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Retention of the highly educated migrants: From the perspective of urban e-service capability

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Abstract: China's e-government construction continues to accelerate, but little attention has been paid to whether the highly educated talents would be attracted by the high-quality public services. This article evaluates the urban e-government service and other factors in attracting the new-generation of highly educated migrants for the first time by using the China Migrants Dynamic Survey in 2017 and the data from the Evaluation Report of Government E-service Capability Index (2017). The results show that a city with better e-service capability is highly attractive to the high-educated talents and makes them have strong settlement intention, the highly educated migrants who are female, married, and from non-agricultural areas have stronger urban-settlement intention because of having stricter requirements of urban e-service capability. This research demonstrates the importance of the urban e-public services on retaining the new-generation of highly educated migrants.

Keywords: Urban e-service capability; settlement intention; new-generation migrants; highly educated; China

1. Introduction

Knowledge accumulation and technological progress are sources of regional sustained economic growth (Romer, 1990; Wang et al, 2020). As carriers of knowledge and technology, highly educated talents are key drivers of national and regional development. How to attract, retain and make effective use of talents is a common concern of governments around the world (Lee et al, 2004). The gathering of talents can bring about a variety of agglomeration economies, such

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as knowledge spillovers, low-cost communication and learning externalities, and a specialized talent pool for certain industries that need intelligence (Fujita & Thisse, 1996). China has experienced dramatic economic restructuring and industrial upgrading in recent years, with the technological innovation becoming a core driving force for national and regional development (Duan et al, 2016; Xu & Ouyang, 2018). Talents are undoubtedly the first element to promote technological innovation and regional economic and social development (Florida et al, 2012). Therefore, the Chinese central government has implemented several policies which attach the importance to highly educated talents for China's regional economic growth in the transition period. For example, National Medium- and Long-Term Talent Development Plan (2010–2020), and pointed out in its outline that China must change from a country with huge human resources to a country with a huge number of talents, and be a winner in the fierce international talent competition. The report of the 19th CPC National Congress in 2017 pointed out that "we should firmly implement the strategy of strengthening the country with talents and cultivate a large number of talents, for example, strategic talents, leading talents in science and technology, young talents and high-level innovation talents." Furthermore, in recent years, local governments have formulated a series of public policies for attracting and retaining highly educated talents, which means that the competition for talents becomes increasing fierce (Gu et. Al, 2020; Wang et al, 2020).

China's economic reforms since 1978 have brought about an unprecedented population migration. The migration is an inevitable phenomenon in the process of social and economic development (Guo et al, 2020). According to the data of China's seventh census, the number of migrants in China has reached 376 million, and the composition of migrants is gradually diversified. In terms of age composition, the new-generation migrants born after 1980 is increasing. With China's participation in economic globalization, industrial transformation and college enrolment expansion, a new type of migrant worker has emerged, skilled migrants (Zhou et al, 2020). According to the national 1% population sampling survey in 2015, China's population with college degree or above reached 170.93 million, an increase of 42.87% compared with 2010. With the rapid development of economy and the advancement of urbanization, the new-generation of highly educated migrants have a higher level of human capital and competitiveness in the labor market, which play an important

role in optimizing the working age population structure, alleviating population aging and promoting the rapid development of urban economy. The new-generation of highly educated migrants once provided a flexible workforce and facilitated the industrialization and urbanization in China's post-reform period, but due to their floating or unstable nature in spatial and social sense, they are increasingly regarded as unsustainable in the future (Yeh et al., 2015). Therefore, facilitating migrants to permanently settle down in cities is crucial for sustainable urbanization in China.

In the Internet plus initiative background, the digital city construction may have a new impact on the long-term settlement intention of migrants. The city e-government public service ability is an important guarantee for the digital city construction. However, there are few studies about the settlement intention of the new-generation of highly educated migrants in China from the perspective of urban e-public service capability. In addition, most studies did not consider the effectiveness of the selected variables and the possible estimation bias of the variables when selecting the influencing factors. In this context, our study is expected to supplement previous ones in the following aspects: first, this study uses the China Migrants Dynamic Survey in 2017 and the data from the Evaluation Report of Government E-service Capability Index (2017) to investigate the impact of urban e-public service capability on the settlement intention of the new-generation of highly educated migrants for the first time; second, Lasso method in machine learning was used to screen out the influencing factors, constructs a comprehensive index to analyze the settlement intention in this kind of migrants at different levels.

