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Spatial-temporal Characteristics and Factors Influencing Commuting Activities of Middle-class Residents in Guangzhou City, China

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Abstract: The middle class in metropolitan Chinese cities has become an important social group. With the rapid development of urbanization and constant advancement of suburbanization, the middle class has increasingly come to influence city traffic. Research into middle-class commuting activities thus has practical significance for improving traffic congestion and reducing the commuting burden in metropolitan cities. Based on a dataset formed by 816 completed surveys, this paper analyzes the commuting mode, time and distance of middle-class residents in Guangzhou City using the descriptive statistical method. The results indicate that private cars are the main commuting mode, followed by public transport. Meanwhile, middle-class residents mainly undertake medium-short time and medium-short distance commuting. The study subsequently uses multilevel logistic regression and multiple linear regression models to analyze the factors that influence commuting mode choice, time and distance. The gender, age, number of family cars, housing source and jobs-housing balance are the most important factors influencing commuting mode choice; housing, population density, jobs-housing balance and commuting mode significantly affect commuting time; and transport accessibility, jobs-housing balance and commuting mode are the notable factors affecting commuting distance. Finally, this paper analyzes what is affecting the commuting activities of middle-class residents and determines the differences in commuting activity characteristics and influence factors between middle-class and ordinary residents. Policy suggestions to improve urban planning and urban management are also proposed.

Keywords: middle-class residents; commuting mode; commuting time; commuting distance; influencing factors; Guangzhou City, China

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1 Introduction

Over the past thirty years, urbanization and suburbanization have entered an advanced stage in China. The ′spatial mismatch′ that occurs between urban housing and employment has become increasingly prominent. Urban traffic congestion problems have been highlighted by the increasing traffic demand, and residents′ daily commuting burdens have become increasingly severe. The numbers of middle-class residents have mushroomed along with the ceaseless differentiation between social classes, and middle-class residents who have higher incomes and abundant material conditions are having a greater influence on the traffic in metropolitan cities. Thus, studying the commuting activities of the middle class can improve traffic congestion and reduce the commuting burden of metropolitan cities while providing a reference for urban planning and urban management.

Research into urban commuting began in the 1950s and originally used various perspectives, ranging from the macroscale and mesoscale to the microscale, based

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on conventional survey data such as resident activity diary surveys, urban transportation surveys and population and economic census data, in addition to big data including cellular signaling and GPS data to discuss the commuting activities of ordinary residents in different cities (Toronto, Atlanta, Chicago, Beijing and Guangzhou, *etc*.) and specific urban areas (gentrified neighborhoods and central districts, *etc*.). The research can be roughly divided into five aspects. First, theoretical models were developed. Based on the balance of commuting and housing costs and the collaborative selection of residential and employment locations and transport modes, scholars put forward the trade-off theory (Muth, 1961) and spatial mismatch theory (Kain, 1968) and established the concentric circle (Alonso, 1964), gravity (Dodd, 1950), pull-push (Guest and Cluett, 1976) and discrete choice (Anas, 1981) models. Second, the factors influencing commuting activity characteristics were described, and the spatial-temporal patterns of commuting activities including commuting mode, time, distance, and efficiency, were summarized (Cropper and Gordon, 1991; Wachs *et al*., 1993; Schwanen *et al.*, 2004; Zhou and Yan, 2005; Niedzielski, 2006; Danyluk and Ley, 2007; Kawabata and Shen, 2007; Zhou *et al*., 2013; Liu and Hou, 2014). Third, the factors influencing commuting activity were analyzed, mainly using statistics, meterage regression and the model simulation method to determine the factors influencing residents′ commuting times, distances and mode choices. To be more specific, this analysis included the effect of urban forms related to land use (Maat *et al.*, 2005), the built environment (Elldér, 2014; Hong *et al*., 2014), city size (Gordon *et al.*, 1989), population density and facility accessibility (Crane, 1999; Horner, 2004), and spatial factors related to the jobs-housing balance (Peng, 1997; Zhao *et al.*, 2011; Zhou *et al.*, 2013), job accessibility (Wang, 2000; Liu and Wang, 2011) and spatial imbalance (Sultana, 2002; Watts, 2009). The analysis also included institutional factors interrelated with land, housing and labor market reformation; *Danwei* (work unit) system transformation; and cross-regional transportation policy that influenced the jobs-housing spatial separation and commuting activities (Blumenberg and Manville, 2004; Chai *et al*., 2011) in addition to the influence of socioeconomic factors such as gender, age, race, income, academic background, occupation and family lifecycle on commuting activities (Abraham and Hunt, 1997; Hanson, 1982; Wang *et al.*, 2009; Meng *et al.*, 2011; Sun, 2015). Fourth, the relationship between urban spatial structure and commuting behavior, including the effect of urban spatial expansion on commuting activities against the background of residential suburbanization, were analyzed along with the balance between residential and employment locations as premises for forming the polycentric city (Giuliano and Small, 1993; Sun and Pan, 2008; Liu *et al.*, 2014). Fifth, the relationship between urban sustainable development and commuting was discussed, including the unsustainable urban development caused by traffic congestion, urban sprawl and petroleum-based emissions from vehicles (Black, 1997).

In addition, some scholars have studied the commuting activities of specific occupational groups such as nurses (Festini *et al.*, 2011), manual laborers (Silva *et al.*, 2012) and white-collar workers (Tarumi, 1992), and special social groups such as the disabled (Fan *et al.*, 2013), commuting couples and families (Hansson *et al.*, 2011), migrant workers and low-income populations (Blumenberg, 2004; Sanchez *et al.*, 2004; Liu and Feng, 2012). Research related to the commuting behavior of white-collar workers has mainly explored the effects of work and commuting times on health.

Overall, the aforementioned research has mainly focused on residents of cities or certain internal areas of cities, specific occupational groups and special social groups while lending less attention to the middle class. Moreover, analysis of the relationship between the commuting mode choices of the middle class living in gentrified neighborhoods and gentrification has also been conducted, although not comprehensively. In recent years, the numbers of middle-class residents have increased rapidly, and these residents are playing a more significant role in urban space. This paper thus studies the commuting activities of middle-class residents in Guangzhou City, China. Using survey data, it analyzes the spatial-temporal characteristics of the commuting modes, times and distances of these residents. It then discusses the factors influencing these commuting mode choices, times and distances to reveal the internal formation mechanism of middle-class commuting activities, determines the differences between the commuting activities of middle-class and other residents, and offers several policy suggestions.

2 Materials and Methods

2.1 Study area

The regions in this study include seven districts in the main urban area of Guangzhou City (Yuexiu, Haizhu, Tianhe, Liwan, Panyu, Baiyun and Huangpu Districts), which have a total area of 2090 km^2. The study area is divided into three circular layers: the old, central and suburban districts (Fig. 1). The old district includes the sub-districts that were present before the founding of the China, the central district includes the sub-districts closely adjacent to the old district and the suburban district consists of the surrounding area adjacent to the central district and mainly includes the towns and sub-districts located there.

2.2 Data

A random survey was conducted in 36 typical middle-class communities from July 2014 to October 2014. The communities were located in the old, central and suburban districts of Guangzhou City and were chosen upon examination of the social areas occupied by the middle class. The ′middle class′ in Guangzhou City refers to groups with annual household incomes in the range of 4×10^5–2×10^6 yuan (RMB) or annual personal incomes in the range of 1.7×10^5–8×10^5 yuan (RMB), calculated according to the middle-class lifestyle cost calculation and social class proportion methods. The survey contents included the socioeconomic attributes of individuals and households such as the genders, ages, occupations, incomes, housing sources and resident and work locations of the middle-class residents, in addition to activity diaries for one working day and one weekend day. Overall, 881 valid questionnaires were completed, of which 816 (92.60%) included complete commuting activity information.

2.3 Socioeconomic attributes of sample

Middle-class respondents with registered households in Guangzhou City account for 93.38% of the observations.

