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A DISSERTATION APPROVED FOR THE
COLLEGE OF ARCHITECTURE

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Abstract

China's fast urbanization, population growth, and housing reform policies contributes significantly to urban sprawl, environment degradation, and excessive commuting in major cities in recent decades. This research investigates factors directly or indirectly affecting job-housing relation, which is described by employment options, residence choice, and commuting patterns, in three types of communities in Beijing, China. Descriptive statistics and structure equation models using variables for household socio-economic status, individual preference, home-workplace distance, and commuting behavior are implemented. The results indicate that traditional and semi-Danwei community residents have a more balanced job-housing relation, shorter daily commuting time and lower dependency on motor vehicles than residents of non-Danwei community. This research also finds that income, housing qualities, distance from home to workplace, community elementary schools and daycare centers, and sense of belonging significantly affect the choice of community when purchasing houses. These findings show that China's job-housing relation are dramatically different in the plan economy in which Danwei housing-employment was popular with low vehicle dependency and shorter commuting time. In the free market economy today, non-Danwei housing-employment is dominant with high vehicle dependency and longer commuting distance.

Chapter 1: Introduction

Since the 1980s, the reform and opening-door policy with an urbanization oriented development strategy has accelerated urban growth in China. The average urbanization rate of Chinese cities increased from 17.9% in 1978 to 51.3% in 2011 (CSB, 2012). The rapid urban development pulls people from rural areas to cities, especially large cities, causing larger urban populations, higher population densities, and more demand for city resources such as transportation, infrastructure, housing, employment, and facilities (Wang et al, 2011). Table 1 displays the population size, land areas, and population densities for the four primary Chinese cities. Table 2 illustrates the rapid growth of paved roads, annual public transport passengers, and private vehicles, including escalating tendencies of commuting distance and vehicle dependency.

Due to large population migration from rural areas to towns and cities, urban expansion is facilitated by constructing more residential communities for migrants in suburban areas of China's cities. However, the inadequate self-sufficiency of suburban areas leads to heavy dependency on employment, infrastructure, and services provided by the inner cities (Presas, 2004). As a consequence, most people in China's cities have to commute longer distance or time, even though the improved transportation capacities and technologies can reduce the pain to residents with excessive commuting distance (Barcus, 2004).

More residents in China's cities have been used to the pattern of "urban working and suburban living" (Chen & Pu, 2002). Further commuting distance enlarges the commuting volumes and vehicle dependency which increase the fossil energy

consumption and inflates the environmental pollution (Chen et al, 2005; Zhao, 2002). Therefore, reducing commuting distance or time and solving related travel issues are critical for urban sustainability within China's cities, especially large or megacities.

Existing studies have demonstrated that commuting behaviors are affected by urban form, household socio-economic factors, individual preferences and life styles (Cervero, 1989a; Sermons and Koppelman, 2001; Guilano, 1991; Guilano and Small, 1993, Bothe et al, 2009; Cao et al, 2009; Schwanen and Patricia, 2005). These studies focus more on social-economic factors, individual preferences, and life styles, but ignore the effects of job-housing balance on commuting demands by individual preferences and characteristics.

The literature about the effect of job-housing balance on commuting has provided a number of models or methods, including the Transportation Problem Method (TPM), to quantify the job-housing relation. With TPM, theoretical minimum and maximum commutes, excess commuting, commuting potential used and other relative factors are computed to reveal the relation between job-housing balance and commuting (White, 1988; Giuliano and Small, 1993; Horner, 2002, 2007; Scott et al, 1997).

Table 1 Urbanization and urban expansion of China's megacities

	Beijing			Shanghai			Guangzhou			Chongqing		
	TP (million)	PD (person/ sq.km)	BA (sq.km)	TP (million)	PD (person/ sq.km)	BA (sq.km)	TP (million)	PD (person/ sq.km)	BA (sq.km)	TP (million)	PD (person/ sq.km)	BA (sq.km)
2005	11.80	719.50	1182	13.60	2078.95	820	7.50	1009.59	735	31.26	384.59	492
2006	11.97	729.75	1182	13.68	2157.68	860	7.60	1023.24	780	31.98	390.06	631
2007	12.13	739.30	1193	13.78	2174.86	873	7.73	1046.46	834	32.35	394.50	662
2008	12.99	748.81	1199	13.91	2193.46	886	7.84	1053.33	895	32.57	397.26	694
2009	12.45	759.14	1209	14.00	2209.31	886	7.94	1068.90	927	32.75	398.83	708
2010	12.57	765.25	1225	14.12	2220.83	886	8.06	1084.13	952	33.03	400.43	870
2011	12.77	778.70	1231	14.19	2238.74	886	8.14	1095.75	990	33.29	402.01	1035
2012	12.98	790.60	1261	14.26	2250.68	886	8.22	1106.13	1010	33.43	405.89	1052
2013	13.16	802.11	1306	14.32	2259.21	886	8.32	1119.60	1024	33.58	407.70	1115

Note: TP – Total Population, PD – Population Density, BA – Built-up Area
Source: Statistical Yearbook of Chinese Cities, 2006-2014

Table 2 Commuting status and vehicle dependency of China's megacities

	Beijing			Shanghai			Guangzhou			Chongqing		
	ACPR (million sq. m)	TAVPT (million person time)	TVPV (million)	ACPR (million sq. m)	TAVPT (million person time)	TVPV (million)	ACPR (million sq. m)	TAVPT (million person time)	TVPV (million)	ACPR (million sq. m)	TAVPT (million person time)	TVPV (million)
2005	70.10	4423.45	1.54	78.56	2781	0.41	83.25	1842.89	0.53	49.63	1057.18	0.15
2006	72.04	4682.25	1.81	80.26	2740	0.51	86.63	2124.76	0.63	67.79	1254.12	0.19
2007	77.34	4226.45	2.12	83.63	2650	0.61	90.00	2356.29	0.76	62.33	1467.66	0.25
2008	89.41	4708.63	2.48	87.44	2660	0.72	93.34	2461.02	0.88	83.53	1553.06	0.31
2009	91.79	5165.17	3.00	92.81	2706	0.85	95.02	2439.65	1.03	89.53	1387.00	0.43
2010	93.95	5051.44	3.74	97.23	2808	1.04	97.31	2501.96	1.26	99.31	1619.32	0.60
2011	91.64	5032.72	3.90	99.42	2811	1.95	100.50	2528.46	1.49	108.70	1749.30	0.78
2012	92.36	5154.16	4.08	91.17	2803.60	2.13	101.40	2623.06	1.65	119.36	2403.54	1.02
2013	96.11	4843.06	4.23	99.32	2710.48	2.35	102.41	2634.33	1.73	127.23	2420.31	1.31

Note: ACPR-Area of City Paved Roads, TAVPT-Total Annual Volume of Passengers Transport by Buses and Metro, TVPV-Total Volume of Private Vehicle

Source: Statistical Yearbook of Chinese Cities, 2006-2014

In China, Danwei was a basic urban neighborhood unit integrating working place, houses, and other service facilities in a compound pattern (Liu, 1993; Lu, 1999). The highly integrated spatial structure makes each Danwei self-sufficient, and reduces the commuting demands of residents to the surrounding areas outside Danwei. The advantage of Danwei includes a relatively balanced job-housing relation, self-sufficient infrastructure support for shorter commuting distance, and lower vehicle dependency (Wang and Chai, 2009; Zhang and Chai, 2014). These advantages of Danwei have shown to be the case for many Chinese cities. Dismantling of Danwei over the recent decades is regarded as contributing to job-housing imbalance and excessive commuting (Zhou et al, 2014a, b; Zhao et al, 2011).

The deficiencies and limitations of the literature about the effect of job-housing balance and Danwei on commuting can be listed as follows:

1) Existing studies just measure the current situations, but cannot provide any prediction or guidance.
2) Focusing only on traditional Danwei or non-Danwei for job-housing balance or commuting. The understanding of commuting status and job-housing relation for semi-Danwei still remains missing.
3) The interaction between socio-economic factors, individual preference and commuting is only based on the job-housing selection order (select job first, and then select house). Hence, housing-job selection order is not taken into consideration.

4) Self-selection factors have been demonstrated to affect commuting distance. However, their relative importance to commuting status and job-housing relation in Chinese cities, particularly large or megacities is unknown.

5) Existing studies research the commuting distance of Danwei at city and district levels. The effect of Danwei on commuting at the community level may be underestimated.

The purpose of this research is to identify socio-economic factors and self-selection choices that affect residents' choices for types of living community, housing, and further affect both commuting time and job-housing balance. This research also considers the job and housing selection order important to various commuting patterns. Non-Danwei employees but Danwei-housing residents and residents of semi-Danwei communities are also taken into consideration in this research.

This dissertation research is structured as follows. Chapter 2 presents the literature review about the relation between job-housing balance and commuting, and discusses the effects of Danwei and Housing Reform on commuting times in China. Chapter 3 defines three types of communities, and describes the correspondent cases in Beijing. Chapter 4 discusses the variables, questionnaire, and survey. Chapter 5 presents the descriptive statistics over the survey data. Chapter 6 lays out a set of structure equation models as the research methodology; Chapter 7 reports the modeling results; Chapter 8 explains significant statistical relations, including direct, indirect, and total effects among the variables. Chapter 9 summarizes main findings, research contributions, guidelines for practice, and potential future research directions.

Chapter 2: Literature Review

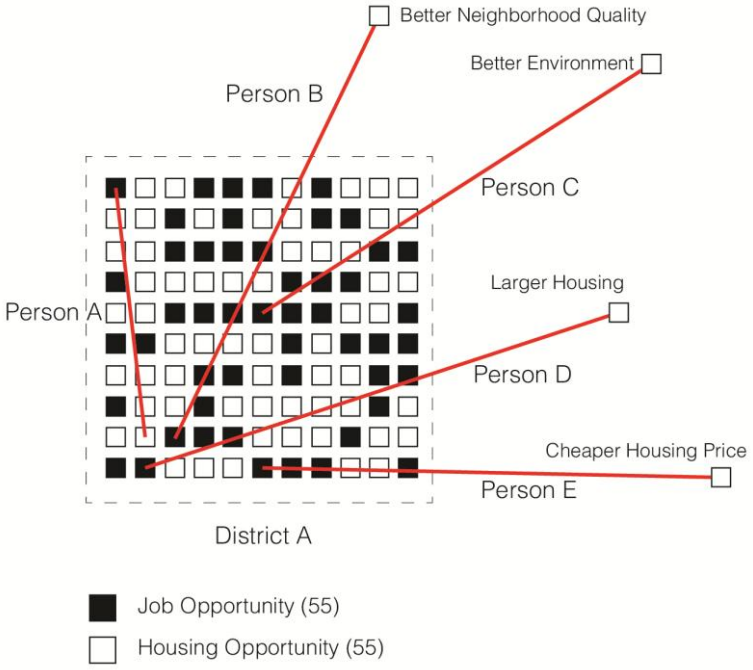
Numerous existing studies have discussed the effect of job-housing balance on commuting time with a range of findings. The consideration of the current studies about job-housing balance can be classified into three groups: 1. Job-housing balance has a significant effect on commuting (Cervero, 1989a; Sultana, 2002; Frank and Pivo, 1994; Horner, 2002); 2. Job-housing balance has a relatively low or no significant effect on commuting (Guliano, 1991; Guliano and Small, 1993; Suzuki and Lee, 2012; Cao et al, 2009; Bohte et al, 2009); and 3. Measuring job-housing balance is the initial to discuss the effective (Cervero, 1989a; Margolis, 1973, Horner, 2002; Ma and Banister, 2006a; Niedzielski, 2006; Horner, 2007). Nonetheless, the correlation between job-housing balance and commuting distance in China's megacities has a different context from western cities. As a relative high self-sufficient land use form, Danwei provides an equal number of job and housing opportunities, and refined commuting behaviors at community level. Even though current Housing Reform and the dismantling of Danwei has resulted in an imbalanced job-housing relation and increasing commuting distance, the positive effect of Danwei on job-housing relation and commuting times still persist (Wang and Chai, 2009; Zhou et al, 2014; Zhou et al, 2014; Zhou et al, 2013).

2.1. Job-housing Balance Has Significant Effects on Commuting

Job-housing balance describes the commuting distance and time from housing and employment opportunities within suburban areas to interest points of the city (Cervero, 1989a, b; Giuliano, 1991). The definition of job-housing balance is displayed through the ratio between the total number of houses and job opportunities in the

selected urban areas (Cervero, 1989a; Margolis, 1973). Cervero (1989a), Horner (2002) and Sultana (2002) argue that the imbalance between jobs and housing results in the extension of commuting distance. If job-housing relationship is balanced in space, both working and living behaviors of residents will happen in the same urban areas, and commuting distance will decline. Findings from Atlanta, San Francisco, Chicago, the Pudget Sound Region and the 26 other U.S. cities demonstrate the above conclusion to some extent (Cervero, 1989a; Frank and Pivo, 1994; Horner, 2002; Sultana, 2002). Levinson (1998) analyzes the correlation between the accessibility to jobs and homes and commuting time in Washington, DC. The data for the research is based on the household travel survey of metropolitan Washington DC in 1987 and 1988. The research utilizes the accessibility measure derived from the gravity model, and analyzes the accessibility to jobs and homes within the traffic zones of Washington DC at the origin and destination ends of commuting. The analysis demonstrates that the suburbanization of the amount and location of jobs and houses forms a polycentric urban form of Washington DC which will improve the job-housing balance, stemming increasing commuting distance. The perspective function of job-housing balance is to reduce commuting distance, especially commuting times, to relieve the negative influence caused by traffic including congestion, air pollution, and urban sprawl (Cervero, 1989a; Zhou et al, 2009). Additionally, existing studies have demonstrated that the growth of commuting distance and vehicle dependency is relative to the job-housing imbalance (Cervero, 1996; Cervero, 1989a; Sultana, 2002).

Figure 1 Effect of self-selection on commuting



Source: the author

The potential weakness of the job-housing relation on commuting is that some studies test the effect of job-housing balance with a hypothesized precondition not specified. Distance to work is assumed as the first priority of inhabitants rather than other preferences when purchasing houses. Self-selection can be defined as the individual preference and lifestyles involved in house selection. Job-housing balance provides equal numbers of jobs and houses within a geographic area. If inhabitants are willing to choose both employment and housing opportunities in this area, it is certain that their commuting behaviors will be refined within this geographic area. Nonetheless, due to the socio-economic and self-selection factors, distance to employment may not be the first preference when inhabitants purchase houses or find jobs (Fig.1). In other words, job-housing balance just provides equal numbers of job and housing opportunities to refine commuting distance in a geographic area. However, if residents

are not willing to work and live in this area, job-housing balance is not able to reduce the commuting distance.

2.2. Job-housing Balance Has Relatively Low or No Effect on Commuting

Existing studies identify that commuting behaviors are affected by three aspects: 1. urban form dimension affects transport mode choice and commuting distance at neighborhood level (Cervero, 1989a); 2. Socio-economic factors such as gender, household structure and income result in various commuting distance and transport mode (Sermons and Koppelman, 2001); and 3. Individual preference and lifestyle will lead to different commuting distances and modes (Guilano, 1991; Guilano and Small, 1993, Bothe et al, 2009; Cao et al, 2009; Schwanen and Patricia, 2005). The second and third arguments deny or question the effect of job-housing balance on commuting.

