The spatial characteristics of residential mobility in the information era: a perspective of information channel in Nanjing city, China

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Abstract

A number of studies focus on the impacts of telecommuting on residential mobility, but few studies pay attention to the change of information channel and its impact on moving space. Based on the theory of search space, this paper uses data of Nanjing Residents Behavior Survey (NRBS) and Multinomial logistic model to respectively discuss the changes of moving distance and commuting distance influenced by different information channels (internet channel and traditional channel). The main results show that information channel has significant impact on both moving distance and commuting distance in general. Internet channel users prefer to make longer moving distance and commuting distance than traditional ones with strong distance bias. However, internet channel makes less impact on commuting distance than telecommuting. Meanwhile, traditional channel is also confirmed with significant impact on moving distance, but no significant impact on commuting distance.

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1. Introduction

With rapid development of information and communication technology (ICTs), the space pattern of residential mobility has experienced more changes. On the one hand, households get out of the limitation from work location and have more choices to find new houses with lower housing price, better neighborhood environment or enough service facilities. Because they can use computer or telephone connected on internet to finish their work at home to reduce daily commute. On the other hand, numerous and complete information about new houses is also been provided directly by internet that households can make more flexible decisions on relocation. As an important kind of ICT use, impact of telecommuting on residential mobility has aroused much more interests of scholars over the past decade. Almost studies believed that telecommuters often move into suburban areas with longer commuting distance than the commuters because of their flexible time for working at home to better meet other housing demands [1-5]. However, it is difficult to find discussions about the direct relationship between different information channels (especially internet use) and moving space such as moving distance (from previous house to current house) or commuting distance (from current house to workplace) after households finished their relocation (distance bias), what is more important to urban planners and policy makers reasonable arrange the residential space in the information era.

In general, current studies mainly focused on the selection of information channels and its impacts on search space in the moving process [6-9].The most representative one related with change of moving space is the 'Residential mobility: The impacts of Web-based information on the search process and spatial housing choice patterns' published on the journal of 'Urban Geography' by Palm and Danis (2001) [10]. They investigated 1200 randomly households in Wake County of North Carolina, USA and descriptive analyzed that the difference of mean values of moving distance between internet users (users of websites) and nonusers (users of real estate agents, newspapers, personal network, or ads, etc.) is not statistically significance and no tendency can be found. They also confirmed that neither internet users nor non-users show evidence of directional bias with less limitation of workplace because of many urban areas have more than a job center instead of only one single and dominant center in the region. However, it has been supported by some studies in 1960s with the reason that households preferred to rely on more traditional sources and often got final decision around their workplaces. Based on comparison of mean distance, Palm and Danis (2001) tried to consider the relationship between in-

ternet use and moving distance, and also discussed change of limitation of workplace to move. But it did not clearly confirm whether or not information channel promote the change of moving distance or commuting distance as a factor.

Meanwhile, transport mode and socio-economic attributes also can make some impacts on moving space. Wang and Chai (2009) interviewed 736 heads of households who were employed to investigate the interactions between job-housing relationship and commuting time in Beijing, China [11]. They applied a structural equation model to find some results as follows: transport mode shows negative and significant impact that pedestrians and cyclists have shorter commuting time than bus riders or private car drivers; age and income have significant impacts on commuting time that the younger age and the higher income commuters have, the more time they spend on commute; gender, education and occupation are not found to have significant determinants. Antipova (2011) also proved some similar results, but few studies have found clear relationship between these attributes and moving distance, which needs to be tested in-depth [12].

In present study, we take Nanjing city (China) as a case and focus on the impacts of different information channels on moving distance and commuting distance to find exactly spatial changes of residential mobility with some other related factors, when households have finished their move. The next section will discuss the theory of search space and its relation with different information channels based on previous studies to put forward our hypothesis. The third section will introduce data sources and variable design for analysis. The forth section will do some descriptive analysis to explore spatial characteristics of residential mobility for different information channel users. The firth section will take Multinomial logistic model to evaluate the impacts of information channel on moving distance and commuting distance respectively. Finally, we will also make a summary and give some advisements, research shortcomings and future research directions.