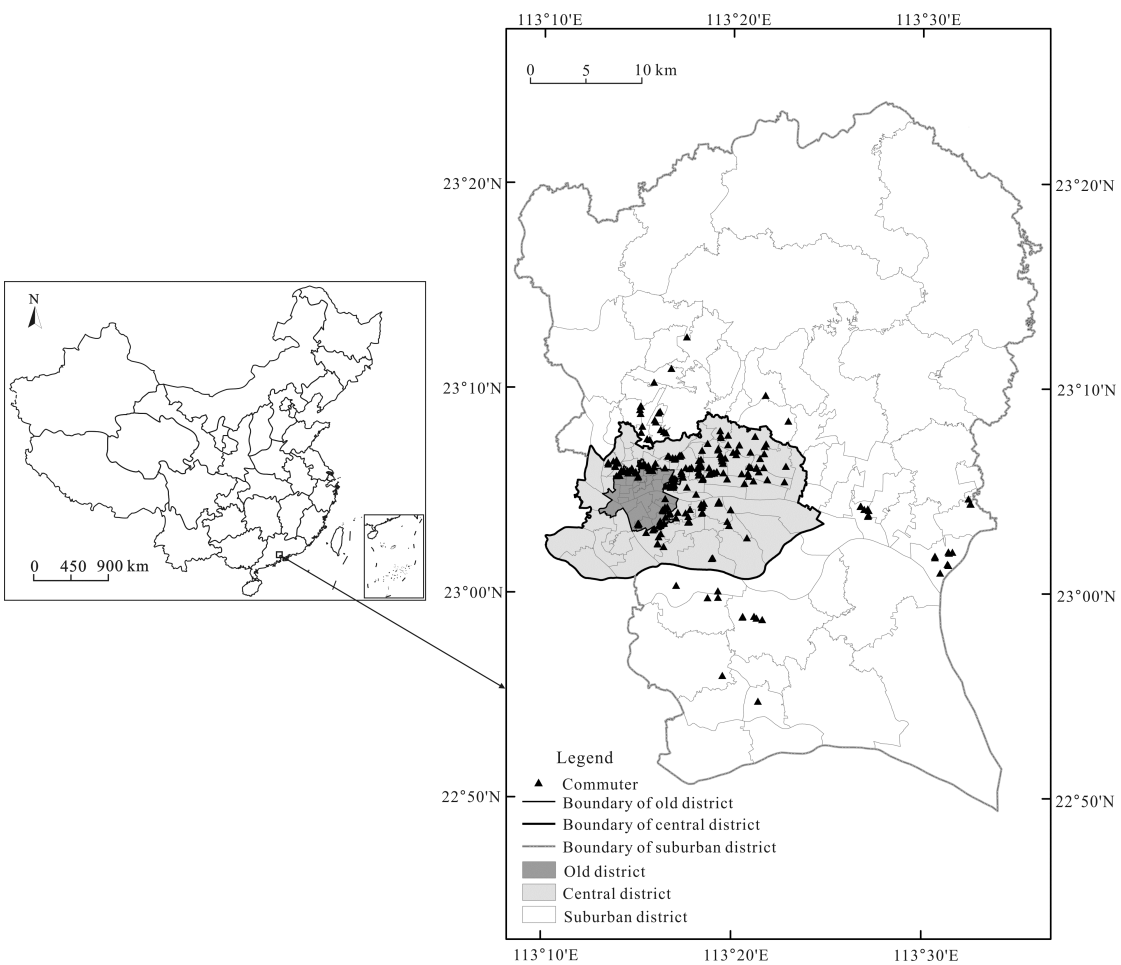

Fig. 1 Location of case commuter

The percentage of females is 58.95%. The residents are mainly in the range of 30–50 years of age, and the more than two thirds have Bachelor′s or higher degrees. Most of the residents are senior management workers at enterprises and public institutions, self-employed laborers, and private entrepreneurs. A majority (52.09%) are engaged in the financial, information, wholesale, retail, and manufacturing sectors. The typical middle-class household consists of three members, and in most cases two members in each family are employed. Overall, 95% of the families own personal vehicles, and 60% own one or more houses (Table 1).

2.4 Variable selection and model

Based on related research and the actual circumstances of the middle-class residents in Guangzhou City, this paper selects fourteen variables to construct a model based on five aspects: socioeconomic attributes of individuals and households, housing, transport accessibility①, population density and jobs-housing balance (Table 2).

A. Socioeconomic attributes of individuals and households: the main object of commuting activities is people, who are affected by household factors. For example, household incomes affect commuting activities by influencing one′s residential location choices or ability to afford commuting costs. A gender difference is apparent in the commuting distance, and married men have a longer commuting distance than married women (Giuliano and Small, 1993; Stead, 2001; Wang, 2001; Vandersmissen *et al*., 2003; Watts, 2009).

Table 1 Socioeconomic attributes of middle-class residents surveyed

Category		Number of respondents	Percentage (%)	Category		Number of respondents	Percentage (%)
Gender	Male	335	41.05	Household structure	1	17	2.08
	Female	481	58.95		2	23	2.82
Annual household income (yuan)	$< 4 \times 10^5$	47	5.80		3	484	59.31
	4×10^5–8×10^5	540	66.20		4	128	15.69
	8×10^5–2×10^6	208	25.50		≥ 5	164	20.10
	$\geq 2 \times 10^6$	21	2.60	Employment	Agriculture, geology, mining or construction	45	5.51
Age	≤ 30	82	10.05		Manufacture	58	7.11
	30–40	347	42.52		Social services	144	17.65
	40–50	332	40.69		Information	74	9.07
	> 50	55	6.74		Transportation, retail, real estate or financial sectors	293	35.91
Academic Background	Junior college or below	137	16.79		Public management, social security and social organization	119	14.58
	Bachelor′s degree	571	69.98		Other sectors	83	10.17
	Master′s degree or above	108	13.24	Occupation	Professional or technical worker	57	6.99
Household registration	Guangzhou City	762	93.38		High- or middle-level management worker	447	54.78
	Not in Guangzhou City	54	6.62		Junior management worker	71	8.70
Number of family houses	0	3	0.37		Self-employed worker or private entrepreneur	176	21.57
	1	299	36.64		Clerk or other	65	7.97
	2	399	48.90	Number of employed people in family	1	35	4.29
	≥ 3	115	14.09		2	618	75.74
Number of family cars	0	39	4.78		3	123	15.07
	1	406	49.75		≥ 4	40	4.90
	2	318	38.97				
	≥ 3	53	6.50				

①Transport accessibility: public transport accessibility refers to the number of public bus stations within a service distance of 500 m and metro stations within a service distance of 1000 m around a middle-class residential community. Auto transport accessibility refers to the number of city expressways, ring roads and city main roads within a service distance of 1000 m around a middle-class residential community

B. Housing: a resident′s housing source has a greater influence on his or her commuting activities, and the commuting time of residents living in housing under the *Danwei* system is shorter than that of those living in other housing. In addition, the housing system reform has broken the jobs-housing balance and increased commuting costs (Zhao *et al*., 2011).

C. Transport accessibility: studies have found that transport accessibility has distinct effects on commuting activities for residents using various commuting modes (Zhao *et al*., 2011).

D. Population density: population density is important for land development and is interpreted as a significant variable influencing commuting activity (Levinson and Kumar, 1997; Gordon *et al*., 1989).

E. Jobs-housing balance: numerous studies have demonstrated that the jobs-housing balance significantly influences commuting times and is an effective way to shorten these times and enhance commuting efficiency (Gordon *et al*., 1989; Peng, 1997).

This paper adopts the multilevel logistic regression method to analyze the factors that influence commuting mode choices based on the aforementioned five aspects. Together with the aforementioned five aspects, commuting mode is used to construct the multiple linear regression model for the factors influencing commuting time and distance. The specific model construction is expressed as follows:

$$\ln\left(\frac{p(m_k=j/x)}{p(m_k=i/x)}\right)=\alpha_j+\sum_{k=i}^{n}\beta_{jk}X_k, \quad (1)$$

$$j\in(1,2,3,...,i-1,i+1,...,n)$$

$$\ln(t_k)=\beta_0+X_k\times\beta+\varepsilon_k \quad (2)$$

$$\ln(d_k)=\beta_0+X_k\times\beta+\varepsilon_k \quad (3)$$

where m_k is the commuting mode of the employed person k; $\ln\left(\frac{p(m_k=j/x)}{p(m_k=i/x)}\right)$ is the commuting mode selected by the employed person j (select group) and the odds of the commuting mode i (reference group); t_k is the commuting time of the employed person k; d_k is the commuting distance of the employed person k; X_k represents the characteristics of the employed person, including the person′s gender, household registration, academic background and age in addition to housing source and period of residence; β, β_{jk} is the regression coefficient vector of each variable; and β_0, α_j is the constant term.