The main purpose of this paper is to construct a comprehensive index of the residence intention using the China Migrants Dynamic Survey organized by the China Health and Family Planning Commission in 2017, and to study the impact of urban E-public service capability on the settlement intention of the new-generation of highly educated migrants in China. The rest of this study is organized as follows. Section 2 summarizes the literature on the influencing factors of migrants' settlement intention and puts forward the corresponding theoretical hypotheses. Section 3 describes the research design, including research data, variable selection and research methods. Section 4 discusses the impact of urban E-public service capability on the settlement of the new-generation of highly educated migrants, and the robustness of the

conclusion is tested, then explores the heterogeneity of the impact of urban e-public service capability on the new-generation of highly educated migrants, lastly discusses the mechanism of urban e-public service ability affecting the settlement intention of the new-generation of highly educated migrants by constructing an intermediary effect model. Section 5 draws the conclusion and puts forward some suggestions to improve the settlement intention of the new-generation of highly educated migrants and promote the sustainable development of the city.

2. Literature review

2.1. Theory and influencing factors of migrants' settlement intention

The determinants of migration process and settlement intention have attracted substantial scholarly attention from various theoretical perspectives. The discussion is mainly based on the following theories. Firstly, from the perspective of rational choice theory, migrants decide to move or stay in their hometowns to maximize expected and long-term benefits (Todaro, 1969; Massey et al., 1993); migration is an outcome of the regional income difference and a result of cost–benefit calculation at individual level. These factors mainly include the differences in wages, living standards, job opportunities, public facilities, and services. Individual factors affecting expectations often affect migration stability (Hu et al., 2011). However, due to the complexity of Chinese urban society, empirical research conclusions obtained at different times and regions are very different (Huang et al., 2018; Gu, et al, 2020; Zhou et al, 2018). Secondly, the new labor migration theory emphasizes the influence of families on migration decisions. Having more family members at the destination will increase the intention to settle down (You et al., 2018; Mincer, 1978), but some studies have pointed out that family members do not necessarily promote the intention to stay (Fan et al., 2011). In many rural families, members work in cities, which is as one of the means to temporarily increase family income (Cao et al., 2015). Thirdly, based on the social network theory, in the migration research, it is generally believed that social capital is generated in the social network (Zhu et al., 2019). This support system will make it easier for the migrants to obtain starting capital, accommodation, work information and opportunities. Physical and mental health play a crucial role in shaping the

settlement intention of migrants (Huang et al, 2021). Finally, based on the push-pull theory, settlement intention is affected by push and pull factors at the origin and destination, that is, the positives of staying, the negatives of moving, and their converses (Lee, 1966). Based on these theories, we put forward the hypothesis 1.

Hypothesis 1: The individual factors, economic factors and social factors are the core factors affecting the settlement intention of the new-generation of highly educated migrants.

In the relevant empirical research, the factors affecting settlement intention are mainly economic and social factors and individual characteristics. Previous studies have suggested that individual characteristics like gender, income, age, education level, type of occupation, marriage, mobility and experience are the important factors (Yang et al, 2019). Among migrants, those who receive high education and are from non-rural areas, married, and older so forth have strong settlement intention (Yang, 2017). Also, women are more willing to stay than men (Liu et al., 2019). The floating factors, for example, the flow time and scope of the migrants, are also important for their settlement intention. Generally speaking, the longer the cross-province migration, the stronger the settlement intention is; and the new-generation of highly educated migrants like to seek cross-province jobs (Yang et al, 2019). Along with job opportunities, the ones who float for the job are more likely to stay in the city (Masahiro & Yasushi, 2021).

At the economic level, the intention for migration is the result of comparing expected income with migration costs. According to Stark and Bloom (1985), labor migration is the result of household income diversification and risk minimization decisions. Labor migration occurs not only to maximize individual economic benefits, but also to achieve household economic income goals. Once laborers achieve their expected income targets have their own houses, they may choose to settle down (Xie & Chen, 2018). So, among migrants, those have the high income and the self-owned housing are more likely to settle down (Yang, 2017).

With the sustained urban development, the migrants, while expecting to obtain economic benefits, are eager to obtain social acceptance of the inflow city and gradually integrate into the society (Li & Liu, 2020). The degree of social integration and the sense of identity with the cities where they work have be-come important factors for their settlement

intention. The higher the recognition of the migrants by the inflow city, the stronger their desire to settle down (Liu et al., 2017). Based on these empirical studies, we put forward the hypothesis 1a-1d:

Hypothesis 1a: Among migrants, those who receive high education and are from non-rural areas, female, married, and older so forth have strong settlement intention.

Hypothesis 1b: Among migrants, those who work outside their own provinces for a long time have strong settlement intention.

Hypothesis 1c: The high income, the self-owned housing and so forth lead to the strong settlement intention among the new-generation of highly educated migrants.