Guliano (1991) argues that job-housing balance has limited influence on reducing commuting distance. Neighborhood quality, accessibility to amenities, school quality, race, and micro-climate may be the other considerations when purchasing houses rather than commuting distance or time. In other words, if distance to a job site is not the first preference when choose housing location, job-housing balance is not able to reduce commuting distance. According to the research of 30,000 employees in Kaiser, Wachs et al (1993) demonstrate this conclusion. The research claims that not only distance to job but also school, safety and neighborhood quality will result in different commuting behaviors. Based on the survey in South California, Guiliano and Small (1993) conclude that the effect of job-housing relation on commuting is relatively low compared with other factors. Suziki and Lee (2012) certify this conclusion. Bohte et al

(2009) and Cao et al (2009) define these preferences of housing location as self-selection. Self-selection represents residents' preference of special housing characteristics. In order to pursue such preferences, distance to a job site may not be the first priority when select housing location. However, job-housing balance still is able to influence commuting patterns at city levels. Sermons and Koppelman (2001) consider that socio-economic factors such as gender, household composition and annual income will result in different commuting behaviors as well. Socio-economic factors can be treated as the reason behind different self-selection choices. For example, residents with different annual income may have different attitudes about housing prices which will result in various housing location preferences. Socio-economic factors are an indirect cause of commuting behaviors. For the research of self-selection factors enables one to more directly and accurately measure the influence of socio-economic factors on commuting.

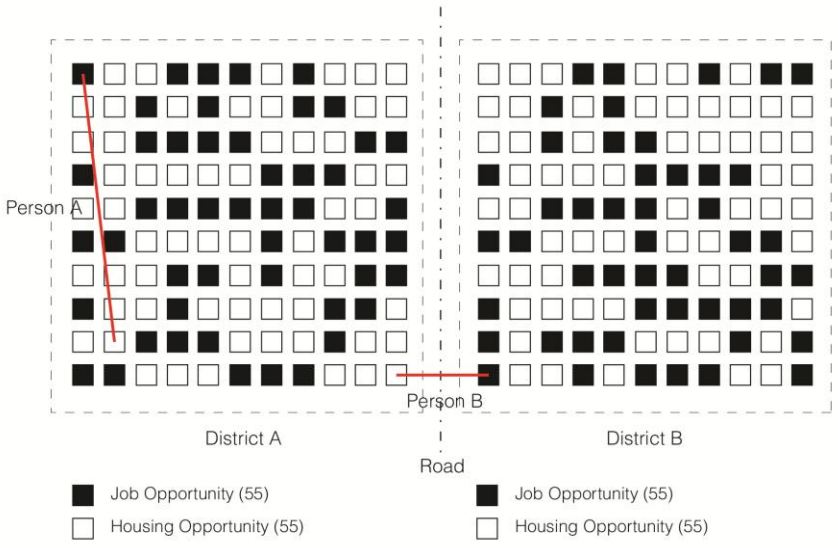
The potential weakness of the existing findings on the importance of job-housing balance is the underestimation of role of self-selection aspects of residential choice. There are two preconditions to realize a decrease commuting distance. First, job and housing opportunities should be balanced in geographic space, or briefly stated the volume of jobs is approximately equal to the volume of housing in a district. Second, both the characteristics of job and housing opportunities meet the requirement of residents' self-selection which make residents more willing to work and live in the same district. In other words, it is not enough if residents are just willing to work and live in the same district. This district must be able to provide corresponding volumes of job and housing opportunities for these residents as well as other site amenities. Job-housing

balance must be realized at both geographic and individual level simultaneously. Only if these two preconditions are implemented concurrently, job-housing balance is able to stem the increasing of commuting distance.

2.3. Measuring Job-housing Balance

Margolis (1973) considers that if the ratio between jobs and housing opportunities ranges from 0.75 to 1.25 at district level, the relation between jobs and housing is balanced. Cervero (1989) enlarged this range to 1.5. On the contrary, Giuliano (1991) proposes that job-housing balance cannot just be measured by ratio. Housing scale, work force participation rate, and dwelling unit potentially make the ratio bias. Meanwhile, Giuliano (1991) questions the 3 mile radius of geographic research area of job-housing balance defined by Cervero (1989a), because most of the commuting distances of residents are further than 3 miles.

Figure 2 The Deficiency of Initial Job-housing Balance Measurement



Source: the author

The initial job-housing balance measurement may generate inaccurate conclusions due to the definition of geographic area. For example (Fig.2), District A and District B are two adjacent urban districts separated by a road. Both job opportunities and housing opportunities in District A and District B are 55. According to the definition of job-housing balance, the job-housing ratios of District A and B are 1 which has reached the perfect level. Theoretically speaking, commuting status in District A and B should be reduced to a minimum degree. Nonetheless, it is obvious that the commuting distance of Person A is longer than Person B.

In respond to revise the deficiency of the job-housing relation measurement by ratio, Transportation problem method (TPM) is another general implemented measurement which uses T_r (theoretical minimum average commuting distance or time) to test the job-housing balance (White, 1988; Giuliano and Small, 1993; Horner, 2002, 2007; Scott et al, 1997). The minimized value of T_r is expressed as:

$$Min: Z = \frac{1}{N}\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_{ij} \tag{1}$$

$$s.t. \sum_{i=1}^{n} X_{ij} = D_j \quad \forall_j = 1,...,m \tag{2}$$

$$\sum_{j=1}^{m} X_{ij} = O_i \ \forall_j = 1,...,n \tag{3}$$

$$X_{ij} \geq 0 \ \forall i, j \tag{4}$$

Note: m: number of origins; n: number of destination; O_i: trips beginning at zone I; D_j:trips destined for zone j; C_{ij}:travel cost from zone I to zone j; X_{ij}:number of trips from zone I to zone j; N: total number of trips.

According to the same data source of Hamilton's research (1982), White selected 25 cities overlapping the selected cities of Hamilton's study for average

minimum commuting estimation. Comparing the minimum average commute with the actual (or observed) average commute (T_a), T_a-T_r identifies the absolute excess commuting. The wasteful commuting degree is expressed as:

$$EC = (\frac{T_a - T_r}{T_a}) \times 100 \quad (5)$$

White concludes that the average wasteful commuting degree of U. S. metropolitan areas is 0.11which is an indicator that reflects the degree of wasteful commuting. This value is much lower than the result of Hamilton's research (1982). Hamilton (1989) identifies the potential deficiency of White's measurement approach. Only if all within-jurisdiction commutes are optimal that average minimum commuting estimation is acceptable. Small and Song (1992) implement the minimum average commuting and actual average commuting measurement approach for Los Angeles-Long Beach metropolitan area based on the 1980 journey to work data of Los Angeles Region. The analysis results of wasteful commuting for large jurisdictions are similar as White, but higher in smaller zones. Small and Song conclude that the size of zones results in the bias of the measurements. If the actual commuting (T_a) is equal to the value of minimized commuting (T_r), it can be conclude that job-housing relation reaches perfect balance, and local residents will work and live in the same geographic areas.

Horner (2002) creates the theoretical maximum average commuting approach to measure the maximum travel capacity at regional level. The theoretical maximum average commuting is expressed as:

$$Max: Z = \frac{1}{N} \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij} \quad (6)$$

Combining with theoretical minimum average commuting, T_m-T_r measures the absolute commute potential; and T_m-T_a measures the absolute remaining commute potential. Horner (2002) further develops a commuting potential used indicator to measure cities' available commuting capacity expressed as:

$$C_u = (\frac{T_a - T_r}{T_m - T_r}) \times 100 \quad (7)$$

Based on the Census Transportation Planning Package of the Bureau of Transportation of 26 cities in the United States, Horner (2002) compares the analysis results by transportation problem method and disaggregate model. The analysis results indicate that commuting will be reduced by improving the internal job-housing balance at a regional level; and Land use policies are correlated to commuting distances. Comparing with single theoretical minimum average commute measurement, theoretical maximum average commute approach offers a comprehensive measurement including extreme commuting, carrying capacity and remaining commuting resource.

Horner (2007) further develops the wasteful commuting measurement approach at zonal level. Zonal commuting is separated into zonal output commuting (ω_i) and zonal inbound commuting (μ_j). Meanwhile, Horner (2007) utilizes worker-jobs ratio to measure the job-housing relation (B_i).

$$B_i = O_i / D_i \quad (8)$$

$$\omega_i = \frac{\sum_j C_{ij} X_{ij}}{\sum_i C_{ij} X_{ij}} \quad (9)$$

$$\mu_i = \frac{\sum_i C_{ij} X_{ij}}{\sum_i X_{ij}} \quad (10)$$

Note: O_i: total workers in zone i; D_i: total employments in zone i; C_{ij}: travel cost from zone i to j; X_{ij}: numbers of trip from zone i to j.

Horner (2007) also takes the scale of transportation analysis zone into consideration. TAZ is various in sizes, and the larger size of TAZ means longer distance from the centroid of a TAZ to another centroid of a TAZ. As a consequence, different sizes of TAZs will result in different results on commuting times. In order to alleviate the influence of TAZ scale on analysis results, Horner (2007) decomposes all TAZ to 0.25 mi^2 squares to avoid the potential bias caused by scale of TAZ. Census Transportation Planning Package (CTPP) by Bureau of Transportation Statistics (BTS) of Tallahassee is utilized for commuting measurement at a regional level. Data based on Florida and Leon County are utilized for zonal commuting measurements. Horner (2007) concludes that Tallahassee experiences urban sprawl in the past decade with stable job-housing balance. A more balanced job-housing relation will result in the reduction of average commuting distance. Zonal inbound and output commuting measurement illustrate the status of minimum (or maximum) commuting flows into local level calculation for each zone with accommodation for multi-types of commute matrices.

The job-housing balance measurement of existing studies may neglect two potential aspects: 1. Inadequate concentration on qualitative research about the effects of self-selection on job-housing balance; and 2. Neglect of the job-housing measurement at a community level. Ma and Banister (2006) argues that the measurement of T_r only test the job-housing balance at physical level which is defined as quantitative balance. This balance is decided by the volume of job and housing in spatial arrangement. However, it is not able to explain the qualitative balance composed by socio-economic, behavioral and preference factors.

A job and housing selection process can be classified into two scenarios: 1. Finding job first, and select a housing location according to different preferences of houses (Fig.3); and 2. Finding housing first or have already owned a house, and selecting job location according to different preferences of jobs (Fig.4). Different job and housing selection sequence with different preferences of jobs and houses will result in various job and housing location combinations. The existing studies utilize the present urban spatial forms to measure the job-housing balance based on the commuting data of residents. However, the job-housing relation has already been decided during the job and housing selection process which is highly affected by the diversity of individual self-selection factors. A transportation and spatial-based measurement method is just able to test and demonstrate the effect of job-housing balance on commuting status, but cannot identify the reasons resulting in the various job-housing relation. Which factors of self-selection have significant correlations with job-housing balance still remain questionable. In other words, which factors can be illustrated with statistized significance that makes residents willing to live and work in the same geographic area or not is unknown.

Figure 3 Scenario 1: Job-housing Selection Sequence

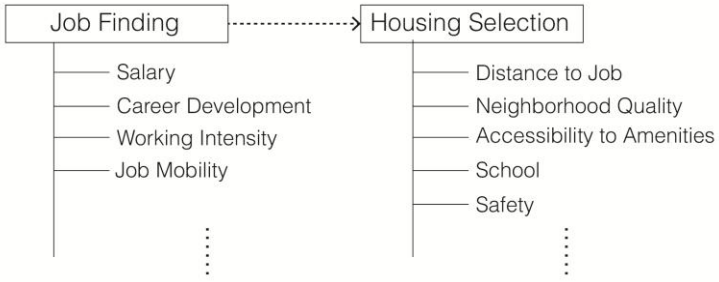
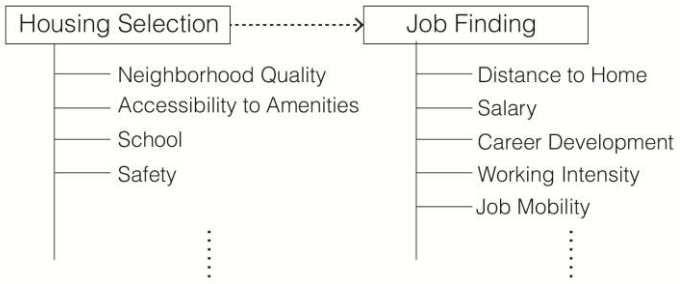
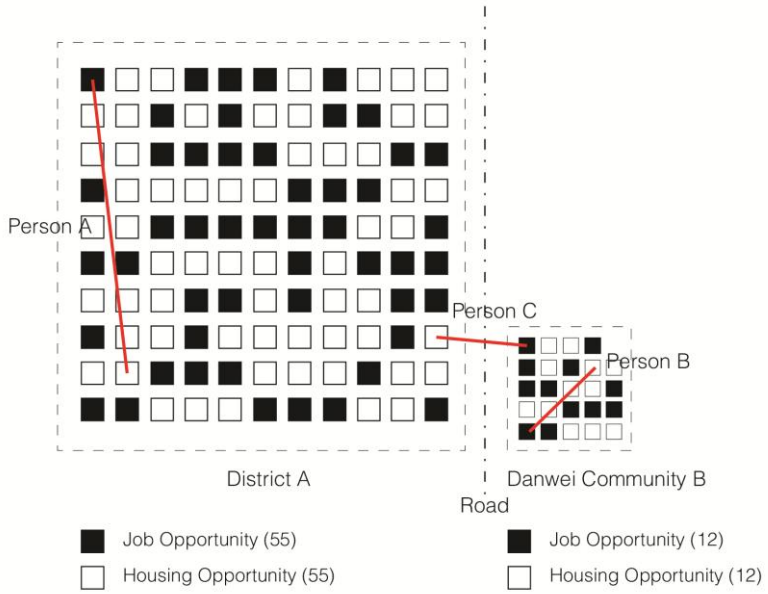


Figure 4 Scenario 2: Housing-job Selection Sequence



Source: the author

Figure 5 The Limitation of Transportation Problem Method



Source: the author

The geographic areas for job-housing balance measurement of existing studies are based on city and regional levels. Giuliano (1991) considers that three miles radius of geographic area limits the actual commuting distance of residents, because most of the commuting distances to job of residents are longer than 3 miles. The conclusion of Giuliano (1991) is based on the research of Western cities with market-oriented housing. Houses and jobs are dispersed at a city or region level. Nonetheless, houses and job in

China's megacities are Danwei-oriented before 1980s. Danwei integrates jobs and houses in each single compound with a high degree of self-sufficiency. If the locations of jobs and houses can be refined to a smaller geographic area, the commuting distance between jobs and houses will be relatively shorter as well (Fig.5). If the job-housing balance measurement at community level is neglected, the effect of job-housing balance on reducing commuting distance may be underestimated. As a community level spatial form, whether Danwei is able to refine commuting distance between job and housing into a relative shorter range than job-housing balance in city and regional level is still unknown. It is feasible to measure the job-housing balance of Danwei at community level.