2. Search space theories and information channels

Residential mobility is an important field for urban researchers all the time. As to change of search space in moving process, it is often associated with anchor points theory and distance-decay. Huff (1986) investigated 35 households who were searching for new houses in the San Fernando Valley of Los Angeles and constructed a location preference model to reveal that previous house and work place as key anchor points do play more important role in structuring the spatial strategy of the household search than

other points such as school, CBD, bus stops, etc [13]. It means that the longer distance a new house is far away from key anchor, the less opportunities it is to be searched by households because of similar lifestyle with the previous one including neighborhood and working environment, public services, social contacts, and commuting cost, etc [13-16]. These results were also supported by many European studies and they believed that, due to limitation of vacancy information manipulated by households, the probability of visiting a given vacancy declines with increasing distance between the vacancy place and key nodes within the household's contact field [17-20]. In other words, both of reasons for keeping the condition of similar lifestyle and finding vacancies are all related with the manipulation of housing information when households decide to move and also follow the rule of distance-decay. Therefore, information is a key determinant of the geographic nature of intra-urban moves [10].

In the pre-Internet era, according to many studies, households usually obtained housing information from several sources including newspapers, ads and leaflets, personal networks (e.g. introduction of friends or relatives) and real estate agents. Brown and Moore (1970) believed that newspapers, ads and leaflets provide low quality information to a household within a large area, where as personal network provide much more detailed information to a relatively restricted area [6]. Meanwhile, real estate agents had more limited information of second-hand houses around their companies provided by sellers or their owning personal channels and less information within areas far from them [10, 17]. Several studies suggest that there are more narrow choices of offers available on newspapers and ads or leaflets, households prefer to use real estate agents and network of friends or relatives to make decision [8, 10, 21, 22]. However, in the pre-Internet era, every information channel was all influenced by the rule of distance-decay that the probability of information obtained by various channels is to decrease with increasing search distance and households often choose to search shorter distance around the key anchors (previous house or workplace) in general [10].

Since the appearance of ICT, especially the internet, many changes have taken place in the information channels for residential mobility and search space of households. On the one hand, households can obtain much complete housing information on kinds of professional websites from anywhere and at any time, and also with low transaction costs, high interactivity and often instant updates or feedback. On the other hand, real estate agents now also regularly incorporate internet into their daily operations, and provide much more information and creative consulting services (e.g. virtual visit) [5, 23]. Therefore, many scholars believe that the extensive information sources have the potential to influence spatial process in the

housing search by eliminating information barriers, reducing the friction of distance, changing the ranking of motives and preferences, and increasing flexibility of search space [5, 24, 25]. For instance, based on 221 personal interviews in the New York City area, Chen and Lin (2011) confirmed by multinomial logistic model that although internet use for households does not appear to significant increase in search space during the search process, there is a tendency for a big step away from the prior home location and longer search distance. Meanwhile, personal visiting, social network and other information sources display no relation with the search space [9]. These results were also supported by his study in the New York City area with mental map of 82 households [26].

According to the search theories, a weakening of the spatial constraint on housing information by using internet may result in an increase of flexibility for search space and a wider range of housing choices over a larger area far away from the previous house or workplace. Therefore, in order to understand the impact of information channel on spatial change of residential mobility clearly, we put forward to two hypotheses in present study, which are as follows:

- Information channel has a significant impact on moving distance, and internet channel users prefer to take a longer moving distance than traditional channel users;
- Information channel has a significant impact on commuting distance, and internet channel users prefer to take a longer commuting distance than traditional channel users.

3. Research design

Nanjing, located at China's east coast, is one of the core cities in the Yangtze River Delta area and also the provincial capital of Jiangsu. It is a mono centric metropolitan area characterized by a hierarchical center structure with one main centre and three sub-centres. Based on data in the Statistical Yearbook of Nanjing (SYN, 2012) [27] and Statistical Bulletin of Nanjing National Economic and Social Development (2012) [28], Nanjing has a total population of 8.16 million, an area of 4732 km2 and an urbanization rate of 80.23%. The city features a per-capita living area of 33 m2 and a per-capita house occupancy of approximately 1.2. During 2007 to 2012, 1.2 million residents of Nanjing city experienced improved living conditions in the commercial housing market, and 0.4 million residents get their houses from secondary market. Meanwhile, there are 2.7 million households with internet access and 5.1 million mobile users with 3G service. In

general, Nanjing city has a high level of residential mobility and internet use.