According to the preceding models, the independent variable is subjected to a multicollinearity test. The test results reveal that the regression equation has no serious multicollinearity problems. As such, the regression results are robust and highly credible, and all of the VIF values are less than 10.

3 Spatial-temporal Characteristics of Commuting Activities of Middle-class Residents

3.1 Commuting mode

Private cars comprise the main commuting mode of the middle-class residents (accounting for 71.94%), followed by public transportation (bus and metro, accounting for 16.18%), non-motorized modes (walking and biking, accounting for 6.74%), and other commuting modes (*Danwei* vehicle, taxi, *etc*., accounting for 5.15%). This is different from the ordinary residents, who mostly use traditional commuting modes such as walking, biking and buses (Table 3).

There are some differences in the commuting modes of middle-class residents with different socioeconomic attributes. First, males more often select private cars as their commuting mode, and females more often select public transportation. Second, the proportion of middle-class residents selecting public transportation gradually decreases as their age increase, and the proportion of residents using non-motorized commuting modes gradually increases. Third, the proportion of residents using private cars rises gradually with increasing education level, and the proportion of residents using public transportation constantly decreases. Fourth, the proportion of residents using private cars gradually increases with improving income, while that of using other commuting modes gradually decreases. When the residents′ household annual income reaches a certain value, the proportion using private cars begins to decrease and the proportion of residents using non-motorized modes increases.

In addition, the commuting modes of the middle-class residents in different residential locations also show significant differences. The middle-class residents living in the suburban and central districts have larger proportions of private car use than those living in the old district. The commuting modes of the middle-class residents in different residential locations are basically the

Table 2 Descriptive statistics of commuting activity variable

Variable type	Variable name	Value and description
A. Socioeconomic attributes of individuals and households	A1. Gender	1 = male
	A2. Household registration	1 = Guangzhou City
	A3. Academic background	
	Junior college degree or below	1 = junior college degree or below
	Bachelor's degree	1 = Bachelor's degree
	Master's degree or above	1 = Master's degree or above
	A4. Age	
	≤ 30	1 = less than or equal to 30 years old
	30–40	1 = 30–40 years old
	40–50	1 = 40–50 years old
	> 50	1 = more than 50 years old
	A5. Occupation	
	Professional or technical worker	1 = professional or technical worker
	High- or middle-level management worker	1 = high- or middle-level management worker
	Junior management worker	1 = junior management worker
	Self-employed worker or private entrepreneur	1 = self-employed worker or private entrepreneur
	Clerk or other	1 = clerk or other position
	A6. Annual household income (yuan)	
	$< 4 \times 10^5$	1 = annual household income is less than 4×10^5
	4×10^5–8×10^5	1 = 4×10^5–8×10^5
	8×10^5–2×10^6	1 = 8×10^5–2×10^6
	$\geq 2 \times 10^6$	1 = annual household income is more than 2×10^6
	A7. Household structure	
	1	1 = one family member
	2	1 = two family members
	3	1 = three family members
	4	1 = four family members
	≥ 5	1 = five or more family members
	A8. Number of family cars	
	0	1 = no private car
	1	1 = one private car
	2	1 = two private cars
	≥ 3	1 = three or more private cars
B. Housing	B1. Housing source	
	Newly built commercial housing	1 = newly built commercial housing
	Secondhand housing	1 = secondhand housing
	Original public housing	1 = original public housing
	Other	1 = other type of housing
	B2. Period of residence	
	Short	1 = less than 5 years residence
	Medium	1 = 5–10 years of residence
	Medium-long	1 = 10–15 years of residence
	Long	1 = 15 or more years of residence
C. Transport accessibility	C1. Public transport accessibility	
	Low	1 = less than 5 public transport stations near the community
	Medium	1 = 5–10 public transport stations near the community
	High	1 = 10–15 public transport stations near by the community
	Very high	1 = 15 or more public transport stations near the community
	C2. Auto transport accessibility	
	Low	1 = less than 10 roads near the community
	Medium	1 = 10–30 roads near the community
	High	1 = 30–50 roads near the community
	Very high	1 = 50 or more roads near the community
D. Population density	Low	1 = population density of community less than 100 persons/ha
	Medium	1 = population density of community 100–200 persons/ha
	High	1 = population density of community 200–300 persons/ha
	Very high	1 = population density of community 300 persons/ha or above
E. Jobs-housing balance	Home-based job proximity	1 = residential location and work location in same district
F. Commuting activities	Commuting mode	
	Private car	1 = private car
	Public transport	1 = bus or subway
	Non-motorized transport	1 = walking or biking
	Other	1 = *Danwei* vehicles, taxi, ferry, *etc.*
	Commuting time	logarithm of one-way commuting time
	Commuting distance	logarithm for measuring the commuting distance

Table 3 Commuting mode choices of middle-class residents with different socioeconomic attributes

	Total	Proportion of sample (%)	Private car (%)	Public transport (%)	Non-motorized commuting mode (%)	Other commuting mode (%)
		100.00	71.94	16.18	6.74	5.15
Gender	Male	41.05	86.57	3.58	6.27	3.58
	Female	58.95	61.75	24.95	7.07	6.24
Age	≤ 30	10.05	67.07	26.83	1.22	4.88
	30–40	42.52	74.93	15.85	5.19	4.03
	40–50	40.69	70.48	14.76	8.43	6.33
	> 50	6.74	69.09	10.91	14.55	5.45
Academic background	Junior college or below	16.80	67.20	18.98	11.68	2.19
	Bachelor's degree	70.00	73.00	16.64	5.25	5.08
	Master's degree or above	13.20	72.20	10.19	8.33	9.26
Annual household income (yuan)	$< 4 \times 10^5$	5.76	57.45	14.89	12.77	14.89
	4×10^5–8×10^5	66.18	68.15	19.26	7.41	5.19
	8×10^5–2×10^6	25.49	84.13	9.62	3.37	2.88
	$\geq 2 \times 10^6$	2.57	80.95	4.76	9.52	4.76
Residential location	Old district	8.60	50.00	18.57	17.14	14.29
	Central district	62.00	73.52	18.38	5.14	2.96
	Suburban district	29.41	75.00	10.83	7.08	7.08

same as those of ordinary residents (Table 3).

3.2 Commuting time

From the perspective of 3D visualization space-time paths of daily activities, the commuting activity of the middle-class workers in Guangzhou City presents a clear dual-peak pattern: 90% of the commuting time is within 6:00–10:00 and 14:00–16:00 (Fig. 2).