Hypothesis 1d: The new-generation of highly educated migrants who are willing to integrate into the society are more likely to stay in the cities they move in.

2.2. Public service and migrants' settlement intention

When the population can move freely, the urban public service level is the key factor affecting the migrants' intention to stay (Lin et. al, 2019). However, some studies have studied the impact of education public service (Li, 2020), industrial and social citizenship public service (Hou, 2016), social insurance (Huang et al., 2020; Xie et al., 2021) and urban public service quality (Yang, 2017) on the migrants' settlement intention. With more attention paid to the highly educated migrants, the experts began to pay attention to the flow of public services and highly educated migrants. Cities with high public service capacity are more attractive to highly educated migrants (He, 2020). High-end medical equipment and high-quality educational resources are important factors to attract the highly educated population (Tong & Liu, 2018); and so are the high-quality smart city environment and the regions with well-established amenities (Zhang et al., 2019; Chou & Lim., 2015).

The positive effect of the expansion of urban scale on the city has also been concerned by experts. The expansion of urban scale promotes the labor production efficiency, which makes the migrants entering the city have a strong intention to stay (Glaeser & Resseger, 2010). The migrants' settlement intention in big cities is higher than that in small and

medium-sized cities (Lin et al., 2019). The expansion of city scale has a certain positive impact on the migrants' intention to stay (Liu & Wang, 2020). As we know, big cities have become an ideal platform for China's new-generation of population migration. Based on these, hypothesis 2 is proposed.

Hypothesis 2: The improvement of urban e-public service level can promote the settlement intention of the new-generation of highly educated migrants. The improvement of urban e-public service level has different effects on the settlement intention of the new-generation of highly educated migrants, depending on urban sizes and individual characteristics.

Based on the review of the literature, the theory frame of this work is proposed, as shown in fig. 1. In the hypothesis we proposed, variables are selected strictly, as shown in table 1.

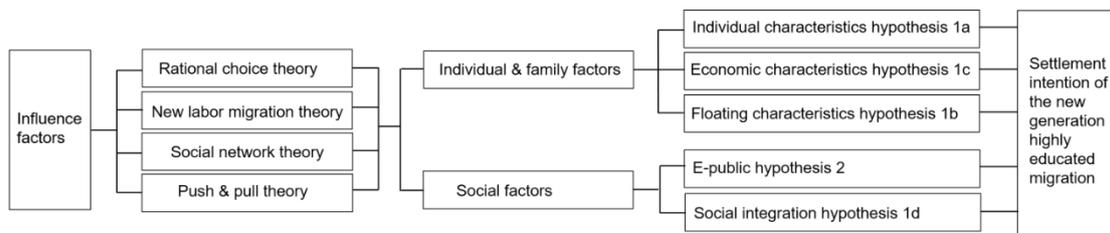


Fig. 1 Theory frame of this work

3. Data and methodology

3.1. Data source

This paper uses data from the China Migrants Dynamic Survey (CMDS) in 2017, the CMDS is an open access and nationally representative cross-sectional survey of internal migrants aged 16 and above who did not have the local hukou and had been living in local cities for more than 1 month. Using the stratified multi-stage random sampling method with the probability proportional to size (PPS) approach, the survey draws samples from 348 cities covering 32 provincial units in China. We use the “Evaluation Report of Government E-service Capability Index” jointly released by Nanjing University and Xinhua News Agency in 2017 to measure the urban e-service capability level.

3.2 Variable selection and description

3.2.1 Dependent variable

This paper constructs a comprehensive index system including 3 indicators of "city-staying intention", "long-term city-residence intention" and "household city-moving-in registration intention" to measure the urban settlement intention with the migrants having a degree of junior college or above. The 3 indicators correspond to the 3 questions: "do you have any plans to stay in this locality in the future", "if you plan to stay in this locality, how long do you expect to stay", "if you meet the local settlement conditions, are you willing to transfer your household registration to this locality?". The migrants usually have the intention to stay in the city before having the intention of long-term settlement and transferring the household registration. In this paper, we assign a value of 1 to the choice of "consider to stay in city" and "willing to move into the city registered residence" with the value of 1 for the indicators of city-staying intention; otherwise, 0. For long-term staying in city, we assign a value of 1 to the staying time of 6-10 years, 2 to the staying time over 10 years or more; otherwise, 0. We accumulate the value of the 3 indicators with equal weighting to measure the settlement intention of the migrants, and the intention is presented by a value (0, 1, 2, 3, 4), in which 0 means "no intention", 1 means "low intention", 2 means "medium intention", 3 means "high city-staying intention", 4 means "very high intention".