2.4. Job-housing Balance and Commuting of Danwei

The initial Danwei in China is based on the concept proposed by former Soviet Union. During the First-Five Year Plan in 1950s, Danwei was implemented as the basic unit within urban areas to integrate working places, housing and other facilities in a compound pattern (Liu, 1993; Lu, 1999). Bjirklund (1986) considers that China requires an urban framework to maintain the social harmony and the stability of politics, and inspire economic development simultaneously after liberation. Meanwhile, due to the recombination of urban population structure, a significant portion of population does not have the experience of urban living. Many people are new migrants to urban area, and not familiar with urban networks and cultures. Danwei integrates social activities, economic activities and political control in a single spatial structure which meets the requirement of the China's urban areas in 1950s. Chai (1996) considers that social

organizations providing employment opportunities in China are defined as Danwei. Danwei does not have a certain scale with various functional characteristics including enterprise, social institutes, party organizations, government institutes and military units. Danwei also provides multiple services including housing, a dining hall, education, medical care, day care, and recreation. Danwei displays a composition and management of employment opportunities, housing and social welfare in a top-down organization structure and rural-urban spatial structure (Wang and Chai, 2009). Before Housing Reform in the 1990s, the housing allocation system of Danwei takes the full responsibility for the housing of employees, and Danwei is the only housing resource for all workers because there is no housing market for residents to purchase or rent houses (Wang and Li, 2004). Danwei provides essential daily requirement for the employment residents, and residents do not need to purchase products or service outside the Danwei (Walder, 1986). Compared with market housing, commuting distances from Danwei houses to workplaces in Danwei are shorter, and commuting times are reduced as well. Additionally, reduced commuting distances result in a higher preference of non-motor vehicle travel of residents in Danwei. The high accessibility to living facilities reduces the travel demand as well. Thus, a better job-housing balance and shorter commuting distance are provided by a Danwei format community.

In the post-socialist period (since 1980), the abolishment of Danwei and the Housing Reform policy resulted in housing suburbanization and the aggravation of job-housing imbalance along with the increasing of commuting distance (Yang, 2006). The State Council of China published the *Notice on implementing town Housing Reform in batches* to promote the housing market development by housing privatization from

Danwei-oriented housing provision in February 1988. Commercial housing is permitted to be constructed and traded by public and private developers (Huang and William, 2002). In order to further promote the Housing Reform and accelerate housing market development, the State Council issued the *Notice on further deepening the reform of urban housing system and speeding up housing construction* in 1998. The primary objective of Housing Reform is to abolish the social welfare, especially the housing welfare provided by Danwei, and makes Danwei transit from a comprehensive functional work unit to a production unit where employees get salaries for their work (Wang and Murie, 1999). After Housing Reform, Danwei houses are sold to employees. Meanwhile, employees have the property right of the houses, and they can sell or rent out their Danwei housing on the housing market. Many Danwei employees and their children have to leave the original Danwei for new jobs and houses due to the dismantling of Danwei. Non-Danwei employees can rent or purchase the traditional Danwei houses as well. The conventional commuting pattern and job-housing relation in Danwei is fading. Additionally, the leaving of original Danwei employees to suburban areas generates various commuting flow with different destinations. Since 1998, China's megacities accelerate the dismantling of Danwei. The conventional job-housing balance in Danwei communities has been broken. China's megacities gradually form a downtown working and suburban living spatial form which is similar to western developed metropolitan areas.

Even though Housing Reform and the dismantlement of Danwei results in the spatial mismatch between jobs and housing opportunities, several studies considers that the effect of Danwei on job-housing balance and commuting distance regulation still

persist (Wang and Chai, 2009; Zhou et al, 2014; Zhao et al, 2011; Zhou et al , 2013; Zhang and Chai, 2014).

Zhao et al (2011) argues that there is a significant correlation between job-housing balance and workers' commuting time in Beijing if transport accessibility, population density, and the socioeconomic attributes can be refined. Meanwhile, the analysis indicates that the commuting time of workers who live in Danwei houses is shorter than the commuting time of residents who live in market houses. In other words, Housing Reform and Danwei reform policy undermine the job-housing balance in Beijing, and inflate the commuting distance. In this study, multilevel probability proportion to size sampling strategy (PPS) is used to collect 1500 household samples from 60 communities from all urban districts in Beijing. The selection probability of communities is based on the proportion to size measurement. 25 households were randomly selected from each community for face to face interviews. The are 712 samples are picked for the analysis. The research about job-housing balance is based on the measurement at the sub-district level which is more meaningful to guide relative policy research. Sub-district as the geographical unit of measurement has two advantages: 1. Sub-district is the fundamental management level in the urban administration system; and 2. Sub-district is the fundamental unit for census tract which is coordinated with the census tract of foreign countries. Nonetheless, this approach also has weaknesses reducing the effect caused by the various geographical scale of sub-district. The areas of the entire sub-district in Beijing range from 74 to 5670 ha, and the average area of each sub-district is 995 ha. The average area of each selected sample is 650 ha which is less than the average area of all sub-districts is. Only 36.7% of the

selected sample have area larger than 650 ha. The study sample has smaller local areas than the total sub-district areas for job-housing balance measurement. A disaggregated method is used in this research to analysis commuting time at a household level. Housing is classified into two groups: Danwei housing (state-owned housing) and market housing (housing purchased from a private developer). The land data is based on the Beijing Land Readjustment Data, and the population data is from Beijing Census Data. The results indicate that the job-housing balance of Danwei system still has significant correlation with the commuting time of workers in Beijing. Meanwhile, the Housing Reform in Beijing increasing the share of non-Danwei houses in the total, and has a negative correlation with the job-housing balance and commuting times. The results also displayed that higher population density has a positive influence on reducing commuting times for workers living in central areas of Beijing. However, the characteristics and housing preferences of residents also have influence on commuting behavior as well. From socio-economic and self-selection perspectives, gender, household composition, private income, travel-related attitude and lifestyle are able to affect commuting demands as well (Schwanen and Patricia, 2005). Without the correlation test between individual characteristics and commuting demands, the significant of Danwei community on reducing commuting distance still remains uncertain.

According to the case study of Xi'an, Zhou et al (2014) considers that the commuting distance in Xi'an has reached the theoretical minimum value with relative balanced job-housing ratio. However, the job-housing balance in Xi'an does not have a significant correlation with commuting distances and time. On the contrary, the job

density and migrant ratio are significantly correlated with commuting distance. Xi'an is chosen for the case study with two reasons: 1. The primary districts of Xi'an still retain a traditional urban format before Housing Reform without too much housing suburbanization, and Danwei still dominants the urban format; 2. As a typical western city of China, this research provides the first-ever household travel survey data with a local connection. This study utilized the transportation problem method (TPM) to measure the T_r (theoretical minimum commute), T_m (theoretical maximum commute), *EC* (excess commuting), and C_u (commuting efficiency). Comparing with the existing studies based on TPM method, this research relies on the first-ever household travel survey to measure *EC*, T_r and C_u with less possibility of biases resulted by inaccurate weighting and deducting samples. This study also is the first analysis of excessing commuting and commuting efficiency based on the disaggregated modal choice for China's city. The measurement of urban spatial form, job-housing balance and commuting distance in new districts is available based on the suburban area analysis. The comparison of commuting and job-housing balance between China's city and selected foreign cities based on the analysis of *EC*, T_r and C_u makes the estimation about the correlation between job-housing balance and commuting distance in China more reliable. Nonetheless, TPM is not able to measure the influence of social and spatial transformation on job-housing balance and mode choices. The effect of spatial and social transformation caused by Housing Reform and Danwei reform is still questionable. According to the research of 417 Traffic Analysis Zones (TAZs) within Xi'an, the result indicates that job opportunities and housing opportunities are relative balanced in Xi'an, and an excess commuting in Xi'an stems residents to find

employment opportunities near homes. In other words, job-housing balance is not correlated with commuting distance. This conclusion also is demonstrated by the low average minimum commute value, and TPM is not able to identify the reason. Meanwhile, the result displays a non-significant correlation between job-housing balance and average commuting distance across the suburban areas. However, the ratio of job density to (residents outside of old city)/ (all residents) is significantly correlated with average commuting distance. The comparison between Xi'an and foreign cities indicates that Xi'an is not able to refine the commuting distance with a relative compact urban form and balanced relation between job and housing.

As a western city of China, the spatial structure and population composition of most Danwei communities in Xi'an still remains unchanged due to the relatively low economic development. The effect of a Danwei community on commuting in modern China's city with socio-economic and lifestyle change still remains questionable. A single TPM based research finding is not able to identify the effect of spatial and social transform of Danwei on job-housing balance and commuting. A mixed research method focused on comprehensive perspectives is required as well.

The research of Wang and Chai (2009) is focused on identifying the difference of commuting behaviors between residents living in Danwei houses and residents living in market houses in Beijing. The data collection is based on a household interview survey in Beijing. A sub-district is defined as the basic unit for sample selection, and the multilevel probability proportion to size sampling strategy is utilized to choose the sample sub districts. There were 25 households sampled in each sub-district according to the systematic sampling approach for face to face interview. Ten categories of data

are required from the survey including gender, age, marital status, annual income, occupation, education, types of work unit, source of housing, physical relationship between jobs and housing, and transportation mode. A structural equations model (SEM) is selected to measure the relationship among the characteristics of samples. SEM is appropriate to evaluate the causal effects of exogenous variables on endogenous variables and the interactions among endogenous variables (Golob, 2003). SEM integrates path analysis, factor analysis and regression analysis. SEM is able to estimate the interactions among several factors. According to SEM, gender, age, annual income, occupation, education, the nature of work unit and marital status are classified as exogenous variables, and sources of housing, the physical relationship between job and housing and transportation mode are defined as endogenous variables. LISREL 8.0 is applied to assess the structural equations, and the generally weighted least square method is applied to reduce the basis caused by the multi categorical variables. Generally speaking, the results indicate that the source of housing has a significant correlation with job-housing balance and commuting time. Danwei housing promotes the job-housing balance and reduces the commuting time. As a result, non-motor vehicle travel modes are preferred by workers of Danwei. Meanwhile, the result also suggests that Danwei housing has a positive effect to promote sustainable land use and transportation than other sources of residential spatial layout. A more detailed conclusion suggests the following: 1. Residents who work and live in the same districts have higher possibility to use non-motor vehicle travel modes for commuting; 2. The commuting time of non-motor vehicle travel modes is shorter than public transportation and private vehicle; 3. Age has significant correlation with source of housing and

commuting time (the older have higher possibility to live in Danwei housing with shorter commuting time); 4. Gender has a significant negative effect on job-housing balance (males have less possibility to live and work in the same place); 5. The relationship between education and job-housing balance is significant and positive (residents with higher education have higher possibility to be allocated a Danwei housing); 6. Education does not have significant correlation with travel modes and commuting time; and 7. Residents of Danwei housing have higher possibility to work and live in the same place than residents of market-based housing. According to these conclusions, the research predicts that the dismantlement of Danwei will increase the transport demands and commuting distances.

According to research about the relationship between individual characteristics and living status of original Danwei residents, this study explores the effects of Danwei on job-housing balance, travel modes and housing location. Nonetheless, this research still has three deficiencies which may result in the bias of the conclusion. First, the SEM test of job-housing balance is at district level. This is similar as the method of Giuliano (1991). Danwei integrates jobs and houses in a single compound. As a highly self-sufficient urban unit, Danwei is able to refine the commuting distance of residents at neighborhood level. If job-housing balance is constrained at lower spatial level, the commuting distance will be reduced to a relatively lower degree. What is the community level effect of job-housing balance on commuting distance is still unknown. Second, commuting mode choices and commuting distances are affected by three elements: urban form dimension, socio-economic factors and individual self-selection. Wang and Chai (2009) measure the qualitative balance of job-housing relation rather

than quantitative balance as other studies. According to the survey sample, working and living in the same district is defined as job-housing balance. An inter-correlation test is implemented between job-housing balance, commuting status and socio-economic factors. However, what is the effect of self-selection factors on job-housing balance and commuting demands is still unknown. The neglect of individual self-selection may result in biased and erroneous conclusions. Third, the SEM test of Danwei is based on the information of original Danwei employees living in conventional Danwei houses. Nonetheless, numerous Danwei houses have been sold or rent to non-Danwei employees after Housing Reform. In other words, non-Danwei employed residents live in Danwei houses but work outside Danwei communities. The commuting demands and job-housing relation of these non-Danwei employed residents change the original job-housing patterns of Danwei, and may lead to biased conclusions.

Zhang and Chai (2014) explore the effect of Danwei transformation on urban livability from both a spatial perspective and a neighborhood scale. The research selects Beijing as the research target because Beijing integrates various types of Danwei communities with different scale and administrative levels from central and municipal to district and local. Tongrentang Chinese herbs pharmaceutical factory is chosen as the research example. Tongrentang is a typical state-owned enterprise which successfully has transformed to a market-based enterprise. Meanwhile, during the transformation, the produce function of the Danwei was removed, and replaced by extra residential and service land uses. The data for the research is composed by local planning archives, construction records from Tongrentang Housing Management Division, and two rounds of face to face interviews. In the first round of interviews, 15 samples are randomly

selected from each of the four residential districts with 20 min interviews to collect the individual information including job type, history about Tongrentang community and neighborhood satisfaction. Based on the first round of interviews, 10 samples are decided from the 60 samples of the first phase in various departments, administrative levels, and residential districts. If there are already three participants with the same characteristic in one of the three categories, the next potential participant still with the same characteristics was skipped. The second round interview is focused on the information in four aspects: 1. Employment and annual incomes; 2. The property right, area, rooms, facilities and neighborhood environment of houses; 3. Commuting status and accessibility to service and facility; and 4. Satisfaction of current housing, and willingness of move. According to the local planning archives and construction records, a site plan of current Tongrentang community is generated. Based on the information from interview, three site plans in different spatial transformation eras were created as well (the transformation of Tongrentang community is separated into four eras: Initial construction and production phase from 1973 to 1978; the zoning and improving production phase from 1979 to 1985; the intensive production and redeveloping phase from 1986 to 1992; and the transforming phase after 1993). According to the interview data, Zhang and Chai consider that the removal of limited gates and the construction of extra entrance of Tongrentang community improve the accessibility of surrounding residents to the open space of the community. The replacement of enclosing wall by approachable rails promotes the public outreach and brand marketing. According to the land use data, industrial and warehouse land use transformed to service and residential land use which indicates the transformation of Tongrentang from a single producing

institution to a more comprehensive functional community. According to the research, Zhang and Chai (2014) conclude: 1. Comparing with Danwei in Central and Rastern European, China's Danwei do not display a decline tendency; 2. China's Danwei break the traditional Bolshevik fortress form, and complete the transition from wall and gate enclosing, self-sufficient, and strictly constrain work unit to an highly accessible, aggregated, mixed-used urban community; 3. The transition of Tongrentang can be treated as an example for the transition of other Danwei; 4. Danwei has similar transformation processes with different driving forces and mechanism; and 5. Residents of Tongrentang still primarily rely on the service and commercial facility of the community for daily life requirement despite there are several new shopping malls, restaurants and hospitals constructed near the community after Housing Reform. According to the research results, this study provides four suggestions for the reforming of Danwei in China: 1. traditional walls and gate should be removed to improve the accessibility of surrounding residents to public services and facilities; 2. Expired land use function of traditional Danwei should be replaced by new service and commercial land use functions for the daily requirement of residents; 3. Environmental modification is necessary for brownfields and other previous industrial compounds; and 4. Due to the dismantlement of Housing Management Division, property owners committee should take the responsibility to maintain the quality of the community.