The average commuting time of the middle-class residents is 24.73 min. The commuting time of 50% of the middle-class workers is within 22 min and that of 75% of the residents is within 30 min. The commuting time is mainly medium-short and shows obvious attenuation rules. The mode of commuting time is 30 min and the standard deviation is 12.18. There are certain differences in the internal commuting time. In 2010, the

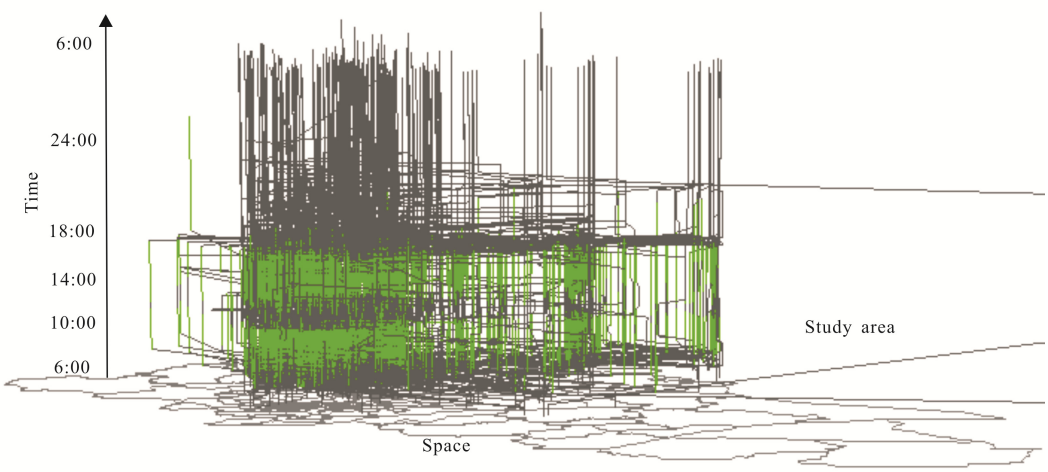

Fig. 2 Space-time paths of daily activities of middle-class residents. Green lines represent commuting activities, grey lines represent other activities such as shopping, leisure and sleep

average commuting time of ordinary residents in Guangzhou City was 17.60 min (Liu and Hou, 2014), and the average commuting time of middle-class residents was longer than that of ordinary residents. The commuting time varies among middle-class residents with different socioeconomic and spatial attributes in several ways. First, the average commuting times of males are slightly higher than those of females. Second, the commuting time of persons under the age of 50 constantly increases with increasing age. Third, persons with Bachelor′s degrees have longer average commuting times. Fourth, persons with lower incomes have longer commuting times, but the standard deviation is large, so there are clear internal differences. Fifth, the mean, median and mode of the commuting times of residents living in the old district are higher than for those living in the central and suburban districts, but the standard deviation is lower than for those in the central and suburban districts. The commuting times of residents living in the suburban district exhibit the highest standard deviation. Therefore, the middle-class residents living in the old district have longer commuting times, and there is a small difference in the commuting times between the groups. The internal commuting times of persons living in the suburban district exhibit the largest variation (Table 4).

3.3 Commuting distance

Residents′ perceptions of commuting distance and the straight distance between residential and employment locations are now used as indicators to measure commuting distance.

According to the survey data, the average commuting distance perceived by the middle-class residents is 10.59 km. Furthermore, 50% of these residents believe that their commuting distance is within 7 km and 75% believe that it is within 13 km. The average commuting distance is 5.26 km. In addition, 50% of the measured commuting distance is within 4.19 km and 75% is within 7.29 km. Hence, there is an obvious distinction between the perceived and measured commuting distances. Indeed, the former is twice that of the latter. In addition, the internal difference (standard deviation 28.74) of the perceived commuting distance is well above the difference (standard deviation 4.62) of the measured commuting distance within the group. Therefore, the middle-class residents with different socioeconomic attributes and residential locations exhibit certain differences in terms of their perceptions of spatial distance. Overall, the commuting distance of the middle-class residents is 5–10 km and is mainly in the middle-short distance range (Table 5, Fig. 2).

Table 4 Characteristics of commuting times among middle-class residents

		Number of respondents	Mean (min)	Median (min)	Mode (min)	Standard deviation	25th percentile (min)	50th percentile (min)	75th percentile (min)
Total number of respondents		816	24.73	22.00	30.00	12.18	15.00	22.00	30.00
Gender	Male	335	25.10	20.00	20.00	13.02	15.00	20.00	30.00
	Female	481	24.47	22.00	30.00	11.56	15.00	22.00	30.00
Age	≤ 30	82	25.43	20.00	20.00	12.49	15.00	20.00	30.00
	30–40	365	25.02	25.00	30.00	11.08	18.50	25.00	30.00
	40–50	386	24.07	20.00	20.00	12.94	15.00	20.00	30.00
	> 50	78	24.96	25.00	30.00	12.50	15.00	25.00	30.00
Academic background	Junior college or below	137	24.29	20.00	30.00	12.31	15.00	20.00	30.00
	Bachelor′s degree	571	24.91	23.00	30.00	12.02	15.00	23.00	30.00
	Master′s degree or above	108	24.42	25.00	20.00	12.79	15.00	25.00	32.75
Annual household income (yuan)	$< 4 \times 10^5$	47	29.45	30.00	30.00	15.04	15.00	30.00	40.00
	4×10^5–8×10^5	540	24.51	22.50	30.00	11.68	15.00	22.50	30.00
	8×10^5–2×10^6	208	24.11	20.00	20.00	12.47	15.00	20.00	30.00
	$\geq 2 \times 10^6$	21	26.57	25.00	10.00	12.58	17.50	25.00	35.00
Residential location	Old district	70	26.19	30.00	30.00	9.55	20.00	30.00	30.00
	Central district	506	24.11	20.00	20.00	11.00	15.00	20.00	30.00
	Suburban district	240	25.61	20.00	20.00	14.88	15.00	20.00	30.00

Table 5 Characteristics of perceived and measured commuting distances of middle-class residents

			Number of respondents	Mean (km)	Median (km)	Mode (km)	Standard deviation (km)	25th percentile (km)	50th percentile (km)	75th percentile (km)
Measured commuting distance		Total respondents	816	10.59	7.00	6.00	28.74	4.00	7.00	13.00
	Gender	Male	335	10.25	8.00	5.00	8.15	4.50	8.00	15.00
		Female	481	10.82	7.00	6.00	36.82	4.00	7.00	12.00
	Age	≤ 30	47	12.17	12.00	20.00	8.77	4.00	12.00	20.00
		30–40	540	9.29	7.00	5.00	7.69	4.00	7.00	12.00
		40–50	208	13.45	7.00	6.00	55.30	5.00	7.00	12.00
		> 50	21	12.40	11.00	5.00	9.44	5.00	11.00	18.00
	Academic background	Junior college or below	137	9.13	6.00	2.00	9.00	3.00	6.00	11.00
		Bachelor's degree	571	11.16	7.00	5.00	33.93	5.00	7.00	13.00
		Master's degree or above	108	9.44	7.00	4.00	6.87	4.00	7.00	13.75
	Annual household income (yuan)	$< 4 \times 10^5$	82	10.10	7.00	6.00	9.09	5.00	7.00	13.50
		4×10^5–8×10^5	347	10.29	8.00	6.00	7.54	5.00	8.00	15.00
		8×10^5–2×10^6	332	11.29	6.00	5.00	44.10	4.00	6.00	12.00
		$\geq 2 \times 10^6$	55	9.01	7.00	10.00	6.83	4.00	7.00	12.00
	Residential location	Old district	70	9.71	8.00	5.00	6.30	5.00	8.00	15.00
		Central district	506	9.33	7.00	6.00	7.53	4.50	7.00	12.00
		Suburban district	240	13.49	8.00	20.00	51.70	4.00	8.00	15.00
Perceived commuting distance		Total respondents	816	5.26	4.19	0.00	4.62	2.15	4.19	7.29
	Gender	Male	335	5.74	4.54	1.34	5.32	2.21	4.54	8.09
		Female	481	4.93	3.96	0.00	4.03	2.08	3.96	6.73
	Age	≤ 30	47	6.81	5.58	5.58	5.22	1.88	5.58	12.39
		30–40	540	4.91	3.97	0.40	4.06	2.14	3.97	6.81
		40–50	208	8.51	4.65	1.34	34.72	2.38	4.65	8.78
		> 50	21	4.98	3.96	0.16	4.08	1.65	3.96	8.61
	Academic background	Junior college or below	137	5.13	3.25	0.22	5.87	1.50	3.25	7.68
		Bachelor's degree	571	6.24	4.39	2.85	21.17	2.29	4.39	7.38
		Master's degree or above	108	5.41	4.59	2.17	4.13	2.24	4.59	7.53
	Annual household income (yuan)	$< 4 \times 10^5$	82	6.06	5.28	4.73	4.94	2.63	5.28	8.22
		4×10^5–8×10^5	347	5.63	4.70	0.40	4.26	2.48	4.70	7.79
		8×10^5–2×10^6	332	6.40	3.71	2.94	27.60	1.75	3.71	6.68
		$\geq 2 \times 10^6$	55	4.94	3.60	0.50	5.38	1.47	3.60	7.27
	Residential location	Old district	70	4.96	4.10	0.00	4.35	1.41	4.10	6.81
		Central district	506	4.96	4.20	2.85	3.76	2.48	4.20	6.70
		Suburban district	240	5.99	4.01	0.00	6.05	1.43	4.01	9.72

For both the perceived and measured commuting distances, there are significant differences among middle-class residents with different socioeconomic attributes and residential locations. First, in terms of the perceived commuting distance, 90% of the residents have commuting distances in the range of 15–20 km. The average commuting distance of females is 10.82 km, which is slightly farther than that of males (10.25 km). The standard deviation for females is much larger than that for males, and females have a larger internal difference. Second, in terms of the measured commuting distance, the average commuting distance of males is 5.74 km and that of females is 4.93 km. Furthermore, 50% of the males are within 4.54 km and 50% of the females are within 3.96 km of their workplaces. The internal difference of the males is larger than that of the females. Of the residents living in the old and central districts, 90% have commuting distances within 5–10 km. Meanwhile, 90% of the residents living in the suburban district have commuting distances within 10–15 km (Table 5).