We obtained data from the Nanjing Residents Behavior Survey (NRBS) launched on September 2012 for one month, and the samples cover 11 districts (main centre areas: Gulou, Xuanwu, Baixia, Jianye, Qixia, Qinhuai, Xiaguan, Yuhua; suburban: Jiangning, Pukou and Luhe) in the Nanjing city. Among them, business districts, large parks and other public spaces (e.g., Xinjiekou area, Hunan Street, Xuanwuhu Lake Park) in most of districts were selected as granting locations for questionnaire to randomly ask respondents about the selection of information channel for move, moving year, address of different locations (previous house, current house and workplace), frequency of telecommuting, main transport and some other socio-economic information (Fig. 1). The total number of questionnaires was 1038, and 980 responses were returned excluding samples for travelling, visiting and business, who did not live in the Nanjing city. However, many questionnaires were filled without complete address information to reduce the number of valid samples. In general, only 99 samples can be calculated for moving distance, and 275 samples for commuting distance.

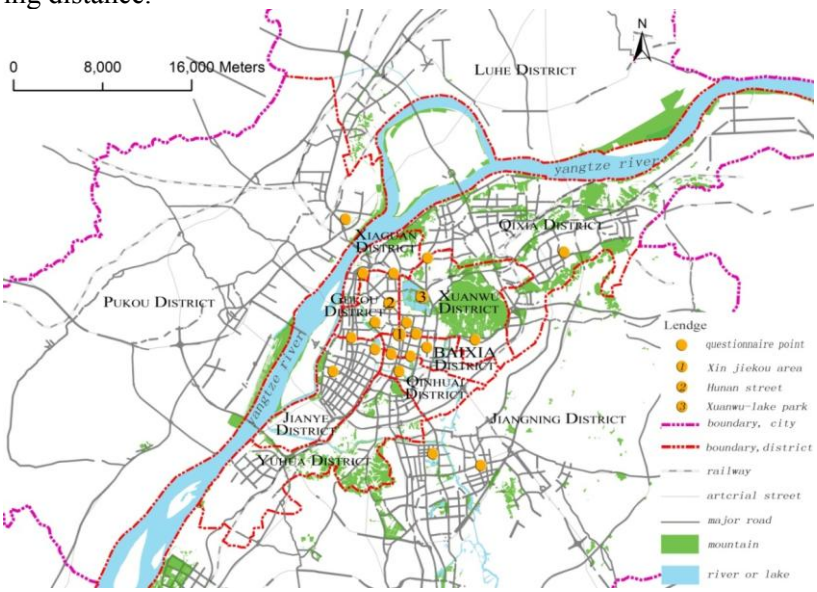

Fig.1. Administrative divisions of Nanjing city (2012) and distribution of questionnaire granting locations

According to previous studies, we take moving distance and commuting distance as the dependent variables respectively, and information

channel, telecommuting, main transport and some socio-economic attributes as the independent variables. On the one hand, we can find the relationships, especially the specific impacts, between information channel and moving distance or commuting distance. On the other hand, it is easy for us to understand what impacts other variables make on the two distance variables, and also the relationships between them and information channel.

Moving distance from previous house to current house is calculated as the shortest distance based on road network instead of liner distance to consider the impact of transportation on search space of residential mobility. At first, we make sure two locations (previous house and current house) based on the address data recorded in questionnaire. And then, due to small sample, Google map is used to measure the shortest distance, which can be selected no matter with the mode of transportation provided by system such as train, bus, car, taxi, bicycle or walk, etc. Meanwhile, we also calculate the commuting distance from workplace to current house in a similar way.

Information channel is divided into three categories including internet channel, traditional channel and mixed channel. Respondents who obtain housing information form professional websites or real estate agents are defined to use internet channel to move. Among them, due to appearance of internet, almost housing information of real estate agents is also obtained from websites instead of neighborhoods around their companies or other social channels in the pre-internet era. Traditional channel mainly includes newspaper, advertisements and leaflets, and introduction from friends or relatives. When respondents use both of internet channel and traditional channel at the same move, we define them as mixed channel users.