This study utilizes Tongrentang community as an example to explore the relationship between spatial transformation and urban livability. Danwei has various functional characteristics including enterprise, social institutes, party organizations, government institutes and military units. As a productive Danwei, the typicality of

Tongrentang is finite. A multiple case study about Danwei with different functions (productive, management, social service) is required to test the relationship between the spatial transformation of Danwei, job-housing relation, and commuting demands. Meanwhile, similar as Wang and Chai (2009), the participants of the interviews are only the original Danwei residents. Non-Danwe employed but Danwei housing residents should be taken into consideration as survey samples as well.

According to the review of existing studies about job-housing balance and Danwei, the potential weakness and deficiencies includes:

1) The conclusions about the effect of job-housing balance and Danwei on commuting behaviors only rely on the data of built-up areas. A potential solution to reduce commuting distance in China's megacities during planning and design phase is still unknown.

2) After Housing Reform, non-Danwei employed residents moved into traditional Danwei houses, and traditional Danwei becomes semi-Danwei community. What is the commuting status of semi-Danwei still remains questionable.

3) The interrelation between socio-economic and commuting behavior is only based on job-housing selection order (select job first, and then select house). Housing-job selection order is not taken into consideration.

4) Self-selection factors have been demonstrated that will affect commuting behaviors. Which factors of self-selection may result in different commuting status and job-housing relation in China's megacities is unknown.

5) Existing studies analyze the commuting behaviors of Danwei at regional, city and district level. The effect of Danwei on commuting at community level may be underestimated.

The objective of this research is to develop a quantitative measurement to test the relationship between job-housing balance, socio-economic factors, individual self-selection factors and commuting time at community level. Comparison between traditonal Danwei, semi-Danwei, and non-Danwei communities is implemented to identify the diversity of job-housing balance and commuting time of different types of communities in China's megacities after Housing Reform. According to the quantitative measurement of Danwei, this research seeks to identify which factors directly or indirectly influence job-housing balance, vehicle dependency and commuting time.

Chapter 3: Case Studies

Three areas within the city of Beijing are selected for the case studies. Since the Yuan Dynasty, Beijing has been the capital of China. The spatial structure of Beijing is monocentric with radial ring roads. Beijing has experienced a rapid urban scale expansion process since the 1990s. The built-up area of Beijing increased from 1182 sq.km in 2005 to 1306 sq.km in 2013. The initial ring road, as well as the second Ring Road, was constructed in 1990s. The latest ring road, the sixth Ring Road, was constructed in 2000. The interior area of the second Ring Road is generally identified as the central area of Beijing. The central area is composed of four urban districts including the Dongcheng, Xicheng, Chongwen, and Xuanwu Districts. The area between the second Ring Road and the fifth Ring Road is the inner-suburban area of Beijing. The internal-suburban area is composed of the Haidian, Chaoyang, Fengtai, and Shijingshan Districts. The urban area outside the fifth Ring Road is the external-suburban area of Beijing composed of ten suburban districts.

The population of Beijing increased from 11.8 million in 2005 to 13.16 million in 2013. Meanwhile, the area of paved roads increased from 70.10 million sq. m in 2005 to 96.11 million sq. m in 2013. The volume of private vehicles increases from 1.54 million in 2005 to 4.23 million in 2013 (CSP, 2014). While population, paved roads and private vehicle ownership have increased. Commuting distance and dependency show moderate growth. Beijing is a typical example of China's megacities with high commuting demands.

Bjirklund (1986) considers that China requires an urban frame work to maintain the social harmony and the stability of politics, and inspire economic growth after

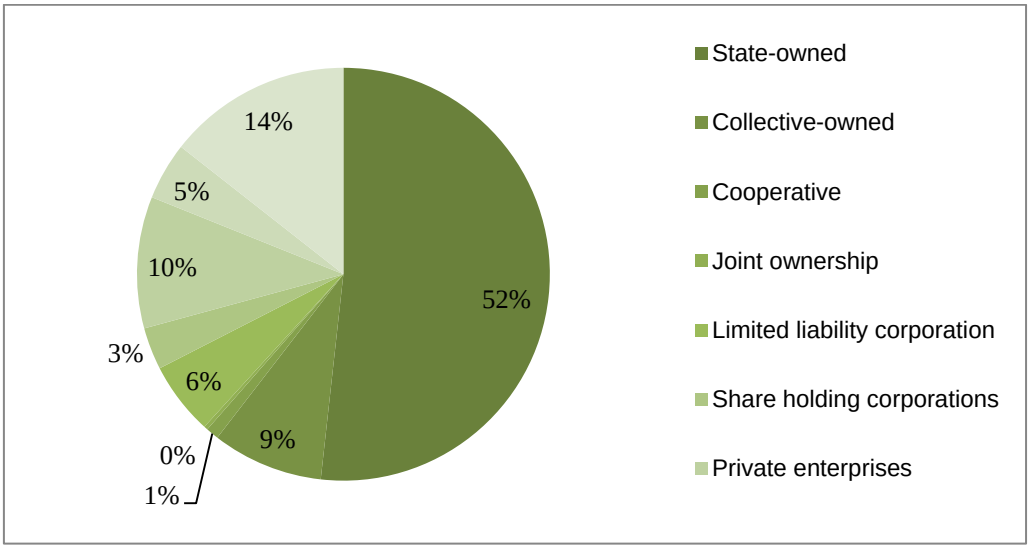
liberation. Meanwhile, due to the dynamic change of the urban population structure, a significant portion of the population does not have experience with urban living. Many people are new migrants to urban areas, and are not familiar with the urban networks and cultures. As a consequence, the Danwei compound was implemented as the basic unit of the spatial composition when Beijing became the capital of the People's Republic of China in 1949. Fig. 6 displays the composition of working units in Beijing. Stated-own and collective-owned work units can be treated as traditional and semi Danwei. Other types of work unit have emerged since the market-oriented reforms of the 1980's, and do not provide housing welfare to employees. Employees need to purchase or rent houses from the housing market. According to Fig. 6, stated-owned and collective-owned work units are the dominant type of work unit in Beijing with 61% of employees in Beijing employed in Danwei. Even though traditional Danwei dismantled after Housing Reform, these compounds are left and have transferred to semi-Danwei communities. Beijing provides adequate sample sources for this research to compare the commuting behaviors of residents in traditional Danwei, semi-Danwei and non-Danwei communities. The commuting distance and vehicle dependency of Beijing has significant increase in the past 10 years. It is appropriate to explore which factors directly or indirectly influence people's choice of a residential community, and further affect their job-housing relations and commuting time. According to the review of existing literature about Danwei and commuting, the following factors should be taken into consideration:

1) Commuting research performed at the community level provides a unique opportunity to compare commuting between traditional Danwei communities, semi-Danwei communities and non-Danwei communities.

2) The effect of job and housing selection order on commuting and related issues.

3) The effect of self-selection factors on commuting and relative issues.

Figure 6 Shares of Employees by Types of Work Unit in Beijing 2012

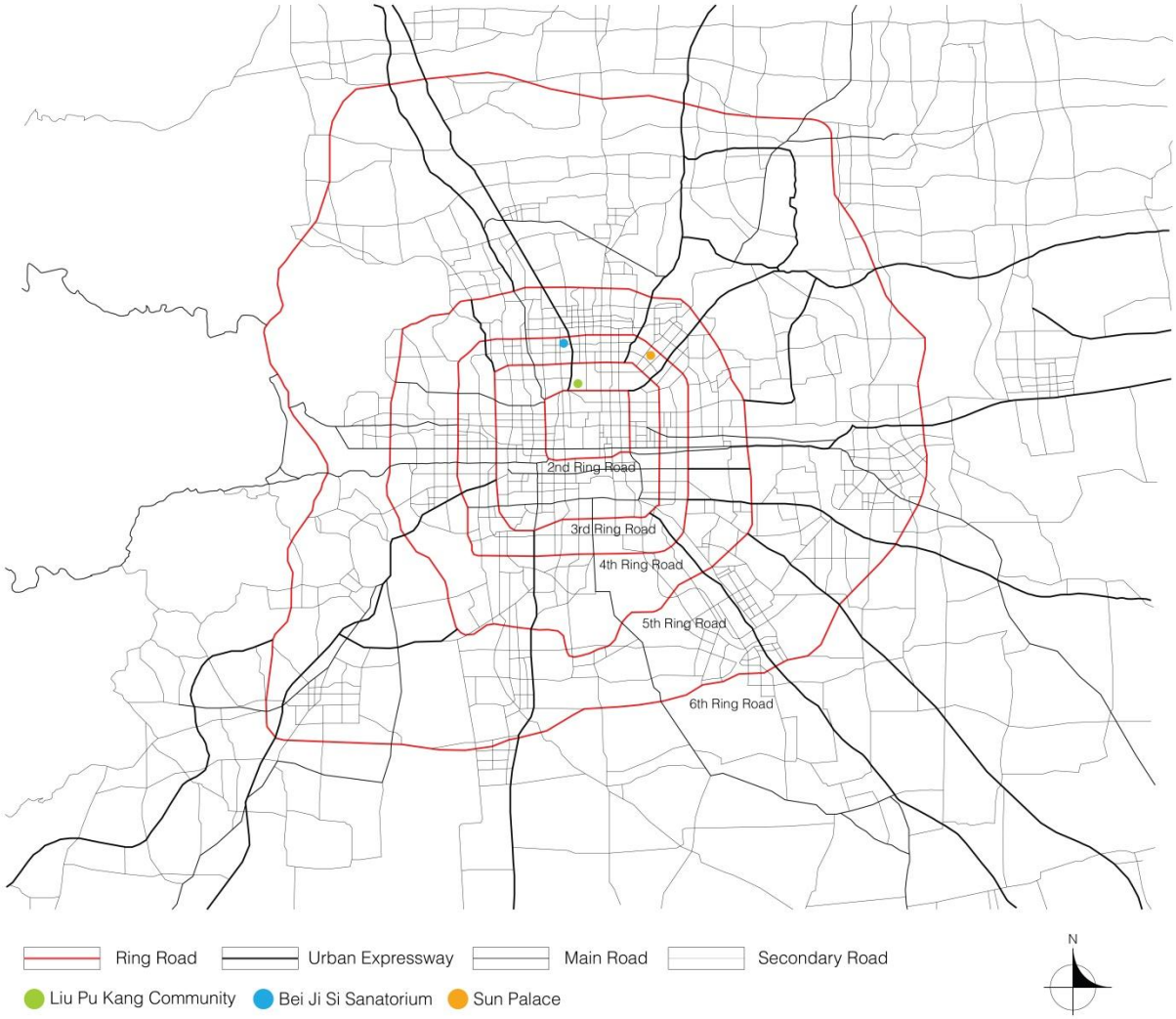


Source: Wang and Chai (2009)

In this research, a traditional Danwei community is defined as the work unit compound integrating working areas, service areas, and residential areas. Residential buildings within the compound are only allocated to the employees through housing provision without any charge. Semi-Danwei not only retains the spatial format of traditional Danwei communities integrating working areas, service areas and residential areas, but also includes commercial areas. However, the property rights of residential buildings are posted to free housing markets. Both Danwei and non-Danwei employed residents are able to purchase or rent these houses. A non-Danwei community is defined as a residential community which only has residential, service, and commercial areas.

Residents purchase the housing property from the free housing market. In order to compare the commuting status of each type of community, this research selects three communities in Beijing as research cases.

Figure 7 Beijing Site Plan and the Location of the Three Cases



Source: the author

3.1. Bei Ji Si Sanatorium Case Study

Bei Ji Si Sanatorium is selected as the traditional Danwei sample. Bei Ji Si Sanatorium is located at the south side of the north part of the fourth ring road. The distance from the community to the central area of Beijing is about 2.45 miles. The site area of the community is 22.9 hectare; the floor area ratio is 0.89; the building density is 0.55; and the landscaping ratio is 0.36. Bei Ji Si Sanatorium was constructed in the 1990s. The purpose of the sanatorium is to provide medical treatment and nursing service for retired cadres of the national government. In response to the environment and security of the sanatorium, the sanatorium is enclosed by a compound wall with entrance guards to be separated from surrounding areas. People who want to enter the compound must show their identity cards. The land use function of Bei Ji Si Sanatorium is composed of three parts: 1. Medical treatment and nursing area (50.8% of total areas); 2. Residential area for medical staffs (38.3% of total areas); and 3. Service facilities (10.9% of total areas).

Houses within the compound are allocated to employees through housing provision, and residents are forbidden to rent out or sell to non-Danwei employed residents. Bei Ji Si Sanatorium has the typical characteristics of traditional Danwei: 1. spatial closure is composed by compound wall with entrance guards; 2. Danwei provide housing to employees by housing provision without any charge, but the houses are forbidden to be rented out or sold; and 3. the community integrates working, residential, and service areas in a single compound.

During the Housing Reform in 1998, Bei Ji Si Sanatorium did not abandon the conventional management system and spatial pattern. In response to guarantee the

security and environment for the retired cadres, Bei Ji Si Sanitarium still maintains the original enclosing wall and entrance guards for spatial segregation. Housing welfare is still maintained, and the sanatorium has kept the responsibility to provide housing for employees without any charge. Meanwhile, the Danwei houses are still not allowed to be rented out or sold to the free housing market. There is no daycare center or elementary school in the community. Parents send their children to the daycare center and elementary school designated by Beijing Education Bureau. Bei Ji Si Sanatorium accurately represents the land uses and ownership restrictions of traditional Danwei community in Beijing.

Figure 8 Bei Ji Si Sanatorium Site Plan



Source: the author

3.2. Liu Pu Kang Community Case Study

The Liu Pu Kang community is located at the north side of the middle part of the second ring road. The location of Liu Pu Kang community is within the central area of Beijing. The site area of Liu Pu Kang community is 49.7 hectares; the floor area ratio is 1.98; the building density is 0.66; and the landscaping ratio is 0.26. Liu Pu Kang community was constructed in the 1950s composed by the headquarters of Chinese Ministry of Petroleum, Chinese Ministry of Chemical Industry, and Chinese Bureau of Hydroelectricity. It is a compound integrated work unit headquarters and project management enterprise. The headquarters of the Chinese Ministry of Chemical Industry and Chinese Bureau of Hydroelectricity are still in Liu Pu Kang community. The Chinese Ministry of Petroleum has moved out from the Liu Pu Kang community. The development and transformation history of Chinese Ministry of Petroleum can be divided into three phases: 1. From 1950s to 1990s, Chinese Ministry of Petroleum moved into the Liu Pu Kang community; 2. Partial departments of the ministry moved out from Liu Pu Kang community, and constituted PetroChina Limited Liability Company in 2000; and 3. The original Chinese Ministry of Petroleum headquarter moved to Dongzhimen District, and the PetroChina Economic Strategy Institute moved into Liu Pu Kang community in 2010. Before Housing Reform in 1998, the houses of Liu Pu Kang community were only provided to the employees of the three work units by housing-welfare allocation. After Housing Reform, some residents sold or rented out their Danwei houses and purchased free market houses in suburban areas. Meanwhile, numerous non-Danwei employed residents purchased Danwei housing through the housing market. After Housing Reform, the job and housing patterns of residents in Liu

Pu Kang community included two situations: 1. Residents employed by the three work units and lived in Danwei houses; and 2. Residents lived in Danwei houses but were not employed by the three work units.