4 Factors Influencing Commuting Activities of Middle-class Residents

4.1 Factors influencing commuting mode choice

Middle-class residents′ commuting mode choice is significantly influenced by the socioeconomic attributes of the individuals and households, housing, jobs-housing balance and population density. Transport accessibility has a minor influence on commuting mode choice (Table 6). The private car transport mode is used as the reference group for specific analysis.

First, the socioeconomic attributes of the individuals and households have an overall significant influence on the residents′ commuting mode choice. Gender, age, occupation and number of family cars have a major influence and household registration, academic background and household structure have a minor influence; and annual household income has basically no influence. Second, housing source has a major influence commuting mode choice. Residents living in original public housing are significantly more likely to select non-motorized commuting modes or other modes than those living in newly built commercial housing. The period of residence has a minor influence. Third, the jobs-housing balance significantly influences commuting mode choice. Compared to the jobs-housing imbalance, the probability of selecting non-motorized commuting modes and other commuting modes under the jobs-housing balance is considerably higher because residential and work locations are adjacent. Fourth, transport accessibility and population density have a minor influence on commuting mode choice.

4.2 Factors influencing commuting time

According to Table 7, the main factors significantly influencing the commuting time of middle-class residents are housing, population density, jobs-housing balance and commuting mode. Transport accessibility and socioeconomic attributes of individuals and households have only a minor influence on the commuting time of middle-class residents.

First, the housing source and period of residence have a remarkable influence on commuting time. The commuting time for those residing in secondhand housing and original public housing is shorter than those residing in newly built commercial housing, and the commuting time of residents with medium-long and long residence periods is less than that of residents with short residence periods. Second, population density is closely associated with commuting time. Given the constant increase in population density, the coefficients of population density and commuting time become smaller and the commuting time is constantly prolonged. Third, the jobs-housing balance is an important influential factor. The commuting time under the jobs-housing balance is shorter than that under the jobs-housing imbalance. Fourth, commuting mode is closely related to commuting time. The commuting time of residents who commute via public transport and other modes is longer than that of residents who commute via private cars, and the commuting time of non-motorized modes is shorter than that of residents who commute via private cars. Fifth, transport accessibility has a minor influence on commuting time. The commuting time under high public transport accessibility and high car accessibility is shorter than that under low public transport accessibility and low auto transport accessibility. Sixth, the socioeconomic attributes of individuals and households have a slight and unstable correlation with commuting time. When variables such as housing and transport accessibility are added separately, the influence of the socioeconomic attributes of individuals and households on

Table 6 Results of regression analysis for middle-class commuting mode choice

	Public transport mode	Non-motorized commuting mode	Other commuting mode
A1. Gender	−3.034***(0.398)	−1.426***(0.436)	−1.767***(0.483)
A4. Age (reference group: ≤ 30)			
30–40	−0.289(0.398)	1.818(1.144)	0.384(0.733)
40–50	−0.099(0.408)	2.202*(1.151)	1.086(0.747)
> 50	1.323*(0.69)	2.986**(1.288)	1.865*(1.044)
A5. Occupation (reference group: clerk or other)			
Professional or technical worker	−0.977(0.606)	0.346(0.863)	1.092(1.078)
High- or middle-level management worker	−0.914**(0.404)	−0.577(0.684)	0.473(0.918)
Junior management worker	0.318(0.517)	0.178(0.84)	1.664*(0.991)
Self-employed worker or private entrepreneur	−1.123**(0.459)	−0.502(0.711)	−1.217(1.21)
A8. Number of family cars (reference group: 1)			
0	4.533***(1.169)	5.27***(1.205)	4.431***(1.201)
2	−2.199***(0.317)	−0.747*(0.424)	−1.905***(0.546)
≥ 3	−1.54**(0.662)	−2.165**(1.041)	−2.528*(1.494)
B1. Housing source (reference group: newly built commercial housing)			
Secondhand housing	−0.586(0.449)	0.755(0.603)	0.233(0.665)
Original public housing	−0.414(0.493)	1.735***(0.59)	1.808***(0.607)
Other	0.909(0.972)	1.879(1.213)	1.148(1.22)
...			
C2. Auto transport accessibility (reference group: high)			
Low	−1.007(0.866)	−1.511(1.631)	−0.719(1.325)
Medium	−0.283(0.735)	−0.42(1.446)	−2.302*(1.209)
High	−0.086(0.717)	0.541(1.411)	−1.779(1.153)
D. Population density (reference group: high)			
Low	1.05**(0.463)	−0.804(0.697)	−1.248(0.798)
Medium	0.227(0.411)	−0.007(0.651)	−0.831(0.798)
High	0.198(0.417)	−0.428(0.58)	−0.073(0.623)
E. Home-based job proximity	−0.754(0.508)	3.208***(0.459)	1.072*(0.566)
Constant term	0.305(1.514)	−3.753(2.491)	0.424(2.235)
LR inspection	520.25***		
Pseudo R^2	0.3681		

Notes: as the reference variable is private car, $n = 816$. The values in parentheses are the coefficient standard errors (S.E). *** indicates significance at $P < 0.01$; ** indicates significance at $P < 0.05$ and * indicates significance at $P < 0.1$. As the regression results are too lengthy, we omit A2, A3, A6, A7, B2, and C1 from the results presented

commuting time is mainly reflected in the residents′ occupations, annual household incomes and household structures. When the housing, transport accessibility and other variables are added to the equation simultaneously to realize the regression, the socioeconomic attributes of individuals and households have a small relevance to commuting time, and the other aspects almost have no influence on commuting time, with the exception of household structure, which has some influence. Therefore, the influence of socioeconomic attributes of individuals and households on commuting time is slight compared with variables such as housing, population density and commuting mode.

4.3 Factors influencing commuting distance

Table 8 shows that the main factors influencing the commuting distance of the middle-class residents include the jobs-housing balance, commuting mode and transport accessibility. The secondary factors include housing and population density. The socioeconomic