3.2.2 Core explanatory variable

The core explanatory variable in this paper is e-service capability. This paper is based on the Evaluation Report of Government E-service Capability Index (2017) to evaluate the e-public service level in prefecture level cities using indicators such as service provision capability, participation service capability, information service capability and civil affair service capability from the website, microblog, WeChat and APP. At the same time, the WCI (WeChat Communication index) and BCI (Micro-Blog Communication Index) are used to measure the e-public service level of prefecture level cities.

3.2.3 Control variables

The other variables that may affect the new-generation of highly educated migrants' intention to stay in cities are

divided into the following five categories. (1) Basic personal statement, income / expenditure, flow characteristics, health, Social integration variables. The variables of the main occupation is classified by using the existing method proposed by other experts (Lin et al., 2019). The white-collar workers are assigned a value of 0 (including civil servants, enterprise staff, professional and technical personnel); business and service personnel a value of 1 (including business, catering, housekeeping, security, express, decoration and other business and service personnel); production and transportation equipment operators a value of 2 (including production and transportation, building and related personnel); other personnel a value of 3 (including production personnel without fixed occupation, agriculture, forestry, animal husbandry and fishery); unemployed personnel a value of 4 (that is, personnel without work at present). The specific variables are given in Table 1.

3.2.4 Variable description

Among the 169,000 questionnaires, the proportion of female and male is 48.3% and 51.7% respectively, which basically reflects the actual situation of the population in China; the average age of respondents is 39.6 years old, and the majority of respondents graduate from the junior and senior middle school, which reflects the actual situation of the nine-year compulsory education in China. Meanwhile, the characteristics of other control variables are basically consistent with the distribution proportion of the data in China's Sixth National Population Census, which means that the samples used in the survey and the survey data are highly representative. In this paper, we select those who receive junior college education or above and are born between 1980 and 1990 as the research objects to study the settlement intention of the migrants. The specific descriptions are shown in Table 1.

Table 1. Variable selection and basic description

variable	implication	Classification	mean	standard deviation	min	max
y	city staying intention		2.572	1.413	0	4

E-service capability	The larger of the value, the greater of the e-service capability	Government services	0.498	0.149	0.077	0.742
familynum	Number of family members living together		2.700	1.183	1	10
gender	female = 0, male = 1		0.460	0.498	0	1
age	Age		28.97	4.146	18	37
education	degree of education from 5 to 7	personal	5.437	0.555	5	7
hukou	Agricultural hukou = 0, non-agricultural hukou= 1	characteristics	0.466	0.499	0	1
party	Party member and League member = 1, others = 0		0.328	0.469	0	1
marriage	Marital status, married =1, others = 0		0.686	0.464	0	1
job	Main occupation, the value is 0-4		1.232	1.305	0	4
ln(income)	Logarithm of total monthly income	Revenue and	8.255	0.677	4.605	11.513
ln(houseexp)	Logarithm of monthly housing expenditure	expenditure information	5.217	3.303	0	10.309
house	Self-owned house = 1, others = 0		0.401	0.490	0	1
totalcity	Total city number of migrants stay		1.834	1.233	1	40
Q306	Father or mother with floating experience = 1, others = 0	migration status	0.216	0.411	0	1
Q309	intersection more with local registered residence people =1, other =0		0.550	0.500	0	1

duziliudong	migration alone = 1, others= 0		0.713	0.452	0	1
migrant	interprovincial mobility =1, and Inner-provincial mobility =0		0.439	0.496	0	1
timeyear	Duration time for this mobility		4.504	4.210	0	35
migrantr	Job relocation = 1, others = 0		0.750	0.433	0	1
health	Health condition, the higher the value, the better the health		3.902	0.306	1	4
Q403	establishment of health record = 1, otherwise it is 0	health	0.281	0.449	0	1
healthnow	In the last year, suffering of illness or indisposed = 1, others were 0		0.521	0.500	0	1
Q501A	Participation in local union activities since 2016 = 1, others = 0		0.193	0.394	0	1
Q501B	Participation in local volunteer association activities since 2016 = 1, others = 0		0.143	0.350	0	1
Q501C	Participation in the activities of the local student union since 2016 = 1, others = 0	social integration	0.430	0.495	0	1
Q501D	Participation in the activities of local villagers' association since 2016 = 1, others = 0		0.213	0.410	0	1