Figure 9 Residential Buildings in Liu Pu Kang Community



Note: Left-residential buildings constructed in the 1950s; Middle- residential buildings constructed in the 1980s; Right-residential buildings constructed in the 1990s.
Source: the author

The residential buildings in the Liu Pu Kang community were constructed in three periods: 1. During the construction period in the 1950s, Soviet Union architects designed and constructed a large amount of residential buildings with four floors; 2. Several residential buildings with a brick-concrete structure were constructed in the 1980s; and 3. Partial brick-concrete structure residential buildings were destructed and rebuilt to high-rise residential buildings with reinforced concrete structures between 1997 to 2000 (Fig.9).

The land use of Liu Pu Kang community is highly mixed-use and self-sufficient. The land use composition of the community is composed of residential, office, service, and commercial areas. The base area of construction of residential buildings is 53% of the total base area of construction; the base area of construction of office buildings is 18% of the total base area of construction; the base area of construction of service facilities is 17% of the total base area of construction; and the base area of construction of

commercial facilities is 12% of the total base area of construction. The community service facilities includes one daycare center, one elementary school, one middle school, one high school, one recreation center and one medical care center. The commercial buildings include two super markets and several retail shops in the bottom floor of residential buildings.

Compared with traditional Danwei communities, the Liu Pu Kang community is not enclosed by a wall. The whole community is divided into 15 blocks, and each block is enclosed by block wall and skirt buildings. The road network of Liu Pu Kang community does not follow the conventional principle of road network planning. The road network is composed by four north-south roads and five east-west roads with two one-way shunt pattern rather than sealed internal circuit. Extraneous traffic is allowed to pass through the community.

Figure 10 Liu Pu Kang Community Site Plan



Source: the author

3.3. Sun Palace Community Case Study

The Sun Palace community is the non-Danwei community sample. The Sun Palace residential community is located at the south side of the north-east part of the fourth ring road. The distance from the community to the central area of Beijing is about 2.24 mile. The site area of the community is 14.1 hectares; the floor area ratio is 2.21; the building density is 0.15; and the landscaping ratio is 0.51. The Sun Palace residential community was constructed in the 2000s. Compared with the traditional and semi-Danwei community, the Sun Palace community was a new type of residential community driven by the new established free housing market (Fig.9). The land use composition of the community is consisted of three parts: residential, service, and commercial areas. The base area of construction of residential buildings was 75% of the total base area of construction; the base area of construction of commercial buildings was 17% of the total base area of construction; and the base area of construction of service facilities was 8% of the total base area of construction. The community is enclosed by walls, entrance guard, skirt buildings, and is separated from the surrounding area.

Figure 11 Residential Buildings of Sun Palace Community



Source: Baidu Image, 2016

The Sun Palace community is a modern residential community. Developers purchase properties through competitive bids, and construct the community through

business cooperation. Residents of the community purchase or rent houses from the free housing markets. Residents of the Sun Palace community have different work units and various social backgrounds.

Table 3 Three Case Communities Site Area Characteristics

	Bei Ji Si Sanatorium	Liu Pu Kang Community	Sun Palace Community
Length of the Community (ft)	1,755.00	2,005.00	1552
Width of the Community (ft)	1,568.00	2,843.00	1469
Site Area (ft^2)	2,459,897.00	5,345,502.00	1,513,616.00
Base Area of Construction (ft^2)	1,106,954.00	3,528,031.00	233,641.00
Total Building Area (ft^2)	2,193,151.00	10,584,093.00	3,342,946.00
Building density	0.45	0.66	0.15
Floor Area Ratio	0.89	1.98	2.21
Landscaping ratio	0.46	0.26	0.51
Resident Population	3,972.00	14,239.00	6741

Figure 12 Sun Palace Community Site Plan



Source: the author

Chapter 4: Data Collection

The variables used in this research are composed of socio-economic factors, self-selection factors and commuting factors. Existing studies have proved that not only socio-economic factors but also self-selection factors affect the housing choice and commuting patterns of residents. This study assumes that different jobs and housing selection orders will result in various job-housing relations and commuting time as well. As a consequence, there will be two groups of variables for participants with different selection sequences.

4.1. Identification of Variables and Questionnaire Design

There are 21 variables within the job-housing selection order (participants find a job first and then find housing), and 13 variables within the housing-job selection order (participants find housing first and then find a job). To complement descriptive statistics, this study implements Structure Equation Model (SEM) for correlation analysis of the variables. 120 is the minimum acceptable sample size for a reliable SEM analysis. Consequently, the sample size of each case is 60, with a total sample size of 180 for the job-housing selection order scenario and 120 for the housing-job selection order scenario. To improve the efficiency and accuracy of the data, this research implements a questionnaire survey for data collection. The variables of this research include privacy information such as income, education background and age which may result in face validity problems. Questionnaire surveys have a high possibility to get the trust of participants, and encouraged them to provide real information than other direct inquiring methods.

4.1.1. Variables of Commuting and Relative Issues

The types of living community, job-housing relation, transport mode and commuting time are selected as the variables for the group of commuting factors within the job-housing selection order scenario. In the housing-job selection order scenario, type of living communities is replaced by types of work unit. Consistent with other transportation studies, this study selects commuting time to describe the commuting stratus of participants. It is easier for participants to recall their one-way travel time to work rather than travel distance with higher accuracy. This study divides the commuting time into five intervals including less than 15 minutes; 15 to 30 minutes; 30 to 60 minutes; 1 to 2 hours; and more than 2 hours. Participants just need to choose the correspondent interval rather than provide a specific number to avoid the potential bias caused by inaccurate memories.

The choice of transport mode is utilized to reflect the vehicle dependency of participants. The options of transport mode include walking, bicycling, bus and metro, taxi, and private vehicle.

Numerous existing studies have discussed the effect of job-housing balance on commuting time without agreement. In this study, working and living in the same community is defined as being job-housing balanced. Working and living not in the same community is defined as an imbalanced job-housing relation. Participants are required to describe their working and living status to measure the relationship between job-housing balance, vehicle dependency and commuting time.

Wang and Chai (2009) have demonstrated that Danwei housing residents represent more balanced job-housing relation. This research further divides Danwei

communities into traditional Danwei and semi-Danwei communities, and compares them with a non-Danwei community to measure the job-housing relation of participants within different types of living communities. Meanwhile, this study also assumes that various types of enterprises will result in different job-housing relations as well. In the housing-job selection order scenario, the type of work unit is categorized into a state-owned work unit, collective-owned work unit, cooperative company, joint ownership company, and Limited Liability Corporation.

4.1.2. Self-selection Variables

In the job-housing selection order scenario, self-selection variables reflecting the conditions of the three living communities including housing quality, distance to job, elementary school, daycare center, medical care center, recreation center, retail shop, environmental quality, open space, names remembered, and talk frequency. These factors are assumed to affect participants' choice of residential community, and further affect the commuting and related issues of residents. Wang and Li (2004) concluded that residents of Beijing prefer houses with better quality, closer distance to work places, and communities with higher living convenience. Housing quality in this study is defined as a comprehensive concept including the layout, size and condition of houses. The living convenience of Wang and Li's research describes the convenience of daily goods shopping in residential communities. This research expands the definition to include access to medical care centers, recreation centers, and retail shops. Distance to home is defined as the time cost of a one-way trip from home to the work place.

Education resource affects residents' attitudes to communities as well. The Hukou system in China makes education resource greatly affect residents' choices of housing. If the addresses of houses recorded in Hukou are located within the service radius of elementary schools or daycare centers, the children of the families are qualified to receive education in the schools or daycare centers. As a consequence, houses located within the service radius of "key" schools or daycare centers are welcomed by customers.

Giuliano (1991) demonstrates that neighborhood quality and quality of area parks also will affect residents' choice of housing and community. Based on the conclusion of Giuliano, this research assumes open space and environmental quality as influential factors as well.

Social life always occurs within or around living and working areas, and forms sense of belonging which provide residents a common frame of reference for daily life (Bjorklund, 1986). Sense of belonging makes residents feel safe which also may affect their choice of residential communities. This research evaluates the attitudes of participants to the sense of belonging by names remembered and talks frequency. Names remember describes how many names of their neighbors can participants recall. Talk frequency is defined as the average number of times that participants communicate with their neighbors in each month.

In the housing-jobs selection order scenario, distance to home, annual salary, career development and working hours are defined as the factors which decide residents' choice of employment opportunities, and further affect commuting and related issues. Distance to home is defined as the time cost of one-way travel from work places to

homes. Salary is the current annual income paid by the employed enterprise. Career development is defined as the promotion chances of salaries and positions. Working hours reflects the average total time for working required by the employed enterprises.

Participants of both selection order scenarios are required to evaluate the satisfaction and importance degrees of the factors about their living communities or employed enterprises. The degree of satisfaction describes the attitudes of residents to the condition of the communities they currently live or within their employed enterprises. It reflects the advantages and weakness of the cases. The satisfaction scale is divided into five categories including Very Satisfied, Satisfied, Normal, Unsatisfied and Very Unsatisfied.

Importance degree represents the priority of residents to the attributes when purchasing new houses or find employment opportunities. Importance degrees are divided to Very Important, Important, Normal, Unimportant and Very Unimportant. Factors with lower satisfaction degrees may be evaluated with higher importance degree. The combination between satisfaction and importance degrees reflects the relationship between the attitudes and requirements of participants to the attributes. This research aims at comprehensively analyzing how the attitudes and requirements of residents affect their choices of housing and employed enterprises, and further affect the commuting times.

4.1.3. Socio-economic Variables

Hegedus (1987) finds that occupation, education background and income are significant predictors of residents' housing choice either in state directed or market

economies. Logan and Bian (1993) conclude that housing committees of conventional Danwei established a formal point system based on marital status and age. Employees of conventional Danwei were ranked for housing allocation. Sermons and Koppelman (2001) demonstrate that gender will affect residents' choice of housing due to the household power structure, localized recruitment strategies and household maintenance activities as well. According to the existing studies, age, gender, marital status, education background, income and occupation are selected as the socio-economic variables of this research. This research assumes that socio-economic factors not only affect participants' choices of living community but also employment opportunities. Marital status is divided to single, married and other status. Educational background is categorized to bachelor, master, Ph. D., high school, and other status. Occupation is categorized into state-owned work unit, collective-owned work unit, cooperative company, joint ownership company, and Limited Liability Corporation. In housing-job selection order scenario, occupation is removed from socio-economic variables, and transferred to commuting related issues became type of work unit.

Age, marital status, education background and income are privacy information. Participants may provide inaccurate information to conceal the real situation for self-protection. In order to reduce the vigilance and avoid face validity problems, question about these four variables are located at the end of the questionnaire.

4.2. Sampling Strategy

A random sampling approach was implemented for sample selection. Families of the three communities were ordinally coded. There are a total of 1,324 families in the

Bei Ji Si Sanatorium, 4,746 families in the Liu Pu Kang community, and 2,247 families in the Sun Palace community. The sample size of each community is 60 for both selection order scenarios. There are totally 180 samples in job-housing selection order scenario. In housing-job selection order scenario, the traditional Danwei community is excluded from the sample selection, because this community still maintains a housing allocation mechanism. If a resident wants to live in traditional Danwei housing, he or she must be employed by the Danwei first and then apply for housing. In other words, the selection order of traditional Danwei residents must be finding jobs first and then find houses. As a consequence, the samples of housing-job selection order scenario are composed by residents of Liu Pu Kang community and Sun Palace community. There are 120 samples in housing-job selection order scenario.

During the data collection process, 60 families were randomly selected from each community at first. In the second round of data collection, the 60 families are removed from the total samples. The number of the second round random sampling was equal to the number of the families which refused to participate in the research during the first round. This process was repeated until enough valid samples were collected.

4.3. Knock Door Visiting and Questionnaire Survey

Following the result of the random sampling strategy, the author implemented a "knock door visit" to each selected family. In order to get participation permission and earn the trust of the participants, the author provided the survey consent forms and student ID at the beginning of the visit. The survey consent form clearly introduces the research background, legal rights of participants, time cost, compensation, approval date

and number of the research, and the contact information of Institutional Review Board. With the introduction of survey consent, the researcher was able to gain more trust from participants, and encourage participants to provide accurate and private information.

In order to avoid face validity problems, all the participants were informed that identifiable information such as names, addresses and phone numbers will not appear in the research. Additionally, they were informed that all the collected data will be destroyed when the research is completed. These survey preparations reduced the precaution consciousness of participants, and encouraged them to provide real information.

If participants agreed to join the research, they were provided the opportunity to participate through a paper-based questionnaire, Word-based questionnaire, or online questionnaire survey. Online questionnaires offer participants more comfort in providing sensitive information, with the aim of reducing validity problems. Anonymous data collection alleviates the fear of privacy information disclosure. The online questionnaire survey is accessed through Qualtrics website in the United States. Participants in Beijing may load the online survey slowly. Word-based questionnaire is an alternative option for participants who are not able to load the webpage quickly. Word-based questionnaire are collected through e-mail. Paper-based questionnaire is offered to the participants who are not able to use computers. Participants were required to finish the questionnaire during the knock door visit if they select paper-based questionnaire survey.

Chapter 5: Descriptive Statistic

In an attempt to efficiently measure and compare variables, all of the ordinal variables were coded during the data processing period. There are six socio-economic factors. Age (*AG*) and income (*IN*) are regarded as continuous variables. Gender (*GE*) is divided into male coded as "1," and female coded as "2." Marital status (*MS*) has 3 categories. Married is coded as "1;" single is coded as "2;" and other status is coded as "3." Education (*ED*) is divided into 5 levels: Ph. D. is coded as "1;" master is coded as "2;" bachelor is coded as "3;" High school is coded as "4;" other education background is coded as "5." Occupation is coded based on the attributes of the work units and companies. State-owned work unit is coded as "1;" collective-owned work unit is coded as "2;" cooperative is coded as "3;" joint ownership company is coded as "4;" and Limited Liability Corporation is coded as "5."

Self-selection variables within the job-housing selection order scenario are composed by housing quality (*HQ*), distance to job (*DJ*), elementary school (*ES*), daycare center (*DC*), medical care center (*MC*), recreation center (*RC*), retail shop (*RS*), open space (*OS*), environmental quality (*EQ*), names remembered *(NR*) and talk frequency (*TF*). Self-selection variables within the housing- job selection order scenario includes distance to home (*DH*), salary (*SA*), career development (*CD*), and working hours (*WH*). Participants were required to evaluate the degree of satisfaction and importance of each of the self-selection variables with the degree of satisfaction is divided into five levels: Very satisfied was coded as "1;" satisfied as "2;" normal as "3;" unsatisfied as "4;" and very unsatisfied as "5." Degree of importance respondents placed on various community attributes was similarly categorized. Very important was

coded as “1;” important as “2;” normal as “3;” unimportant as “4;” and very unimportant as “5.” The name remembered and talk frequency variables in their community reflect the attitudes of participants to the sense of belonging. Names remember has two categories: those responds they remember more than 10 names of neighbors was coded as “1;” and remember less than 10 names of neighbors was coded as “2.” The coding of talk frequency was based on the number of times respondents spoke with neighbors each month of talking per month. There are five intervals of talk frequency: 0 times per month was coded as “1;” 1 time per month was coded as “2;” 2 to 4 times per month was coded as “3;” 5 to 10 times was coded as “4;” and more than 10 times per month was coded as “5.” The importance evaluations of names remembered and talk frequency are the same as the other self-selection variables.