Table 7 Results of regression analysis of middle-class residents′ commuting time

	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
A5. Occupation (reference group: clerk or other)						
Professional or technical worker	–0.102(0.095)	–0.123(0.097)	–0.100(0.096)	–0.076(0.088)	–0.054(0.092)	–0.058(0.084)
High- or middle-level management worker	–0.048(0.07)	–0.059(0.071)	–0.064(0.071)	–0.080(0.065)	–0.046(0.068)	–0.061(0.063)
Junior management worker	–0.043(0.091)	–0.059(0.091)	–0.072(0.092)	–0.093(0.084)	–0.091(0.088)	–0.064(0.08)
Self-employed worker or private entrepreneur	–0.202***(0.076)	–0.204***(0.078)	–0.218***(0.078)	–0.144**(0.071)	–0.176**(0.074)	–0.111(0.068)
A6. Annual household income (reference group(yuan): $< 4 \times 10^5$)						
4×10^5–8×10^5	–0.156*(0.085)	–0.052(0.089)	–0.180**(0.087)	–0.154**(0.079)	–0.161**(0.082)	–0.086(0.078)
8×10^5–2×10^6	–0.199**(0.093)	–0.033(0.097)	–0.168*(0.094)	–0.155*(0.085)	–0.164*(0.089)	–0.112(0.085)
$\geq 2 \times 10^6$	–0.119(0.145)	0.099(0.148)	–0.070(0.147)	–0.070(0.133)	–0.009(0.139)	–0.042(0.13)
A7. Household Structure (reference group: 2)						
1	–0.131(0.166)	–0.156(0.168)	–0.153(0.169)	–0.181(0.155)	–0.179(0.161)	–0.058(0.147)
3	–0.192*(0.114)	–0.208*(0.115)	–0.249**(0.115)	–0.253**(0.106)	–0.260**(0.11)	–0.177*(0.101)
4	–0.112(0.121)	–0.139(0.122)	–0.198(0.122)	–0.224**(0.112)	–0.202*(0.117)	–0.105(0.107)
≥ 5	–0.051(0.12)	–0.081(0.121)	–0.129(0.121)	–0.150(0.11)	–0.109(0.115)	–0.05(0.106)
B1. Housing source (reference group: newly built commercial housing)						
Secondhand housing	–0.275***(0.063)					–0.233***(0.056)
Original public housing	–0.184***(0.068)					–0.107*(0.063)
Other	–0.169(0.152)					–0.247*(0.134)
B2. Period of residence (reference group: short)						
Medium	–0.065(0.05)					–0.028(0.045)
Medium-long	–0.180***(0.061)					–0.132**(0.055)
Long	–0.163**(0.068)					–0.095(0.062)
……						
C2. Auto transport accessibility (reference group: very high)						
Low		0.112(0.119)				0.366***(0.112)
Medium		–0.010(0.107)				0.138(0.098)
High		–0.093(0.109)				0.040(0.096)
D. Population density (reference group: very high)						
Low			–0.144**(0.058)			–0.235***(0.06)
Medium			–0.028(0.054)			–0.129**(0.054)
High			–0.121**(0.053)			–0.094*(0.052)
E. Home-based job proximity				–0.653***(0.052)		–0.578***(0.053)
F. Commuting mode (reference group: private car)						
Public transport					0.213***(0.056)	0.210***(0.051)
Non-motorized transport					–0.564***(0.075)	–0.255***(0.073)
Other					0.079(0.086)	0.139*(0.079)
Constant	3.564***(0.166)	3.301***(0.216)	3.573***(0.176)	3.627***(0.155)	3.399***(0.163)	3.381***(0.194)
F	2.830***	2.050***	1.850***	9.020***	5.300***	8.950***
R^2	0.0885	0.0658	0.053	0.2002	0.1385	0.3159

Notes: values in parentheses are the coefficient standard errors (S.E). *** indicates significance at $P < 0.01$; ** indicates significance at $P < 0.05$; and * indicates significance at $P < 0.1$. Equations (1), (2), (3), (4), and (5) indicate the addition of housing, transportation accessibility, population density, jobs-housing balance and commuting mode as control variables to the regression equation, respectively. Equation (6) indicates the simultaneous addition of all of the control variables to the regression equation. The table omits A1, A2, A3, A4, A8, and C1 from the regression results

attributes of individuals and households have a small influence.

First, the jobs-housing balance is the most important factor influencing commuting distance. As the residential location is close to the work location under the jobs-housing balance, the commuting distance is shorter than it is under the jobs-housing imbalance. Second, commuting mode has an obvious influence on commuting distance. Compared to residents who commute via private cars, the commuting distance of residents who commute via non-motorized modes is shorter and that of residents who commute via other commuting modes is longer. Third, transport accessibility is closely related to commuting distance. The commuting distances of residents with high public transport accessibility and high auto transport accessibility are shorter than those of residents with low public transport accessibility and low auto transport accessibility. Fourth, housing and population density have a small and unstable influence on commuting distance. When controlling for the socioeconomic attributes of individuals and households, housing source and period of residence have a large influence on commuting distance. When population density, transport accessibility, commuting mode and other control variables are added, the influence of housing on commuting distance becomes small and insignificant. When only the socioeconomic attributes of individuals and households are controlled for or variables such as population density, jobs-housing balance and commuting mode are simultaneously controlled for, population density has a slight influence on commuting distance. Fifth, the socioeconomic attributes of individuals and households are not significantly related to commuting distance.

5 Reasons for Commuting Activities of Middle-class Residents

5.1 Differences in commuting activities of middle-class and ordinary residents

In terms of differences in the space-time characteristics of commuting activities, the primary commuting mode of middle-class residents is the private car, followed by the public transport and non-motorized modes. In order of preference, ordinary residents walk, take the bus, drive cars and bike (Zhou *et al.*, 2013; Liu and Hou, 2014). Middle-class residents′ commuting times and distances are longer and their commuting modes are more variable than those of ordinary residents (Fig. 3).

In terms of differences in the factors influencing commuting activities, the jobs-housing balance, commuting mode and population density have the same influence on middle-class and ordinary residents (Cervero, 1989; Levinson and Kumar, 1997; Zhao *et al.*, 2011). The jobs-housing balance is helpful for shortening commuting time and distance, and the commuting time and distance of residents who commute via cars and public transport are longer than those of residents who commute via walking or biking and other non-motorized commuting modes. In addition, a high population density increases commuting time and distance. However, transport accessibility and socioeconomic attributes of individuals and households have different influences on the commuting activities of middle-class and ordinary residents. The commuting activity of middle-class residents is more influenced by transport accessibility and especially auto transport accessibility. In contrast, ordinary residents are usually more influenced by public transport accessibility. The socioeconomic attributes of individuals and households have less of an influence on the commuting activities of middle-class residents than they do on the commuting activities of ordinary residents. For example, although income has a larger influence on the commuting activities of ordinary residents, its influence on the commuting activities of middle-class residents is smaller (Fig. 4).

5.2 Analyzing reasons for commuting activities of middle-class residents

Commuting mode, time and distance are closely related. In general, a long commuting time represents a long commuting distance, and the commuting time and distance of middle-class residents who choose different

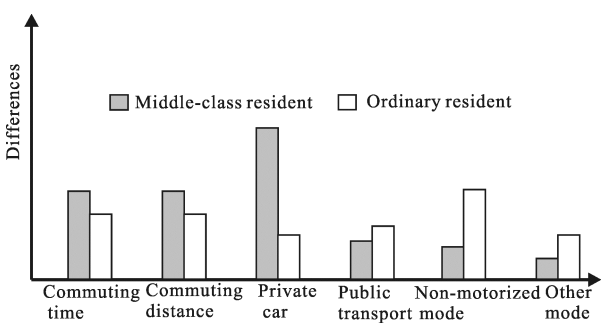

Fig. 3 Schematic diagram of differences in commuting activity characteristics between middle-class and ordinary residents

Table 8 Results of regression analysis for commuting distance of middle-class residents