Telecommuting is calculated as frequency variable to examine the change of distance with increase of frequency and divided into four categories including <=5 per week, 6 to 10 per week, 11 to 20 per week, and >20 per week. Meanwhile, we also identify four transport modes for commute in Nanjing city: car, bus and taxi, subway, bicycle and walk. In addition, some socio-economic attributes are selected for analysis including gender (male and female), education (high level with junior college and above and low level under high school), age (<=19 year, 20 to 29 year, 30 to 39 year, >=40year), income (>8000RMB, 3000 to 8000RMB, <3000RMB) and house ownership (owner-occupied house and rented house).

4. Descriptive analysis

In order to reveal moving characteristics of different information channel users, we calculate the percentage of samples and mean distance to descriptively analyze the relationship between information channel and moving distance or commuting distance.

As Table1 shows, much more households choose internet channel (55.6% and 53.5%) to get move and also make longer moving distance (mean value=7.19km) and commuting distance (mean value=9.1km) than traditional ones (mean value of moving distance= 5.01km; mean value of commuting distance= 6.33km). This may due to expansion of search space by using internet to obtain housing information based on the theory of search space mentioned in the section 2. However, in the study of Palm and Danis (2001), they concluded by comparing mean distance that no significant longer moving distance for internet users than non-users, and also no distance bias to confirm that either internet users or nonusers search new houses around their workplaces. There may be two reasons, one is that the city size, dynamic mechanism of residential mobility (housing polices, prices, vacancies, demands, etc) and current level of internet use for households or real estate agents in Nanjing are very different from the status of Wake County in 2001 to impact on size of search space, the other may be related with the definition of information channel that the real estate agents was not considered by R Palm as internet channel instead of traditional one.

Table 1. Percentage of different information channel users and mean distance for move

Information channel	Moving distance		Commuting distance	
	Percentage (%)	Mean (km)	Percentage (%)	Mean (km)
Internet channel	55.6	7.19	53.5	9.10
Traditional channel	21.2	5.01	25.8	6.33
Mixed channel	23.2	7.38	20.7	6.50
Total	100	6.77	100	7.85

.Source: own calculation.

Except for the difference of search space for different information channel users, socio-economic attributes of households may also associate with the selection of information channel and distance change. According to table 2, higher educated persons, higher incomers (3000-8000 RMB)

and house owners have larger percentage (50.5%, 36.4%, 29.3%) to choose internet for housing information search and longer moving distance than any other groups. It may be because that they have more opportunities of internet channel use and higher housing demands, and also larger moving flexibility than others to move into suburbs confirmed by many empirical studies [24, 29, 30]. As to the commuting distance, table 3 also shows us that females, higher educated persons and house owners make larger usage of internet channel (28.4%, 37.1%, 32%) to move with longer commuting distance than other groups. Among them, females may prefer to use internet to search housing information because of less social networks or other channels and also smaller affordability for houses near employment centre than males.

Table 2. Information channel use and moving distance for households with different socio-economic attributes

Variables	Internet channel (%)	Traditional channel (%)	Mixed channel (%)	Mean distance (km)
Gender				
Male	33.3	6.1	14.1	6.58
Female	22.2	15.2	9.1	6.98
Age				
<=19 year	2	1	0	2.90
20 to 29 year	47.5	15.2	22.2	6.82
30 to 39 year	6.1	4	1	7.45
>=40 year	0	1	0	6.10
Education				
High level	50.5	18.2	22.2	6.96
Low level	5.1	3	1	4.80
Income				
> 8000 RMB	7.1	1	1	6.89
3000 to 8000 RMB	36.4	13.1	15.2	7.04
<3000 RMB	12.1	7.1	7.1	6.05
House ownership				
Owner-occupied house	29.3	16.2	18.2	7.59
Rented house	26.3	5.1	5.1	5.33

.Source: own calculation.