Commuting and related attributes include job-housing relation (*JHR*), transport mode (*TM*), and commuting time (*CT*). Job-housing relation is divided into a balanced code as “1,” and imbalanced coded as “2.” The transport mode has five categories: walking was coded as “1;” bicycling as “2;” bus and metro as “3;” taxi as “4;” and private car as “5.” Commuting time was also divided into five intervals: less than 15 minutes was coded as “1;” 15 to 30 minutes as “2;” 30 to 60 minutes as “3;” 1 to 2 hours as “4;” and more than 2 hours coded as “5.”

5.1. Job-housing Selection Order Scenario

There are more females (58.33%) than males (41.67%). The majority (58.89%) are between 20 and 30 years old, with 31.67% of participants among respondents between 31 and 50 years old. The other 9.44% of respondents were between 51 and 60

years old. 25% of the participants are single, with 71% of the participants being married. In terms of household structure, 25 % of participants are from single worker families. 65.55% of participants are from two-worker families, and employed by different enterprises from their partners. 9.45% of participants are from two-worker families, and employed by the same enterprises with their partners. There are more participants that have achieved bachelor degrees or higher (73.89%) than participants with only a high school education background (26.11%). In terms of income, 62.78% of participants' annual incomes are between 100,000 and 300,000 RMB. 33.89% of participants' annual incomes were lower than 100,000 RMB, and only 6.66% of participants' annual incomes were higher than 300,000 RMB. 77.22% of participants are employed by stated-owned or collective-owned work units with the remaining 22.78% employed by other types of enterprises.

5.1.1. Commuting Time

Table 4 describes the commuting status within the three types of communities. Additionally, it compares the percentage of participants by the interactions between commuting time, job-housing relation and transport mode in the three communities.

According to Table 4, the average commuting time of traditional and semi-Danwei communities do not display a large difference. Whereas the average commuting time of respondents within the non-Danwei community is about three times longer than the traditional and semi-Danwei communities. Participants of traditional and semi-Danwei communities have shorter commuting time than non-Danewi communities. More than 90% of participants with commuting time less than 30 minutes use non-

motorized vehicle for commuting in traditional and semi-Danwei communities, and more than 65% of residents in the non-Danwei community. Meanwhile, more than 95% of participants who commute more than 30 minutes use motor vehicle for commuting in the three types of communities. The data suggests that commuting by non-motor vehicles is correlated with reducing commuting times.

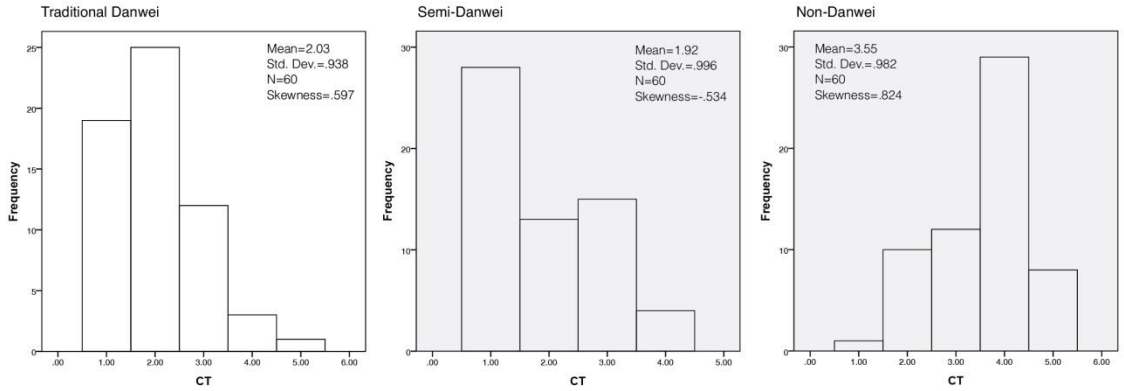
Table 4 Commuting Status of Jobs – housing Selection Order Scenario

	Traditional Danwei	Semi-Danwei	Non-Danwei
ACT (min)	25.6	27.8	76.4
CT < 30 & NMV (%)	61.7	70	13.3
CT < 30 & MV (%)	6.7	3.3	6.7
CT > 30 & NMV (%)	0	0	1.7
CT > 30 & MV (%)	31.6	26.7	78.3
CT < 30 & JHB (%)	68.3	70	0
CT < 30 & JHI (%)	0	3.3	18.3
CT > 30 & JHB (%)	1.7	0	0
CT > 30 & JHI (%)	30	26.7	81.7

Note: ACT: average commuting time; *CT:* commuting time; *NMV*: non-motor vehicle commuting; *MV*: motor vehicle commuting; *JHB*: balanced job-housing relation; *JHI*: imbalanced job-housing relation. *JHI* and *JHB* in the rest of tables have the same meaning

Participants within traditional and semi-Danwei communities display a more balanced job-housing relationship than those residing in the non-Danwei community (Table 4). In traditional and semi-Danwei communities, more than 95% of participants with balanced job-housing relation commute less than 30 minutes. Instead, almost 95% of participants with imbalanced job-housing relation commute more than 30 minutes in three types of communities. The result indicates that job-housing balance contributes to reduce commuting times.

Figure 13 Distribution of Commuting Time (person)



Note: 1: <15 min; *2*: 15-30 min; *3*: 30-60 min; *4*: 1h-2h; *5*: >2h

5.1.2. Transport Mode

Table 5 describes participants' choices of transport modes in the three types of communities. In order to accurately reflect vehicle dependency, table 5 makes further comparisons between the vehicle dependencies of the three communities based on the ownership of a private vehicle. Meanwhile, it helps to represent the influence of the job-housing relations on vehicle dependency.

According to Figure 14, more than 60% of participants in traditional and semi-Danwei communities use non-motor vehicles for commuting. Meanwhile, more than 25% of participants within the traditional Danwei community and almost 35% of participants of the semi-Danwei community who use non-motorized vehicles for commuting have private vehicles. Nonetheless, 15% of participants with private vehicles in the non-Danwei community use non-motorized vehicles for commuting. Participants within the traditional and semi-Danwei community represent lower vehicle dependency than the non-Danwei community.

Table 5 Transport Mode of Jobs – housing Selection Sequence

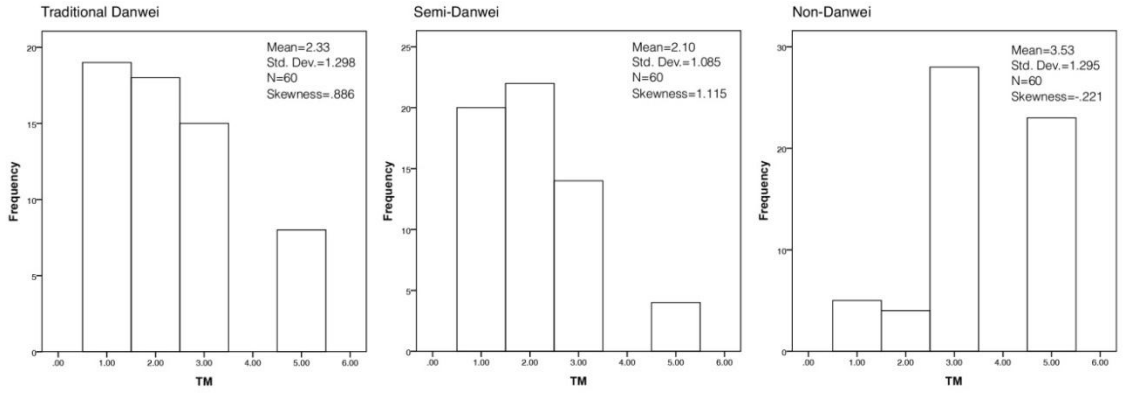
	Traditional Danwei	Semi-Danwei	Non-Danwei
NMV & JHB (%)	61.7	70	0
NMV & JHI (%)	0	0	15
MV & JHB (%)	8.3	0	0
MV & JHI (%)	30	30	85
NMV & PV (%)	26.7	33.3	5
PT (%)	25	23.3	46.7
PT & PV (%)	10	13.33	16.7
PV (%)	13.3	6.7	38.3

Note: NMV: non-motor vehicle commuting; *MV*: motor vehicle commuting; NMV & PV: participants use non-motor vehicle and have private vehicle; PT: participants use public transportation; *PT & PV*: participants use public transportation and have a private vehicle; *PV*: participants use private vehicle for commuting

In traditional and semi-Danwei communities, almost 90% of participants with a balanced job-housing relation use non-motorized vehicle for commuting. On the contrary, more than 85% of participants with imbalanced job-housing relation use motorized vehicle for commuting in the three types of communities. The data suggests that job-housing balance contributes to reduced vehicle dependency. Additionally, traditional Danwei and semi-Danwei communities provide residents more balanced job-housing relation than non-Danwei community.

Among participants within the three communities who use motorized vehicles for commuting, 65% of participants live in traditional Danwei; more than 75% of participants live in semi-Danwei community; and about 55% of participants use bus or metro for commuting. More than 40% of the participants who select public transportation for commuting have private vehicles in the semi-Danwei community. Compared with the other two communities, Participants who reside in the semi-Danwei community reflect a higher preference for public transportation than private vehicles.

Figure 14 Distribution of Transport Mode (person)



Note: 1: walking; *2*: bicycling; *3*: bus and metro; *4*: taxi; *5*: private vehicle

5.1.3. Housing Quality

Table 6 reflects the relationship between the degree of satisfaction respondents have with housing quality and their job-housing relation. More than 65% of participants who respond "normal", "unsatisfied" or "very unsatisfied" with their housing quality have a balanced job-housing relation. On the contrary, more than 90% of participants who are "satisfied" or "very satisfied" with their housing quality have an imbalanced job-housing relation. Over 90% of participants feel normal, unsatisfied or very unsatisfied as to their housing quality lived in traditional and semi-Danwei communities. Satisfaction degree of housing quality in non-Danwei community is relatively higher.

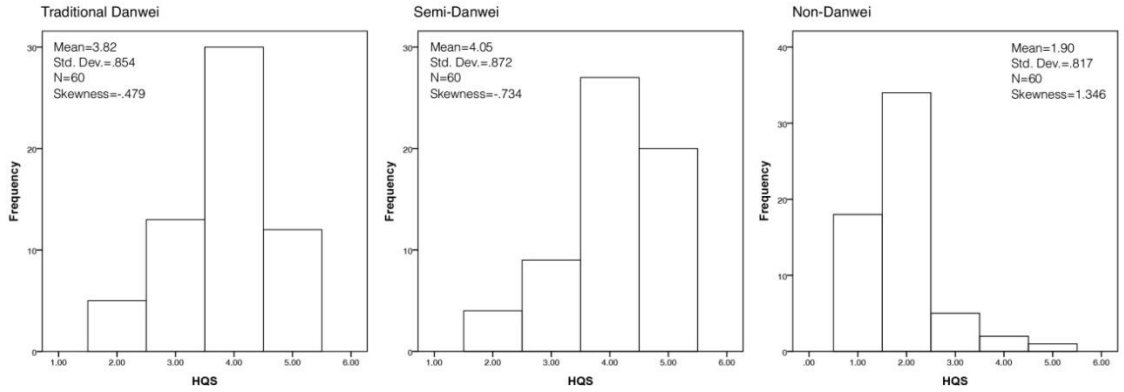
Table 6 Satisfaction Degree of Housing Quality

	Traditional Danwei	Semi-Danwei	Non-Danwei	Total
HQS & JHB (%)	3.3	5	0	2.8
HQU & JHB (%)	66.7	65	0	43.9
HQS & JHI (%)	5	1.7	86.7	31.1
HQU & JHI (%)	25	28.3	13.3	22.2

Note: HQS: satisfied or very satisfied to housing quality; *HQU*: normal, unsatisfied or very unsatisfied to housing quality

Fig.15 indicates that the average degree of satisfaction with housing quality is about 4.00 (unsatisfied) in traditional and semi-Danwei communities. Meanwhile, the average degree is close to 2.00 (satisfied) in the non-Danwei community indicating a high degree of satisfaction with housing quality in the non-Danwei community

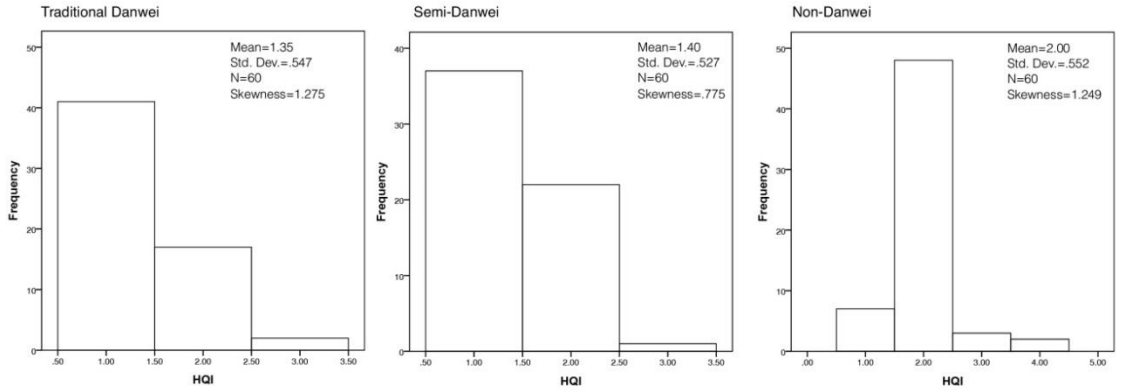
Figure 15 Distribution of Housing Quality Satisfaction Degree (person)



Note: *1*: Very Satisfied; *2*: Satisfied; *3*: Normal; *4*: Unsatisfied; *5*: Very Unsatisfied
The rest of figures about the degrees of satisfaction have the same codes

Among the 180 respondents, the average degree of importance placed on housing quality is 1.58. The general effect of housing quality on residents' choices of housing is located between important and very important. Fig.16 indicates that the influence of housing quality on residents' choices of housing is very important in traditional and semi-Danwei communities, and important in non-Danwei community. Residents of traditional and semi-Danwei communities have a stronger sentiment about the role of housing quality than those in the non-Danwei community. Meanwhile, the improvement of housing quality will attract more residents to purchase traditional and semi-Danwei housing.

Figure 16 Distribution of Housing Quality Importance Degree (person)



Note: 1: Very Important; *2*: Important; *3*: Normal; *4*: Unimportant; *5*: Very Unimportant
The rest of figures about the degrees of importance have the same codes

5.1.4. Distance to Job

Table 7 represents the relationship between the degree of satisfaction between distance to job and job-housing relation. Almost 75% of participants who feel satisfied or very satisfied to their distance to employment location a have balanced job-housing relation. In converse, all of the participants who indicate a normal, unsatisfied or very unsatisfied degree with their distance to a job have an imbalanced job-housing relation. Higher satisfaction to the distance to job is correlated with a more balanced job-housing relation. More than 90% of participants feel normal, unsatisfied or very unsatisfied with their distance to a job in the non-Danwei community. Degrees of satisfaction with distance to job in traditional and semi-Danwei communities are much higher than within the non-Danwei community.