	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
A2. Household register	0.18(0.146)	0.238*(0.143)	0.264**(0.147)	–0.085(0.122)	0.115(0.13)	0.042(0.112)
A4. Age (reference group: ≤ 30 years)						
30–40	–0.093(0.124)	–0.029(0.123)	–0.03(0.123)	–0.027(0.104)	0.033(0.111)	0.019(0.094)
40–50	–0.26**(0.128)	–0.222*(0.127)	–0.212*(0.128)	–0.123(0.108)	–0.116(0.116)	–0.05(0.098)
> 50	–0.342*(0.183)	–0.312*(0.182)	–0.36**(0.182)	–0.331**(0.153)	–0.144(0.166)	–0.089(0.139)
A6. Annual household income (reference group: $< 4 \times 10^5$ yuan)						
4×10^5–8×10^5	–0.266*(0.162)	–0.042(0.166)	–0.239(0.162)	–0.279**(0.135)	–0.266*(0.145)	–0.073(0.127)
8×10^5–2×10^6	–0.135(0.177)	0.172(0.18)	–0.046(0.175)	–0.098(0.147)	–0.104(0.157)	0.04(0.139)
$\geq 2 \times 10^6$	–0.398(0.275)	–0.029(0.275)	–0.282(0.274)	–0.431*(0.229)	–0.255(0.245)	–0.18(0.211)
A8. Number of family cars (reference group: 1)						
0	–0.262(0.174)	–0.193(0.174)	–0.275(0.173)	–0.347**(0.145)	0.091(0.163)	0.097(0.138)
2	0.111(0.078)	0.093(0.077)	0.101(0.078)	0.104(0.066)	0.076(0.073)	0.106*(0.061)
≥ 3	–0.204(0.15)	–0.249*(0.149)	–0.209(0.151)	–0.005(0.127)	–0.301**(0.137)	–0.082(0.115)
B1. Housing source (reference group: newly built commercial housing)						
Secondhand housing	–0.275**(0.12)					–0.158*(0.091)
Original public housing	–0.348***(0.13)					–0.119(0.102)
Other	–0.069(0.289)					–0.132(0.218)
…						
C1. Public transport accessibility (reference group: very high)						
Low		0.1(0.168)				0.348***(0.131)
Medium		0.1(0.163)				0.165(0.125)
High		–0.316*(0.166)				–0.056(0.129)
C2. Auto transport accessibility (reference group: very high)						
Low		0.151(0.222)				0.444**(0.182)
Medium		–0.165(0.199)				0.085(0.159)
High		–0.279(0.203)				0.029(0.157)
D. Population density (reference group: very high)						
Low			0.072(0.109)			0.077(0.097)
Medium			0.052(0.101)			–0.008(0.088)
High			–0.314***(0.098)			–0.173**(0.085)
E. Home-based job proximity				–1.655***(0.089)		–1.5***(0.086)
F. Commuting mode (reference group: private car)						
Public transport					–0.089(0.099)	–0.109(0.082)
Non-motorized transport					–1.811***(0.133)	–1.125***(0.118)
Other					0.198(0.151)	0.351***(0.129)
Constant	1.596***(0.316)	1.244***(0.402)	1.411***(0.328)	1.883***(0.265)	1.509***(0.288)	1.291***(0.314)
F	2.58***	3.29***	2.94***	18.74***	10.89***	19.12***
R^2	0.0813	0.1014	0.082	0.342	0.2483	0.4966

Notes: values in parentheses are the coefficient standard errors (S.E). *** indicates significance at $P < 0.01$; ** indicates significance at $P < 0.05$; and * indicates significance at $P < 0.1$. Equations (1), (2), (3), (4), and (5) indicate the addition of housing, transport accessibility, population density, jobs-housing balance and commuting mode as control variables to the regression equation, respectively. Equation (6) indicates the simultaneous addition of all of the independent variables. The table omits A1, A3, A5, A7, and B2 from the results

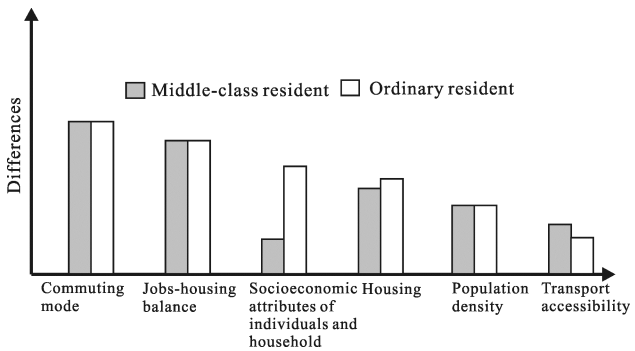

Fig. 4 Schematic diagram for differences in factors influencing commuting activity of middle-class and ordinary residents

commuting modes are discrepant and inseparable. Therefore, the reasons for the influence of commuting mode, time and distance must be analyzed. Middle-class residents have high social statuses and incomes that separate them from ordinary residents in terms of commuting activities. The reasons for this are analyzed at the individual, institutional and environmental levels.

At the individual level, the first reason comprises the individual′s age, gender, occupation, wealth and social status (Fig. 5). Male middle-class residents generally have higher social statuses and more wealth than female residents due to a distinct division in family responsibility, which provides males with more flexibility when selecting commuting modes and a greater ability to endure long commuting distances and times. This division is the same for ordinary residents. Meanwhile, the older the middle-class resident, the richer their professional experience is and the higher their job position is, the greater their wealth accumulation is. In addition, those residents in occupations that grant them the power of independent choice and high wealth and incomes, such as self-employed workers and private entrepreneurs, have shorter commuting times than clerks or others. The second reason comprises the influence of the family lifecycle and various household structures. Those who are single are more concerned about freedom, and their commuting modes are highly affected by employment and residence preferences. Families who have to pick up children often pay more attention to the spatial distance between their residential and work locations and choose locations that are closer. This is different from ordinary residents, who need to consider both their children and their household incomes. The third reason is academic background. Middle-class residents with high levels of education have more opportunities to engage in various occupations, have a greater development space and attain more wealth and income. As such, they are more flexible and high initiated when selecting residential and work locations, and their average commuting time is relatively short. The fourth reason is a family′s number of cars. The more cars a family has, the more likely a middle-class resident is to choose commuting via a private car.

At the institutional level, the first reason is housing system reform, which has led to urban housing marketization, socialization and commercialization. The jobs-housing spatial separation was limited before the housing reform, and the original public and secondhand housing located in the old and central districts with more employment opportunities were mainly built during this period. As the residential and work locations were close, middle-class residents were likely to select non-motorized and other commuting modes and their commuting time and distance were relatively short. Since the housing reform, the newly built commercial housing has been located in the urban periphery districts. However, these districts lack sufficient job opportunities, and work locations remain mainly concentrated in the old and central districts. Thus, the commuting time and distance for the middle-class residents residing in the newly built commercial housing are relatively long, and these residents are more likely to commute via private cars and public transport modes. The second reason is system reform. The land rent differential is caused by the land paid use system, which widens the regional disparity of housing prices and makes the housing prices in the old and central districts higher than they are in the suburban districts. This further aggravates the trend of jobs-housing spatial separation and increases the cost of commuting between residential and work locations. The third reason is household registration system reform. With the continuous reform of the housing registration system, the difference in social resources between residents with and without registered permanent residences in Guangzhou City has decreased. Hence, the influence of household registration on the commuting activities is gradually weakening.

At the environmental level, the first reason is population density. The higher the population density, the greater the traffic demand and the more vehicles accumulate, which causes traffic congestion and leads to long commuting time. The second reason is jobs- hous-

ing balance. As the residential and work locations are close, the commuting time and distance are relatively short and residents are more likely to select the non-motorized commuting mode. The reason for the influence of jobs-housing balance on commuting activities is similar for both middle-class and ordinary residents. The third reason is transport accessibility. Given their abundant wealth and incomes, middle-class residents have a broad range of commuting modes to choose from, regardless of whether public or auto transport accessibility is low or high. Therefore, transport accessibility has a relatively weak influence on the commuting activities of middle-class residents.

The major distinction in the individual-level reasons for the commuting activities of middle-class and ordinary residents is that middle-class residents have relatively high social statuses, incomes and education degrees, possess more abundant material lifestyles, and have more flexibility when choosing residential and work locations. The institutional reasons for the commuting activities of middle-class and ordinary residents exhibit no evident difference. All residents are affected by the housing, land and household registration systems. The environmental reasons, including population density and jobs-housing balance, influence the commuting activities of both middle-class and ordinary residents. However, transport accessibility affects those residents differently. Ordinary residents are restricted by their occupations, social statuses and incomes and have few commuting modes to choose from. Both public and auto transport accessibility significantly influence the commuting activities of ordinary residents. However, these factors have little influence on middle-class residents.