Table3. Information channel use and commuting distance for households with different socio-economic attributes

Variables	Internet	Traditional	Mixed	Mean dis-

	channel (%)	channel (%)	channel (%)	tance (km)
Gender				
Male	25.1	15.3	8.4	6.72
Female	28.4	10.5	12.4	8.92
Age				
<=19 year	1.1	0.7	0	5.54
20 to 29 year	34.9	15.3	13.8	7.66
30 to 39 year	15.6	8.4	5.1	8.50
>=40 year	1.8	1.5	1.8	7.31
Education				
High level	37.1	12.4	15.3	9.02
Low level	5.5	13.5	5.5	5.70
Income				
> 8000 RMB	5.5	1.8	1.5	12.23
3000 to 8000 RMB	33.1	12	13.1	8.22
<3000 RMB	14.9	12	6.2	6.04
House ownership				
Owner-occupied house	32	18.9	16	8.26
Rented house	21.5	6.9	4.7	7.01

.Source: own calculation.

Meanwhile, in general, either internet channel users or traditional channel users, their commuting distance is longer than moving distance (Table1, Table2 and Table3). As a factor, workplace makes a less limitation than previous house that many households prefer to find the similar neighborhood environment and keep current social network in the process of residential search [9, 14]. Even in the information era, this relationship does not disappear at all, and telecommuting also promotes to move freely and far away from the workplace. In addition, percentage of respondents who choose mixed channel to move is between the one of traditional channel users and the one of internet channel users, and both of moving distance and commuting distance also own this characteristics based on these statistics tables, which indirectly supports that result found above.

5. Multivariate analysis

The descriptive analysis shows us that although we have not received consistent results with study of Palm and Danis (2001), there are more or less change of moving space associated with information channel. However, it is possible that some other potential factors take role in information channel to change moving distance and commuting distance such as gender,

education, income and house ownership, etc. Therefore, no direct evidences say that information channel has significantly influence moving distance and commuting distance followed our hypothesis, especially internet channel use.

In present study, we choose Multinomial logistic model instead of liner analysis (no descriptive analysis shows the linear characteristics between distance and information channel) to find the impacts of information channel further. It was often used to analyze probability and tendency of selection between more than two choices in the study of search space, which can find the distribution of final moving decision in several successive intervals of distance around their previous house and workplace to explain the exactly spatial changes (distance bias). Meanwhile, we also take some related variables as control variables including frequency of telecommuting, main transport and socio-economic attributes of respondents.

5.1 The impact of information channel on moving distance

According to the calculation, we can know that the mean values of moving distance for all kinds of variables are all between 5 and 8 km. In order to reveal the impacts clearly, we divide the moving distance (dependent variable) into three categories that the interval of 0 to 5km, 6 to 10 km, and >10 km, and also take the third one (>10km) as reference category. The results of model show that three variables including information channel, frequency of telecommuting and house ownership significantly influence moving distance, and the information channel gets the highest significance than other two variables based on the Likelihood Ratio Tests (LRT) of model. But the other variables including main transport, gender, age, education and income do not show any significant impact on moving distance, whose significance of Likelihood Ratio Tests are all above 0.1 (Table 4).

Information channel has a strong impact on moving distance with the LRT (sig= 0.007) <0.05. As to the internet channel, relative to the >10km, there is a least probability for households to choose new houses in the interval of 0-5km (coef= -1.198, sig <0.1) far away from previous houses, and no significant tendency in the interval of 6-10km (coef= 0.992, sig >0.1). It means that they prefer to move into farther areas with a highest probability in the interval of >10km. Meanwhile, when households use traditional channel to search housing information, they have a highest probability to choose new houses in the interval of 6-10km (coef=3.407, sig <0.05), but no significant tendency in the interval of 0-5km (coef=1.043, sig >0.1) and also in the interval of >10km. Therefore, internet channel and traditional channel have significant impacts on moving

distance with strong distance bias (the former is >10km, the latter is 6 to 10km). Combined with the descriptive analysis in the section 4, we confirm our first hypothesis that there is significant impact of information channel on moving distance, the internet channel can significantly lead to longer moving distance (mean value= 7.19km) than the traditional channel (mean value= 5.01km), and both of two channel users are all association with strong distance bias.

Although the frequency of telecommuting also has a significant impact on moving distance with the LRT (sig= 0.026) <0.05, it is difficult to find a significant P-value in the every categories of variables that it can't take a role in the moving distance. This may be because of the reasons that there are many respondents working at home with less frequency and telecommuting is also not a main factor compared with other factors (housing price, neighborhood, public service, etc.) when households consider to move.

