Shenyang, Xiamen and Shijiazhuang
16th to 30th	4	Taiyuan, Hohhot, Jinan, Qingdao, Ningbo, Hangzhou and Chongqing
31st-45th	3	Beijing and Guangzhou
46th to 53rd	2	Lanzhou and Shenzhen
cities with no talent policies	1	Dalian, Changchun, Harbin, Shanghai, Suzhou, Nanning, Guiyang, Kunming, Lhasa, Xianyang, Xining, Yinchuan and Urumqi

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