According to Fig.17, the average degree of satisfaction with distance to a job is located between very satisfied and satisfied in traditional and semi-Danwei communities with the average degree among respondents within the non-Danwei community is 4.00 (unsatisfied). As table 4 indicated, residents of traditional and semi-

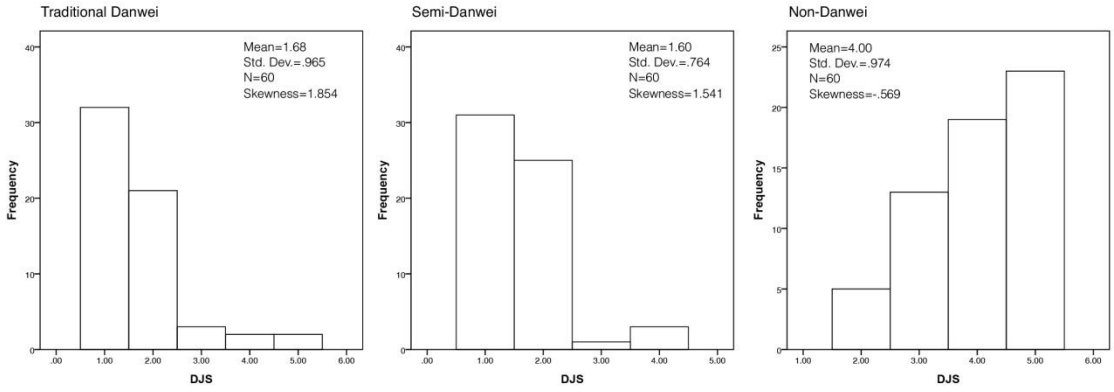
Danwei communities have shorter commuting distances and hence times than those in the non-Danwei community.

Table 7 Satisfaction Degree of Distance to Job

	Traditional Danwei	Semi-Danwei	Non-Danwei	Total
DJS & JHB (%)	70	70	0	46.7
DJU & JHB (%)	0	0	0	0
DJS & JHI (%)	18.3	23.3	8.3	16.6
DJU & JHI (%)	11.7	6.7	91.7	36.7

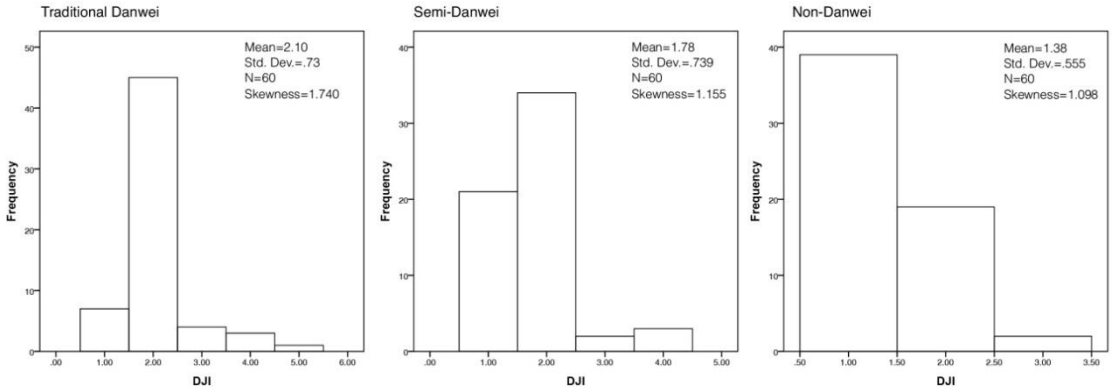
Note: DJS: satisfied or very satisfied to the commuting distance to work place; *DJU*: normal, unsatisfied or very unsatisfied to the commuting distance to work place

Figure 17 Distribution of Distance to Job Satisfaction Degree (person)



The average degree of importance placed by the 180 respondents is 1.75. The influence of distance to a job on residents' choices of housing is close to important. Fig.18 indicates that distance to a job plays more important role to affect residents' choice of housing in the non-Danwei community. Residents of the non-Danwei community place a higher requirement on reduce daily commuting times. Non-Danwei community residents prefer to live in traditional or semi-Danwei communities due to a shorter commuting distance to work places.

Figure 18 Distribution of Distance toJob Importance Degree (person)



5.1.5. Elementary School

Table 8 displays the relationship between the degree of satisfaction with elementary schools and job-housing relations. More than 65% of participants who feel satisfied or very satisfied with their elementary schools have a balanced job-housing relation. Almost 85% of participants who respond normal, unsatisfied or very unsatisfied as to their elementary schools have an imbalanced job-housing relations. Higher satisfaction with elementary schools is associated with a more balanced job-housing relation. Almost 90% of participants indicate normal, unsatisfied or very unsatisfied opinions as to the elementary school in the non-Danwei community where as more than 85% of participants are very satisfied or satisfied to the elementary schools in traditional and semi-Danwei communities.

Fig.19 displays that the average degree of satisfaction with elementary schools is about 2.00 (satisfied) in traditional and semi-Danwei communities and close to 4.00 (unsatisfied) in the non-Danwei community. Elementary schools within the traditional and semi-Danwei communities are viewed more favorably than elementary schools in the non-Danwei community.

Table 8 Satisfaction Degree of Elementary School

	Traditional Danwei	Semi-Danwei	Non-Danwei	Total
ESS & JHB (%)	58.3	63.3	0	40.5
ESU & JHB (%)	11.7	6.7	0	6.1
ESS & JHI (%)	26.7	23.3	11.7	20.6
ESU & JHI (%)	3.3	6.7	88.3	32.8

Note: ESS: Satisfied or Very Satisfied to the elementary school; *ESU*: Normal, Unsatisfied or Very Unsatisfied to the elementary school

Figure 19 Distribution of Elementary School Satisfaction Degree (person)

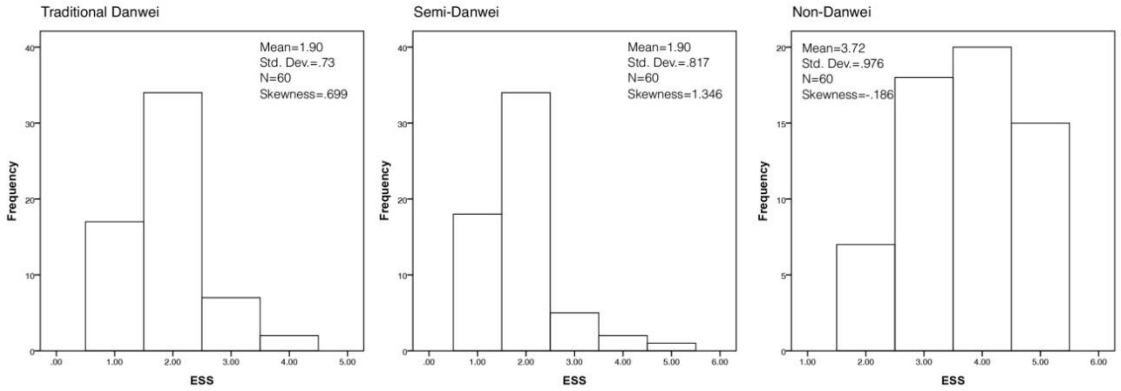
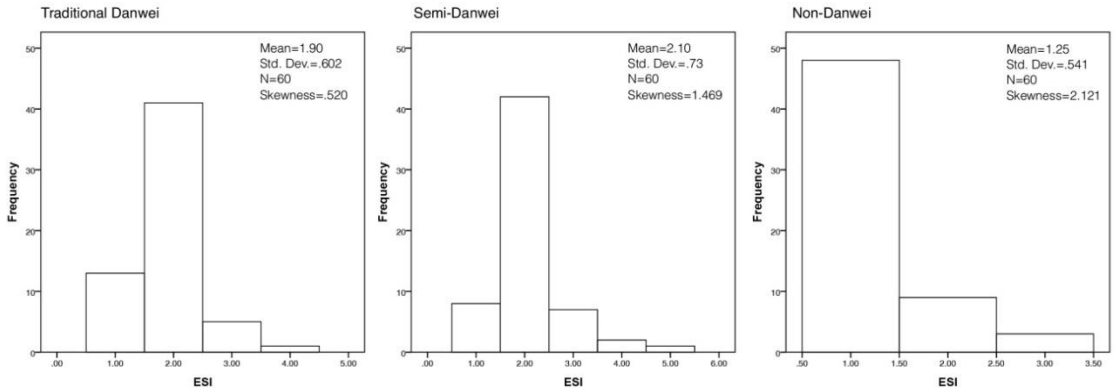


Figure 20 Distribution of Elementary School Importance Degree (person)



The average degree of importance place on the role of elementary schools among the 180 samples is 1.75. The general effect of elementary school on residents' choices of housing is located between important and very important. Fig. 20 indicates

that the influence of elementary school on a residents' choice of housing is important in the traditional and semi-Danwei communities, and very important in the non-Danwei community. Residents of the non-Danwei community indicate a stronger requirement of a better elementary school than traditional and semi-Danwei communities. Non-Danwei residents may prefer to move in traditional or semi-Danwei communities for better elementary schools for their children.

5.1.6. Daycare Center

Table 9 presents the relationship between the degree of satisfaction between the existence of a daycare center and the job-housing relation. Almost 65% of participants who feel satisfied or very satisfied with available the daycare centers have a balanced job-housing relation. More than 85% of participants who respond they feel normal, unsatisfied or very unsatisfied with the daycare centers have an imbalanced job-housing relation. The improvement of satisfaction to daycare centers is correlated with a more balanced job-housing relation. More than 75% of participants feel normal, unsatisfied or very unsatisfied with the daycare center in the non-Danwei community. Whereas more than 80% of participants are very satisfied or satisfied with the daycare centers in traditional and semi-Danwei communities.

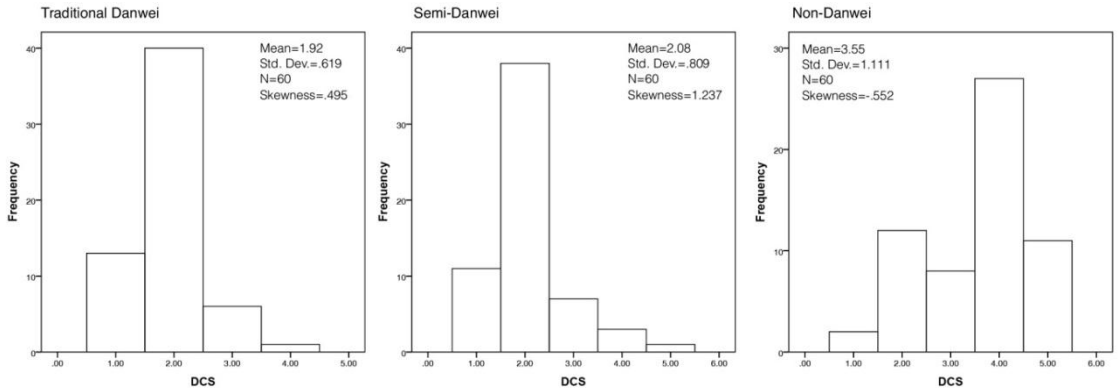
Table 9 Satisfaction Degree of Daycare Center

	Traditional Danwei	Semi-Danwei	Non-Danwei	Total
DCS & JHB (%)	60	65	0	41.7
DCU & JHB (%)	10	5	0	5
DCS & JHI (%)	28.3	16.7	23.3	22.8
DCU & JHI (%)	1.7	13.3	76.7	30.5

Note: DCS: Satisfied or Very Satisfied to the daycare center; *DCU*: Normal, Unsatisfied or Very Unsatisfied to the daycare center

Fig. 21 represents that the average degree of satisfaction with the daycare centers is about 2.00 (satisfied) in traditional and semi-Danwei communities, and the average degree is between normal and unsatisfied in the non-Danwei community. Daycare center of traditional and semi-Danwei community is better than non-Danwei community.

Figure 21 Distribution of Daycare Center Satisfaction Degree (person)



The average degree of importance placed on daycare center of the 180 samples is 2.23. The general influence of daycare center on residents' choices of residential community is about important. Fig. 22 displays that the effect of daycare center on residents' choices of residential community is between important and normal in traditional and semi-Danwei communities, and important in the non-Danwei community. Residents among the non-Danwei community indicate a higher degree of importance on daycare center quality.

5.1.7. Talk Frequency

Table 10 displays the relationship between talk frequency and job-housing relation. More than 65% of participants who respond they speak with neighbors more than 10 times each month have balanced job-housing relations. On the contrary, almost

80% of participants who talk with neighbors more than 10 times each month have imbalanced job-housing relations. Residents who report a higher talk frequency with neighbors have more balanced job-housing relations. Almost 70% of participants' talk frequencies are larger than 10 in traditional and semi-Danwei communities. Residents of traditional and semi-Danwei communities display a higher talk frequency than those within non-Danwei community.

Figure 22 Distribution of Daycare Center Importatnce Degree (person)

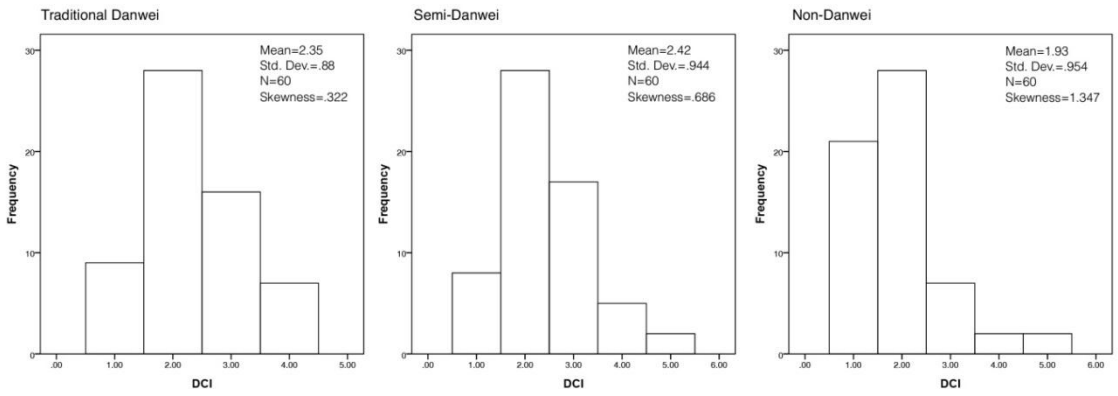


Table 10 Talk Frequency

	Traditional Danwei	Semi-Danwei	Non-Danwei	Total
TF > 10 & JHB (%)	51.7	60	0	37.2
TF < 10 & JHB (%)	18.3	10	0	9.4
TF > 10 & JHI (%)	16.7	23.3	13.3	17.8
TF < 10 & JHI (%)	13.3	6.7	86.7	35.6

Note: TF: monthly talk frequency

Fig. 23 displays that the influence of talk frequency on a residents choice of community is important in non-Danwei and semi-Danwei communities. The influence of talk frequency importance in the traditional Danwei is located between important and normal. Residents of non-Danwei and semi-Danwei communities indicate a stronger requirement to communicate with neighbors than the traditional Danwei community.