House ownership also shows a highly significance with the LRT (sig= 0.033) <0.05, and house owners prefer to move with longer distance. According to the coefficient (-1.509) and sig-value (0.025), the same as internet channel, there is a least probability for house owners to move into these areas in the internal of 0-5km around the previous houses, mostly with longer moving distance in the interval of 6-10km or >10km. Therefore, according to the analysis and table 2, we can know that house ownership is also a significant factor to change moving distance and housing owners often make longer moving distance (mean value=7.59km) than renters (mean value=5.33km) to move into areas far away from previous house above 6 km.

However, we do not find significant impacts of other variables on the moving distance. Although car and subway may support households to move into suburbs because of saving the travel time, the variable of main transport shows no impact on the moving distance with the significance of LRT (0.545) at higher than 0.1. Meanwhile, the socio-economic attributes including gender, age, education and income also do not significantly influence moving distance with the significance of LRT (0.658, 0.777, 0.985, 0.527) at higher than o.1. It means that female, young people (30 to 39 year), persons with higher education and income (3000 to 8000 RMB) have no significant tendency to move with longer distance far from their previous houses as factors, although mean values of moving distance for these groups are larger than other ones (Table 2).

Table 4. Multinomial logistic model of moving distance

Variables	Moving distance (0-5 km)			Moving distance (6-10 km)		
	coef	std	sig	coef	std	sig
Information channel (LRT-sig: .007)						
Internet channel	-1.198*	.682	.079	.992	1.250	.427
Traditional channel	1.043	.961	.278	3.407**	1.433	.017
Mixed channel	0[b]	.	.	0[b]	.	.
Frequency of tele-commuting (LRT-sig: .026)						
<=5 per week	1.166	.730	.110	1.024	.897	.254
6 to 10 per week	.466	.886	.599	-20.590	.000	.
11 to 20 per week	-1.006	.907	.267	-.138	1.038	.894
>20 per week	0[b]	.	.	0[b]	.	.
Main transport (LRT-sig: .545)						
car	-1.231	1.028	.231	-1.123	1.350	.406
Bus and taxi	-1.242	1.013	.220	-.341	1.232	.782
Subway	-1.591*	.933	.088	-1.504	1.166	.197
Bicycle and walk	0[b]	.	.	0[b]	.	.
Gender (LRT-sig: .658)						
Male	.519	.569	.362	.359	.739	.627
Female	0[b]	.	.	0[b]	.	.
Age (LRT-sig: .777)	-.011	.060	.853	.029	.065	.655
Education (LRT-sig: .985)						
High level	-.220	1.329	.869	-.226	1.491	.880
Low level	0[b]	.	.	0[b]	.	.
Income (LRT-sig: .527)						
> 8000 RMB	.530	1.190	.656	2.190	1.437	.127
3000 to 8000 RMB	-.213	.704	.762	.700	1.021	.493
<3000 RMB	0[b]	.	.	0[b]	.	.
House ownership (LRT-sig: .033)						
Owner-occupied house	-1.509**	.672	.025	-.222	.869	.799
Rented house	0[b]	.	.	0[b]	.	.
Intercept	3.552	2.316	.125	-2.182	2.874	.448

.Dependent variable is moving distance (categorical variable); a. the reference category is: >10km; b. this parameter is set to zero because it is redundant; *= P<0.1, **= P<0.05; ***= P<0.01; LRT-sig is significance of Likelihood Ratio Tests.

5.2 The impact of information channel on commuting distance

According to the calculation, we can know that the mean values of commuting distance for some variables are at lower than 10km, and some are between 10km and 20km. Therefore, we divide the commuting distance (dependent variable) into three categories that the interval of 0 to 10km, 11 to 20 km, and >20 km, and take the third one (>20km) as reference category. The results of model show that three variables significantly influence commuting distance including information channel, frequency of telecommuting and main transport, and the main transport gets the highest significance than other two variables based on the Likelihood Ratio Tests of model. But all of socio-economic variables including gender, age, education, income and house ownership do not show any significant impact on commuting distance, whose significance of LRT are all above 0.1 (Table5).