	Participation in the activities of				
Q501E	hometown chamber of Commerce	0.038	0.191	0	1
	since 2016 = 1, others = 0				
	Participation in local activities except				
Q501F	the above-mentioned activities since	0.099	0.298	0	1
	2016 = 1, others = 0				
Q503B	paying more attention to the change of the city lived, the greater the value	2.433	0.573	0	3
Q503C	The more intention to integrate into the life of local people, the greater the value	2.444	0.581	0	3
Q504A1	Participating in rural cooperative medical insurance = 1, others = 0	0.000	0.007	0	1
Q504B1	Participating in urban-rural cooperative medical insurance = 1, others = 0	0.045	0.207	0	1
Q504C1	Medical insurance for urban residents = 1, others = 0	0.080	0.271	0	1
Q504D1	Medical insurance for urban employees = 1, others = 0	0.547	0.498	0	1
Q504E1	Participating in public medical treatment = 1, others = 0	0.047	0.212	0	1
Q505	Personal social security card = 1, others = 0	0.719	0.450	0	1

	Application for temporary residence				
Q506	permit / residence permit = 1, others =	0.620	0.486	0	1
	0				

3.3 Model

The following three models are the main models this paper uses.

3.3.1 Logit model

In the contemporary society, people usually make the best choice according to the principle of utility maximization. The new-generation of highly educated migrants will choose the city to stay with the purpose of maximizing their own effect. With the assumption that the effectiveness of the new-generation of highly educated migrants staying in city depends on the characteristics of individuals and cities, the specific utility function is:

$$U_{ij} = \beta city_{ij} + \theta X_{ij} + \varepsilon_{ij} (j = 1, 2, \dots, N; i = 1, 2, \dots, M) \quad (1)$$

Where $city_{ij}$ represents the e-service capability of city j which individual i inflows. X_{ij} represents the individual characteristics, income and expenditure level, flowing characteristics, health level and social integration status of the migrants. ε_{ij} is the factor that hasn't been observed. The new-generation of highly educated migrants chooses to stay for a long time or settle down when the following conditions are met:

$$choice_{ij} = \begin{cases} 1, \forall k \neq j & E[U_{ij}] > E[U_{ik}] \\ 0, \exists k \neq j & E[U_{ij}] \leq E[U_{ik}] \end{cases} \quad (2)$$

If $E[U_{ij}] > E[U_{ik}]$, the utility of the individual flowing into the city j is greater than that of the city k , so the individual chooses to stay in the city, and $choice_{ij} = 1$, otherwise, $choice_{ij} = 0$. We use no intention, low intention, medium intention, high intention, and very high intention to measure the intention of the new-generation of highly educated migrants to stay in cities, which is represented by 0 - 4. Therefore, the probability of the new-generation of highly educated migrants choosing to stay in cities is as follows:

$$p_w = p(y \leq w | X, city) = \frac{\exp(\beta' city_i + \theta' X_i)}{1 + \exp(\beta' city_i + \theta' X_i)} \quad (3)$$

3.3.2 Lasso model

In order to solve the multi-collinearity of the data, we maximize the likelihood function with LASSO penalty term and estimate the regression coefficient and select the variable. The model can be expressed as:

$$\hat{\beta} = \operatorname{argmin} \|y - \sum_{j=1}^p (\beta_j \text{city}_j + \theta X_j)\|^2 + \lambda \sum_{j=1}^p |\beta_j| \quad (4)$$

Where λ is the nonnegative canonical adjustment coefficient and j is the number of variables. Lasso method is directly used to estimate the coefficient of the unimportant factors affecting the intention to stay in the city as 0. By adopting the Sklearn Library in Python, we use LassoCV function to filter variables and eliminate variables with coefficient equal to 0, so that the unimportant variables can be deleted. Because lasso penalty term penalizes every regression coefficient, the estimator of regression coefficient has deviation. In order to effectively eliminate the estimated deviation with limited samples, we use the method of likelihood function with lasso penalty term to select the important variables.

By using Lasso method, four control variables are eliminated, that is, “party”, “Q501E”, “Q504A1”, “Q504E1”, and the other 32 control variables are retained for empirical analysis.

3.3.3 Mediation model

The following models are used for testing:

$$y_i = \alpha_i + \beta_1 \text{city}_i + \delta X_i + \varepsilon_i \quad (5)$$

$$\text{keji}_i = \alpha_i + \gamma \text{city}_i + \varphi X_i + \varepsilon_i \quad (6)$$

$$y_i = \alpha_i + \beta_2 \text{city}_i + \theta \text{keji}_i + \varphi X_i + \varepsilon_i \quad (7)$$

Where, y_i represents the new-generation of highly educated migrants’s staying intention in the city and city_i represents the government's e-service capability; keji_i represents the proportion of urban science and technology talents in the total population (%), X_i is the control variable; α , β , σ , γ , ϕ , θ are the coefficient corresponding to the variable, ε_i is the error item.