6 Conclusions

The commuting time of middle-class residents in Guangzhou City is within the medium-short time range and that of 75% of residents is within 30 min. The commuting time shows a dual-peak pattern in the morning and evening in addition to an obvious attenuation rule. The commuting distance is mainly within the medium-short distance range at approximately 5–10 km. Middle-class residents with different socioeconomic attributes and spatial attributes have different commuting times and distances. The main commuting mode is the private car, followed by public transport and non-motorized modes. The socioeconomic attributes of individuals and households, housing, transport accessibility, population density, jobs-housing balance and commuting mode are the main factors influencing the commuting activity of middle-class residents. Of these factors, jobs-housing balance, housing source, gender, age and number of family cars are the main factors significantly influencing commuting mode choice. Population density, jobs-housing balance, commuting mode and housing greatly influence commuting time. Transport accessibility, jobs-housing balance and commuting mode are closely correlated with commuting distance (Fig. 6). Overall, the commuting activities of middle-class residents are mainly affected by individual-, institution- and environment-level factors.

There is currently no uniform definition of the middle class, and its proportion among all social classes differs from place to place. Some scholars believe that the middle class in China occupies approximately 23% of the total population but that the middle class in Beijing, Shanghai and Guangzhou City accounts for approximately 40% of the population. The proportion of the middle class is gradually increasing, and the class is becoming the main force promoting the socioeconomic development of cities in China. Hence, the growth of the middle class must be considered in the planning and management of Chinese cities. To ensure the healthy and orderly development of cities, it is important to draw up urban plans scientifically and formulate urban traffic management policy reasonably. Therefore, we make the following suggestions. First, attention should be paid to the jobs-housing balance concept in urban planning and implementation, and reasonable urban planning can be used to remit the jobs-housing spatial separation and decrease commuting costs. Second, the construction of non-motorized commuting facilities should be promoted and incorporated into the traffic construction and management system to encourage the use of walking or biking and other non-motorized commuting modes. Third, public transport accessibility should be improved to decrease the commuting rate of private cars and strengthen the traffic guidance and control of cities. Finally, the spatial distribution of urban population densities and housing structures should be optimized, and urban traffic congestion and environmental pollution relieved.

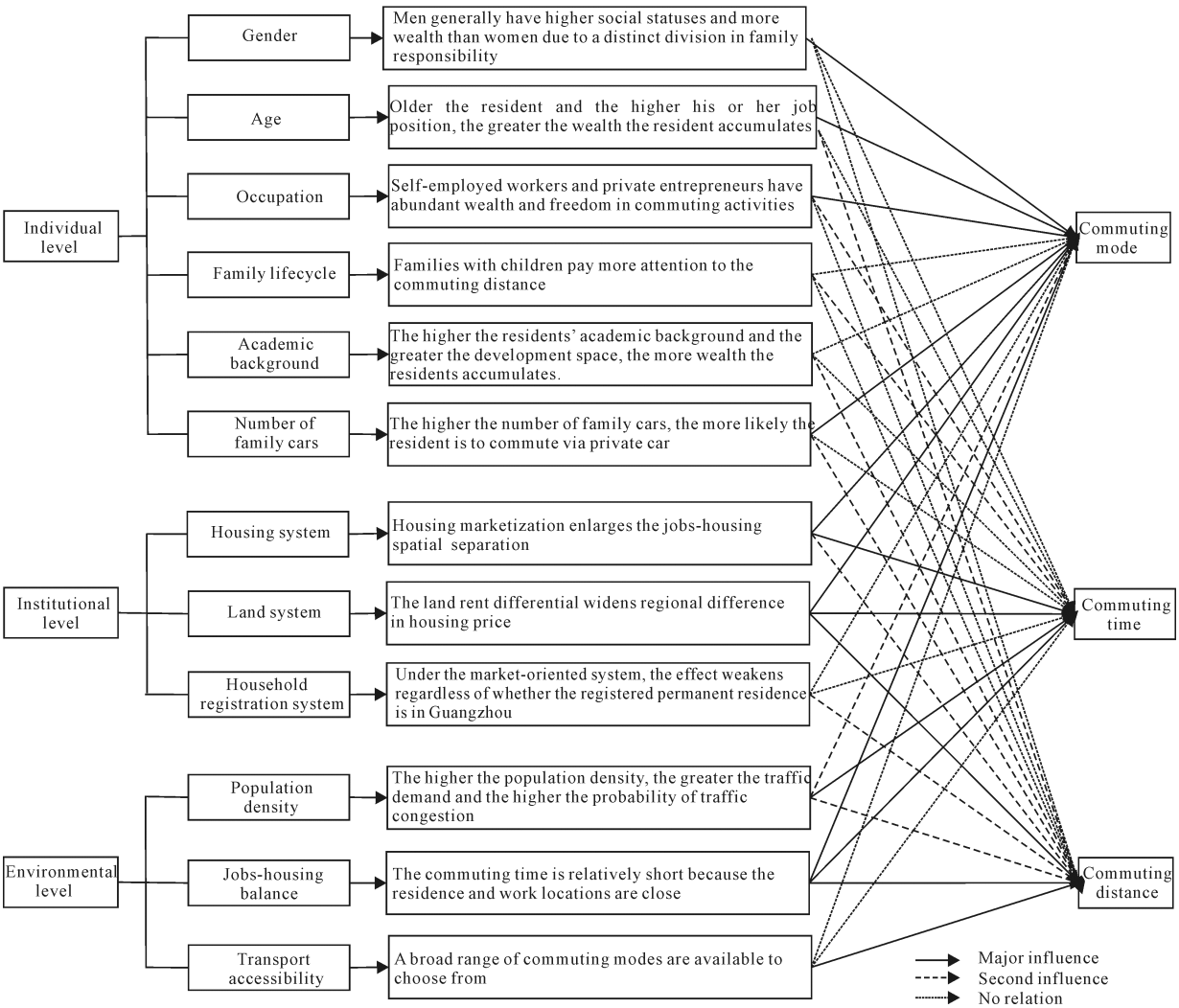

Fig. 5 Reasons for commuting activities of middle-class residents

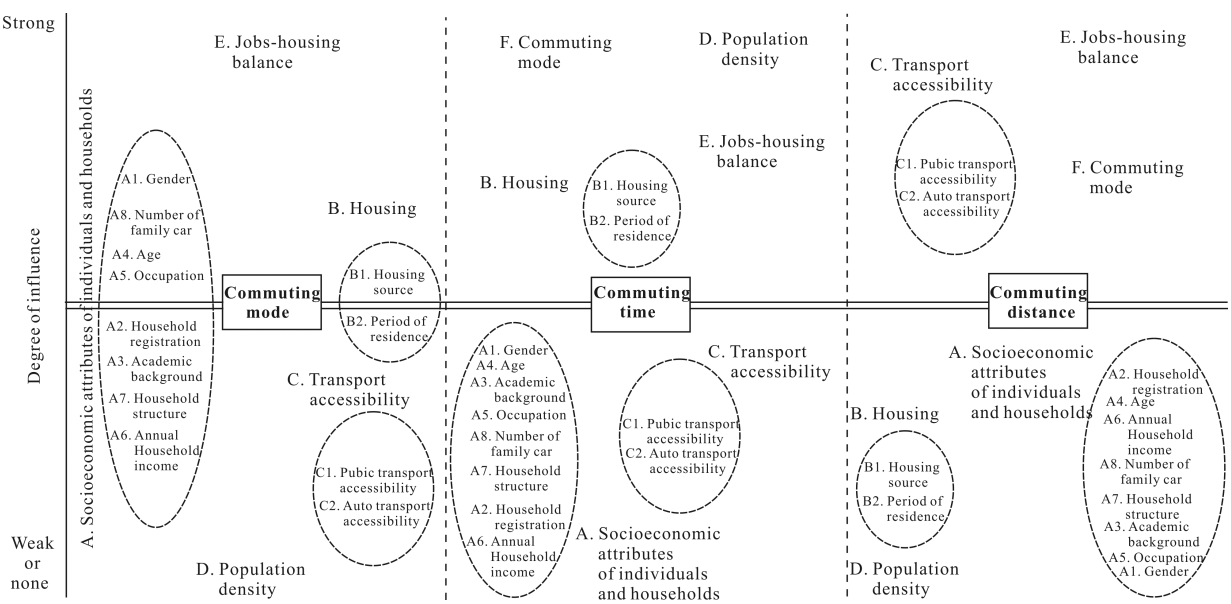

Fig. 6 Schematic diagram of factors influencing commuting activities of middle-class residents

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