Information channel has a significant impact on commuting distance with the LRT <0.05 (sig=0.03) as well as the impacts on moving distance. As to internet channel, households prefer to choose new houses with longer commuting distance and make a largest tendency to move into areas far from workplaces more than 20km at first, then the one between 11km and 20km (coef= -2.557, sig <0.05), and the one between 0km and 10km (coef= -2.731, sig <0.05) in final. Meanwhile, the impact of internet channel on commuting distance is larger than the one on moving distance (coef= -1.198, sig -value<0.1, in the interval of 0 to 5km; coef= 0.992, sig-value >0.1, in the interval of 6 to 10km). However, although traditional channel users also prefer to choose longer commuting distance according to the coefficient of regression (coef= -1.936, in the interval of 0-10km; coef= -1.315, in the interval of 11-20km), both of P-values in the two intervals show no significance. Therefore, combined with the descriptive analysis, we can confirm our second hypothesis that information channel has a significant impact on commuting distance, and internet channel users often make longer commuting distance (mean value= 9.1km) than traditional one (mean value= 6.33km) with a strong distance bias (>20km) and also longer commuting distance (mean value= 9.1km) than moving distance (mean value= 7.19km), but there are no significant impact of traditional channel on commuting distance and also no specific distance bias. Traditional channel users prefer to search new house around their previous

one that it is difficult to find a single distance bias between the three locations including previous house, workplace and new house.

The frequency of telecommuting also strongly influence the commuting distance with LRT (sig=0.013) <0.05. Coefficient is negative value in every interval of frequency and the P-value is almost lower than 0.5. It means that telecommuters prefer to choose new houses with longer commuting distance and make a largest tendency to move into areas far from workplaces more than 20km as well as the internet channel users. In general, the more the frequency increases, the larger significant impact the telecommuting have on commuting distance, which is also supported by many empirical studies. Meanwhile, according to comparing with values of significance, telecommuting also shows a larger impact on commuting distance than information channel, especially frequency interval of 11 to 20 per week makes much larger impact than internet channel. As an important part of ICT, telecommuting directly changes the pattern of work activities to largely reduce the limitation of workplace on residential search, but the internet may only indirectly reduce this limitation by increasing housing information.

Main transport has the largest impact on commuting distance than information channel and frequency of telecommuting with LRT (sig= 0.000) <0.01. Respondents who go to work by car or subway make a higher possibility to get longer commuting distance more than 5 km and there is also a stronger significance for persons by subway (coef= -3.429, sig <0.01) than the ones by car (coef= -2.435, sig <0.05). However, bus, taxi, bicycle, and walk show no significantly impacts on commuting distance. Transportation is still a very important factor for residential mobility, and convenient and faster transport tools extend the search space for households to live in the neighborhoods far away from the workplace.

Although gender, age, income, education and house ownership are related with commuting distance confirmed in our calculation (Table3) that females, young people (30 to 39 year), persons with higher education and income (3000 to 8000 RMB) and house owners make larger mean values of commuting distance than other groups, there are still no significant impacts of these attributes with distance bias because of the significance of their general LRT (0.451, 0.570, 0.111, 0.674, 0.407) are all higher than 0.1 according to our model. These different socio-economic attributes can't lead to move for households with distance bias as factors to take role in information channel to change commuting distance.