Sobel (1982) constructed a test method of mediating effect which can reduce the probability of making the first and second type errors. Firstly, we test whether β_1 is significant, if it is significant, then proceed to the next step, otherwise

there is no mediating effect. Then, if β_1 is significant, then test γ and θ ; if they are all significant, then continue to test β_2 ; if β_2 is significant, then the mediating effect is significant; otherwise, it is a complete mediating effect. If at least one of γ and θ is not significant, Sobel test is performed. For the statistic of $Z = \gamma\theta/(\gamma^2s_\gamma^2 + \theta^2s_\theta^2)$, where s_γ^2 and s_θ^2 are the variance of γ and θ , when the value is significant, it indicates that there is a mediating effect, and the size of the mediating value can be calculated by $\gamma\theta/(\gamma\theta + \beta_2)$. If the statistic is not significant, the mediating effect is not significant.

4. Results

4.1. Benchmark regression

This paper uses the Ordinal Logit model to study the effect of the urban e-service capability on the high-educated migrants' intention to stay in the city. The regression results are shown in Table 2. Model 1 only considers the impact of urban e-service capability on the high-educated new-generation of migrants to stay in the city; Model 2 adds the individual characteristics of the migrants on the basis of model 1; Model 3 adds the income and expenditure level on the basis of model 2; Model 4 adds flow characteristics on the basis of model 3; Model 5 adds health status on the basis of model 4; Model 6 adds social integration related variables on the basis of model 5. All results show that the higher the level of urban e-service ability, the stronger the intention of the highly educated new-generation of migrants to stay in the city. The conclusion is consistent with hypothesis 2.

Table 2 Benchmark regression results

variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
gov	1.269***	1.001***	0.897***	0.781***	0.773***	0.628***
familynum		0.115***	-0.006	-0.028**	-0.027**	-0.020
gender		-0.274***	-0.241***	-0.244***	-0.242***	-0.218***
age		0.043***	0.033***	0.018***	0.019***	0.014***
education		0.227***	0.115***	0.101***	0.100***	0.068***

hukou	0.492***	0.399***	0.376***	0.375***	0.328***
marriage	0.717***	0.406***	0.515***	0.515***	0.500***
ln(income)		0.412***	0.378***	0.378***	0.332***
job		-0.014	0.004	0.007	0.034***
ln(houseexp)		0.014***	0.019***	0.020***	0.016***
house		0.919***	0.835***	0.835***	0.786***
totalcity			-0.038***	-0.037***	-0.030***
Q306			0.089***	0.088***	0.067**
Q309			0.281***	0.277***	0.196***
duziliudong			0.180***	0.178***	0.165***
migrant			0.116***	0.111***	0.108***
timeyear			0.055***	0.055***	0.043***
migrantr			0.157***	0.154***	0.055**
health				0.286***	0.169***
healthnow				0.069***	0.046**
Q501A					-0.079**
Q501B					0.112***
Q501C					0.138***
Q501D					0.085***
Q501F					-0.089**
Q503B					0.124***
Q503C					0.804***
Q504B1					-0.137**

Q504C1	0.077
Q504D1	0.255***
Q505	0.067**
Q506	0.082***

Note: “***”, “**”, “*” are significant at 1%, 5%, and 10% significant levels respectively, the same below.

Among the new-generation of highly educated migrants, those who have a higher education level and registered residence, and are married, female and older, are more likely to stay in the city, which is consistent with hypothesis 1a. Income variables: those who have a high income and rent spending, self-owned houses, and a stable job are more willing to stay in the city among the new-generation of highly educated migrants, which is consistent with hypothesis 1c. Health variables: those who have established health records and who have been sick in the recent year are more likely to stay in the city, which may be related to the city's medical care and social security systems.

The floating experience from at least one of the parents and the contact with local people permanently residing or fellow-townsmen/villagers having local household registration are facilitating factors for the new-generation of highly educated migrants to stay in the city; and the third facilitating factor is the cross-province migration (which is consistent with the conclusion of the study by Yang & Fan, 2019). The development gap between regions profoundly affects job choice and settlement intention for the new-generation of highly educated migrants. Due to the spatial imbalance of employment opportunities, living costs and regional preferences so forth, the cross-province migration into big cities has become a common social phenomenon. Among highly educated migrants, those who stay in more cities have lower intention of settlement, and those who stay in a city for a longer time and whose migration is because of the work has stronger settlement intention in the place of immigration. For the new-generation of highly educated migrants, when staying for a long time, they are willing to integrate into the city and are easy to get good connections, employment and other opportunities. At the same time, job opportunities are important determinants of workers' migration (Taima & Asami, 2021). When the new-generation of highly educated migrants can get better employment opportunities, they are more

inclined to choose the city as the residence city. These conclusions are consistent with hypothesis 1b.

Among the new-generation of highly educated migrants, those who participate in volunteer activities and classmate meetings and pay attention to changes in the city, who are willing to integrate into local life, who purchase urban residents' or urban employees' medical insurance and have the residence permit or temporary residence permit, are more likely to choose to stay in the floating city. These results prove that hypothesis 1d is correct. The new-generation of highly educated migrants who participate in the cooperative medical insurance of residents have a lower intention to stay, because that is a medical insurance system in which main participants are urban minors who do not participate in the medical insurance for urban employees and residents who do not work. The new-generation of highly educated migrants who do not work without employment insurance have weak settlement intention.

4.2 Robustness analysis

In this paper, the robustness of the regression results is verified in three ways, namely, the different models for regression, the instrumental variable method and the intercepted data. The details of these three methods are as follows:

Ordinal probit and poisson regression method. Models 7-8 in Table 3 give the results of ordinal probit and poisson regression respectively.

Instrumental variable method. Considering that there may be a correlation between e-service level and the intention of the new-generation of highly educated migrants to stay in cities, model 9 uses "WCI and BCI" e-service ability as an instrumental variable to verify the robustness of the conclusion.

Regression with intercepted data. Considering that the data may be quite different, Model 10 eliminates the first 1% and the last 1% of the urban e-service level variables to verify the robustness of the conclusion.

All three methods show that China's urban e-service capability promotes the new-generation of highly educated migrants' settlement intention in cities.

Table 3 Robustness analysis

variable	Model 7	Model 8	Model 9	Model 10
gov	0.091***	0.375***	0.677***	0.633***
Controlled variable	yes	yes	yes	yes

4.3 Heterogeneity analysis

Based on the assumption that the migrants has the same preference on the government public services, this part analyzes the new-generation of highly educated migrants' settlement intention from multiple perspectives, and the ordinal logit regression model was chosen to examine the heterogeneity effect of government e-service capability on the new-generation of highly educated migrants' settlement intention from the perspective of individual differences.

4.3.1 Gender, marriage and registered residence

Table 4 shows the effect of the urban e-service capability on the new-generation of highly educated migrants with the different gender, marital status and registered residence. Models 11 and 12 analyze the impact of e-service capability on the male and female migrants' settlement intention in cities. According to the regression results, the improvement of urban e-service capability can significantly promote male and female migrants' settlement intention, and the improvement of e-service capability has a greater impact on the new-generation of highly educated male migrants' settlement intention in the city. Models 13 and 14 examine the impact of urban e-service capability on the settlement intention of new-generation of highly educated migrants with the different marital status. The results show that urban e-service capability has a significant impact on the settlement intention for the new-generation of highly educated migrants who are married, but the impact is not significant for those who are unmarried. Models 15 and 16 examine the impact of urban e-service capability on the settlement intention of the new-generation of highly educated migrants with urban and rural registered residence. The results show that the impact of the e-service capability on the settlement intention of the new-generation of highly educated migrants with urban or rural registered residence is significantly positive, but the impact on those with the urban registered residence is greater. From the results, in order to attract more people, cities should improve the level

of urban e-services and China's urbanization rate.

Table 4 Heterogeneity analysis—gender, marriage and registered residence

variable	Model 11 (male)	Model 12 (female)	Model 13 (married)	Model 14 (unmarried)	Model 15 (rural)	Model 16 (city)
gov	0.684***	0.502***	0.958***	0.044	0.330***	0.911***
Controlled variable	yes	yes	yes	yes	yes	yes

4.3.2 city scale

Model 17-19 examines the impact of the urban e-service capability on the intention of the new-generation of highly educated migrants' settlement intention in cities of different sizes. Model 20 is a mega city with more than 10 million population; Model 21 is a big city with population between 3 million and 10 million; Model 22 is a city with less than 3 million population. The results show that the e-service capability has different impact on the new-generation of highly educated migrants in different sizes of cities. This shows that the new-generation of highly educated population will consider the city size in the migration, and when the new-generation of highly educated migrants come to the city with a population of 3 million, they are more sensitive to the e-service capability. These conclusions are consistent with hypothesis 2.