Table 5. Multinomial logistic model of commuting distance

Variables	Commuting distance (0-10 km)			Commuting distance (11-20 km)		
	coef	std	sig	coef	std	sig
Information channel (LRT-sig: .065)						
Internet channel	-2.731**	1.178	.020	-2.557**	1.196	.033
Traditional channel	-1.936	1.312	.140	-1.315	1.332	.323
Mixed channel	0b	.	.	0b	.	.
Frequency of telecommuting (LRT-sig: .012)						
<=5 per week	-2.489**	1.114	.025	-2.601**	1.131	.021
6 to 10 per week	-2.572**	1.266	.042	-2.329*	1.294	.072
11 to 20 per week	-3.756***	1.220	.002	-3.349***	1.242	.007
>20 per week	0b	.	.	0b	.	.
Main transport (LRT-sig: .000)						
car	-2.435**	1.159	.036	-.600	1.273	.637
Bus and taxi	-.363	1.265	.774	.271	1.387	.845
Subway	-3.429***	1.136	.003	-1.010	1.239	.415
Bicycle and walk	0b	.	.	0b	.	.
Gender (LRT-sig: .352)						
Male	.758	.614	.217	.711	.647	.271
Female	0b	.	.	0b	.	.
Age (LRT-P: .570)	-.030	.043	.485	-.052	.050	.297
Education (LRT-sig: .170)						
High level	-.665	.657	.311	.188	.730	.797
Low level	0b	.	.	0b	.	.
Income (LRT-sig: .681)						
> 8000 RMB	-.118	.960	.902	.541	1.012	.593
3000 to 8000 RMB	.621	.687	.367	.887	.745	.234
<3000 RMB	0b	.	.	0b	.	.
House ownership (LRT-sig: .368)						
Owner-occupied house	-.580	.638	.363	-.114	.681	.867
Rented house	0b	.	.	0b	.	.

Intercept	9.803***	2.316	.000	6.307***	2.452	.010

.Dependent variable is commuting distance (categorical variable); a. the reference category is: >20km; b. this parameter is set to zero because it is redundant; *= P<0.1, **= P<0.05, ***= P<0.01; LRT-sig is significance of Likelihood Ratio Tests.

6. Conclusion and discussion

According to the theories of search space, internet can largely increase the housing information than traditional channel to reduce limitation of previous house and workplace and expand search space in the process of residential mobility. However, there are less empirical studies have discussed the relationship between information channel and moving distance or commuting distance, which is very important for policy makers and planners to clearly understand moving characteristics in information era. In the present study, we take Nanjing city as a case and descriptively analyze the spatial characteristics for internet channel users and traditional channel users at first, and also use Multinomial logistic model to examine the impacts of information channel on moving distance and commuting distance respectively with taking account of other related variables.

From the analysis, we confirm our hypothesis that information channel has significant impact on both of moving distance and commuting distance in general. As to moving distance, internet channel and traditional channel significantly influence on it, and internet channel users prefer to make longer moving distance than traditional ones with strong distance bias (the former is >10km, the latter is 6 to 10km). As to commuting distance, only internet channel takes significant impact with longer distance than traditional one, and also leads to a distance bias (>20km), even longer commuting distance than moving distance, but no significant impact by traditional channel. Telecommuting, as an important part of ICT, promotes households to move with longer commuting distance and makes much larger impact than internet channel, but no significant impact on moving distance.

Meanwhile, other related variables also show some significant impacts. Main transport also has a significant impact on commuting distance and no impact on moving distance as well as telecommuting, especially the households by car or subway often make longer commuting distance. Besides housing ownership significantly influence moving distance, all of socio-economic attributes show no direct impacts on either moving distance

or commuting distance to confirm that they can't take role in information channel to change distance of residential mobility.

Therefore, planners and policy makers should pay attention to the impacts of internet channel on residential mobility that households lived close to the employment centers (city centers) in main city may prefer to move into suburban areas or take inter-administrative move with longer moving distance (>10km) and commuting distance (>20km). Considering the increase of internet users in the future, they need to provide comprehensive housing information and make sure enough housing supply in these areas. Meanwhile, good internet connection and available types (more space) of houses can be planned or designed to easy to work at home for households, and subway also may be used to connect city center and these neighborhoods.

This paper takes information channel as a new perspective to analyze the impact of ICT on space of residential mobility to enrich current related studies. Although small sample of respondents may reduce the accuracy of our investigation, some main conclusions are also consistent with current studies. Meanwhile, we also find some different results compared with study of Palm and Danis (2001) that moving distance and commuting distance impacted by internet channel are all longer than traditional ones.

Based on results of present study, we may further focus on the directional bias of residential mobility influenced by different information channel to reveal specific moving direction and intensity between different districts in Nanjing city to further guide detailed housing planning and police making in the information era. Meanwhile, we can also compare the spatial characteristics of residential mobility impacted by information channel in China with the ones in western countries because of different levels of internet use and characteristics of urban development may lead to different conclusions.

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