Table 5 Heterogeneity analysis—Job and city size

variable	Model 17	Model 18	Model 19
gov	0.398*	0.048	0.366**
Controlled variable	yes	yes	yes

4.4 Mechanism analysis

To further study the mechanism of the impact of urban e-service capability on the high-educated new-generation of migrants' settlement intention, this paper takes scientific and technological talents as the intermediary variable in the study. Model 20-22 take e-service capability as the core explanatory variable, the proportion of scientific and technological talents as the intermediary variable, and Model 23-25 takes MCI and BCI service ability as the core explanatory variable. Whether using the overall urban e-service level or MCI and BCI service level as the core explanatory variable. The test results show that β_1 , γ and θ , β_2 are significant and that scientific and technological talents have a mediating effect. The higher the proportion of urban scientific and technological talents, the better the urban development will be. This attracts the new-generation of highly educated migrants to stay in the city.

Table 6 Mechanism analysis

variable	Model 20 (1)	Model 21 (2)	Model 22 (3)	Model 23 (1)	Model 24 (2)	Model 25 (3)
keji			0.129***			0.109***
gov	0.584***	3.082***	0.213**	0.822***	3.196***	0.493**
Controlled variable	yes	yes	yes	yes	yes	yes

5. Discussion and Conclusion

Urban e-public service capability has a significant positive impact on the settlement intention of the new-generation of highly educated migrants. Urban e-public service affects the settlement intention of the new-generation of highly educated migrants by increasing the proportion of scientific and technological talents. With a wide range of settlement, the main factors for settlement intention of the new-generation of highly educated migrants include individual characteristics, economic opportunities, floating characteristics, health level and social integration characteristics. These

characteristics have different effects on the settlement intention of the new-generation of highly educated migrants.

Based on the above conclusions, the following corresponding policy suggestions are made to promote the settlement intention of the new-generation of highly educated migrants and promote urban sustainable development:

Firstly, we should pay attention to the improvement of China's urban e-public service capability. At present, under the background of smart city construction, the mode of urban public service is changing, and urban e-service has become the focus of attention in cities. Urban e-public service is one of main tasks in smart city construction and development, urban e-government service capability has a great impact on the settlement intention of the new-generation of highly educated migrants. Governments at all levels should pay more attention to the improvement of urban e-public service capability and promote the sustainable development of cities in the information age.

Secondly, we should pay attention to the influence of city sizes on the China's new-generation of highly educated migrants' settlement intention. In order to promote the rational and orderly flow of the new-generation of highly education migrants among different cities, a big city needs to break through the mindset in the reform of household registration system, gradually reduce the threshold of settling down. The central government should guide the rational allocation of migrants among cities of different sizes, pay attention to the development of small and medium-sized cities, and ensure the full supply of employment related public services at the government level. Small and medium-sized cities also need classified development strategies to lead the population to realize nearby and local urbanization.

Thirdly, we should pay attention to the contradiction between the China's new-generation of highly educated migrants' settlement intention and the current policy guidance. In the process of population growth in mega cities and big cities, we should abandon the policies that do not conform to the law of development which have restrict the expansion of urban population scale, such as forcibly implementing population dispersal and expelling ordinary workers from the migrants group. At the same time, big cities should pay attention to the scientific planning of metropolitan areas and their own areas, adjust the industrial structure, promote the sustainable development of resource allocation, so as to lead to a free flow of the new-generation of highly educated migrants between different regions and cities.

In short, as a carrier to promote new urbanization, cities are not only an important gathering place for the new-generation of highly educated migrants, but also an important support for China's economic and social development. The younger generation of highly educated migrants have the characteristics of high mobility, how to attract and retain these highly mobile talents is the key to promote urban economic development. There are still many valuable issues worthy of further discussion in future research: firstly, based on the perspective of urban e-public service, this paper analyzes the flow direction choice and its influence mechanism of the new-generation of highly educated migrants from the dimensions of individual characteristics, flow characteristics, economic characteristics, income status and health level. The psychological pressure, house price level, living environment and so forth in choosing the settlement site can also be important influencing factors for the migrants, which are not covered in the questionnaire and need to be further studied. Secondly, the different resource endowments among regions lead to the imbalance of regional economic development. The economically developed areas such as Beijing, Tianjin, Hebei, Jiangsu, Zhejiang and Shanghai are still the favorite places for the new-generation of highly educated migrants. As the time goes by, the trend of this group gathering in the eastern region will be more obvious. Under the background of the new round of talent competition, the impact of preferential policies given by different regions on the talent flow is also an important topic to be studied next.

CRedit authorship contribution statement

Zhaoyuan Fan: Conceptualization, Methodology, Software, Data curation, Writing – original draft, Validation.

Xiaofeng Liu: Software, Data collection, Data curation, Writing - original draft.

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