Figure 23 Distribution of Talk Frequency Importance Degree (person)

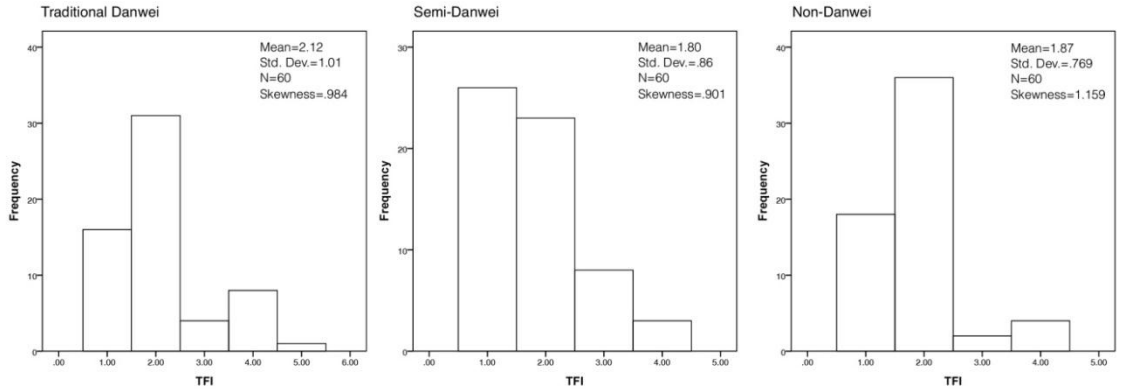


Table 11 displays the Pearson correlation coefficient between self-selection and socio-economic variables. Participants with lower incomes, younger in age, or employed by Limited Liability Corporation or joint ownership company have stronger requirements for housing quality improvements. Participants employed by Limited Liability Corporations or joint ownership companies, or with lower levels of education prefer shorter distance to work places and better elementary school for their children. Females report a higher requirement for the existence of a daycare center. Participants with lower annual income and education background, employed by Limited Liability Corporation or joint ownership companies place a higher degree of importance of talk frequency as to their choice of a residential community.

Table 11 Correlation between Self-selection and Socio-economic factors

	Income	Education	Occupation	Gender	Age
Housing Quality	-1.54*	-	0.267**	-	-0.165*
Distance to home	-	-0.241**	-0.264**	-	-
Elementary school	-	-0.300**	-0.155*	-	-
Daycare center	-	-	-	-0.149*	-
Talk Frequency	-0.172*	0.190*	-0.153*	-	-

Note: **: significant at 0.01 level; *: significant at 0.05 level; -: not significant

According to the descriptive statistics of the job-housing selection order scenario, the data suggests that the quality of elementary schools and daycare centers, distance to job, and the sense of belonging in traditional and semi-Danwei community as compared to the non-Danwei community. On the other hand, residents of the non-Danwei community report a higher degree of satisfaction with their housing quality. As a consequence, residents of traditional and semi-Danwei communities have higher degree of importance on the improvement of housing quality. Residents of non-Danwei community prefer better improvement in elementary school and daycare center, shorter commuting distance to job, and a stronger sense of belonging. This study assumes that residents who feel satisfied with their elementary schools, daycare centers, distance to employment, and talk frequencies have a higher propensity to live in traditional and semi-Danwei communities, which further results in a more balanced job-housing relation. Residents who feel satisfied with housing qualities have a higher propensity to live in the non-Danwei community, which results in an imbalanced job-housing relation.

The data also indicates that a more balanced job-housing relation is associated with reduced vehicle dependency and commuting times. As a consequence, residents of traditional and semi-Danwei communities have a lower vehicle dependency and shorter commuting times than those in the non-Danwei community.

5.2. Housing-job Selection Order Scenario

Table 8 represents the socio-economic factors of participants with housing-job selection order in semi-Danwei and non-Danwei communities. There are more male participants (51.67%) then female participants (48.33%). The majority (94.17%) is

between 20 and 30 years old. 5.83% of participants are between 31 and 50 years old. There is no participant elder than 50 years old. 86.67% of participants are single, and 13.33% of participants are married. In terms of household structure, 86.67% of participants are from single worker families. 12.49% of participants are from two-worker families, and employed by different enterprises from their partners. 0.84% of participants is from two-worker families, and employed by the same enterprises with their partners. 88.33% of participants get bachelor or higher degree. 11.67% of participants only finish high school education. In terms of income, 78.34% of participants' annual incomes are between 100,000 and 200,000 RMB. 10.83% of participants' annual incomes are lower than 100,000 RMB. 10.83% of participants' annual incomes are between 200,000 RMB and 300,000 RMB. 40.83% of participants are employed by stated-owned or collective-owned work units. 18.34% of participants are employed by other types of enterprises. 40.83% of participants are employed by other types of enterprises.

5.2.1. Commuting Time

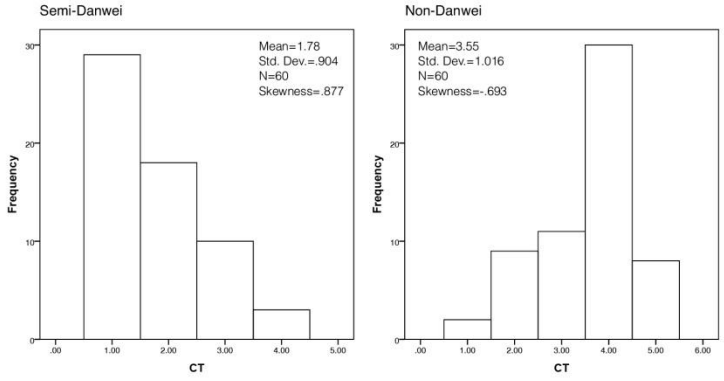
Table 12 reflects the relationship between commuting time, transport mode and job-housing relation in the two types of communities. The average commuting time of non-Danwei community is more than three times longer than semi-Danwei community. Almost 80% of participants with commuting time less than 30 minutes use non-motor vehicles for commuting in semi-Danwei community, but less than 40% of participants in non-Danwei community. On the contrary, more than 90% of participants commuting more than 30 minutes use motor vehicles for commuting in these two communities.

Table 12 Commuting Demands of Housing-job Selection Sequence

	Semi-Danwei Community	Non-Danwei Community
ACT (min)	22.4	76.9
CT < 30 & NMV (%)	61.7	6.7
CT < 30 & MV (%)	16.7	11.6
CT > 30 & NMV (%)	1.6	0
CT > 30 & MV (%)	20	81.7
CT < 30 & JHB (%)	56.7	1.7
CT < 30 & JHI (%)	21.7	16.7
CT > 30 & JHB (%)	0	0
CT > 30 & JHI (%)	21.6	81.6

Compared with the non-Danwei community, participants of the semi-Danwei community illustrate a more balanced job-housing relation. All the participants with a balanced job-housing relation commute less than 30 minutes in these two communities. On the contrary, almost 85% of participants with an imbalanced job-housing relation commute more than 30 minutes in the non-Danwei community, but only 50% of participants in the semi-Danwei community. The results indicate that job-housing balance is associated with reduced commuting times. Nonetheless, the effect of a balanced job-housing relation on commuting times in the semi-Danwei community is crippled by contrast with the effect in the job-housing selection order scenario.

Figure 24 Distribution of Commuting Time (person)



5.2.2. Transport Mode

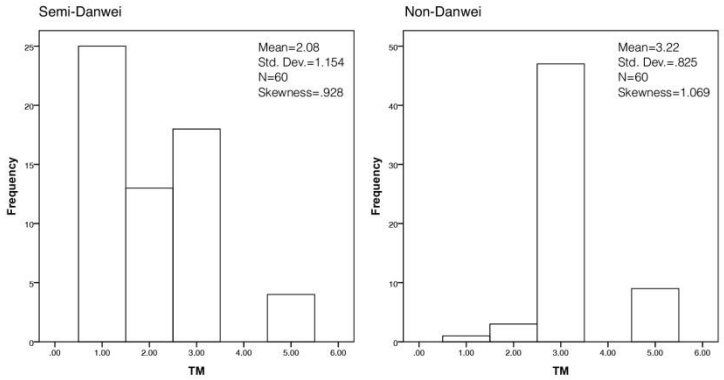
Table 13 reflects survey participants' preference of transport mode in the two types of communities. Table 13 provides a comparison between the vehicle dependencies of the two communities based on the private vehicle amount of private vehicle use, helping to illustrate the connection between job-housing relation and vehicle dependency.

Table 13 Transport Mode of Housing-job Selection Sequence

	Semi-Danwei Community	Non-Danwei Community
NMV & JHB (%)	56.6	1.7
NMV & JHI (%)	6.7	5
MV & JHB (%)	0	0
MV & JHI (%)	36.7	93.3
NMV & PV (%)	41.7	6.7
PT (%)	31.7	78.3
PT-PV (%)	16.7	50
PV (%)	6.7	15

All the participants with a balanced job-housing relation use non-motorized vehicles for commuting in the semi-Danwei and non-Danwei communities. On the contrary, more than 85% of participants with an imbalanced job-housing relation use motor vehicle for commuting in these two communities. The data suggests that a job-housing balance is associated with a lower degree of vehicle dependency. Meanwhile, the semi-Danwei community provides residents with a more balanced job-housing relation than the non-Danwei community. Among participants of the two communities who use motor vehicles for commuting, more than 80% of them use buses or metros for commuting. More than 30% of the participants who select public transportation for commuting own private vehicles.

Figure 25 Distribution of Transport Mode (person)



5.2.3. Distance to Home

Table 14 represents the relationship between the degree of satisfaction of distance to one's home and one's job-housing relation. All the participants with a balanced job-housing relation feel satisfied or very satisfied with their distance to home. On the contrary, more than 80% of participants with an imbalanced job-housing relation evaluate indicate they are normal, unsatisfied or very unsatisfied to the distance to work. Higher satisfaction with the distance to job is associated with a more balanced job-housing relation. More than 95% of participants feel normal, unsatisfied or very unsatisfied as to their distance to home in non-Danwei communities. The degree of satisfaction with the distance to home in the semi-Danwei community is much higher than that in the non-Danwei community.

Table 14 Degree of Satisfaction with Distance to Home

	Semi-Danwei Community	Non-Danwei Community	Total
DHS & JHB (%)	56.7	1.7	29.2
DHU & JHB (%)	0	0	0
DHS & JHI (%)	11.7	16.7	14.2
DHU & JHI (%)	31.6	81.6	56.6

Note: DHS: Satisfied or Very Satisfied to the commuting distance to home; *DHU*: Normal, Unsatisfied or Very Unsatisfied to the commuting distance to home

According to Fig. 26, the average degree of satisfaction with distance to job is about 2.00 (satisfied) in the semi-Danwei community. The average degree of non-Danwei community is located between normal and unsatisfied. Residents of the semi-Danwei community have shorter commuting distances to home than within the non-Danwei community.

The average degree of importance respondents to distance to home among the 120 samples is 1.69. The influence of distance to home on residents' choices of employment opportunity is between important and very important. Fig. 27 indicates that residents of the non-Danwei community have a higher degree of importance placed on reducing daily commuting distances to home than those in the semi-Danwei community.

Figure 26 Distribution of Distance to Home Degree of Satisfaction (person)

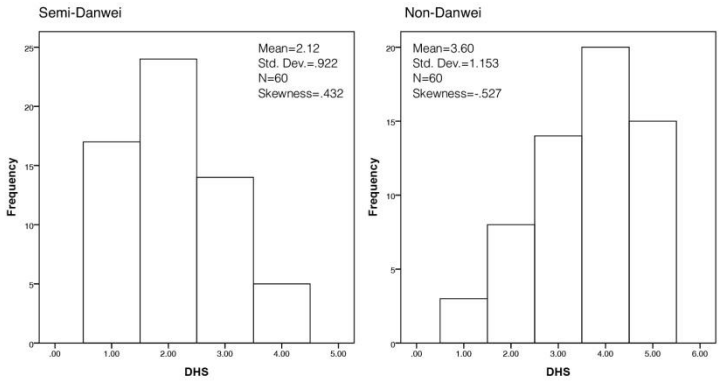
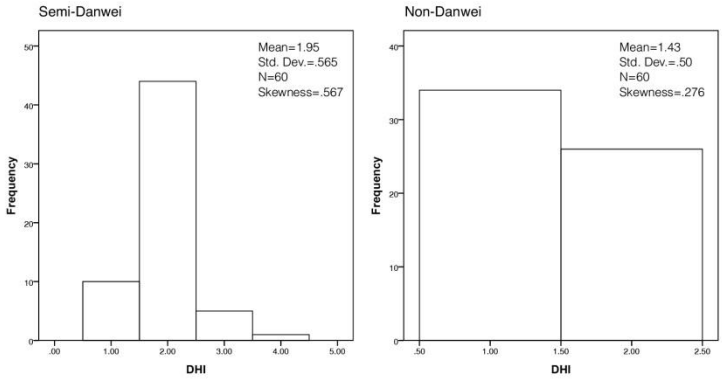


Figure 27 Distribution of Distance to Home Importance Degree (person)



5.2.4. Working Hours

Table 15 displays the association between the degree of satisfaction between the number of working hours and job-housing relation. Almost 90% of participants with a balanced job-housing relation feel satisfied or very satisfied with their working hours in the semi-Danwei community. Alternatively, about 55% of participants with an imbalanced job-housing relation are normal, unsatisfied or very unsatisfied with respect to the working hours in the non-Danwei community. Higher degrees of satisfaction with working hours is associated with a more balanced job-housing relation. 80% of participants indicate they are normal, unsatisfied or very unsatisfied as to the housing quality in non-Danwei communities. The degree of satisfaction with working hours in the semi-Danwei community is much higher than within the non-Danwei community.

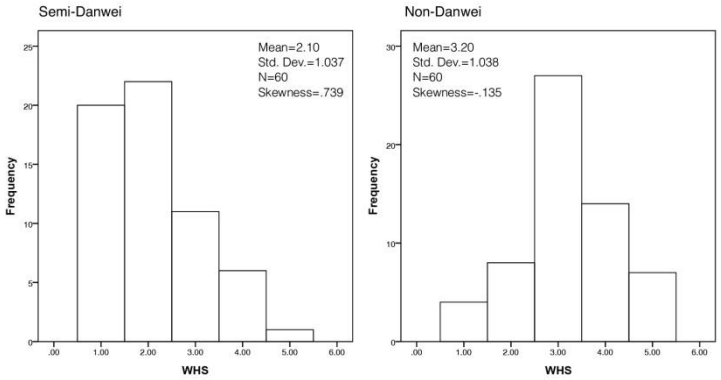
Table 15 Degree of Satisfaction with Working Hours

	Semi-Danwei Community	Non-Danwei Community	Total
WHS & JHB (%)	50	0	25
WHU & JHB (%)	6.7	1.7	4.2
WHS & JHI (%)	20	20	20
WHU & JHI (%)	23.3	78.3	50.8

Note: WHS: Satisfied or Very Satisfied to the working hours; *WHU*: Normal, Unsatisfied or Very Unsatisfied to the working hours

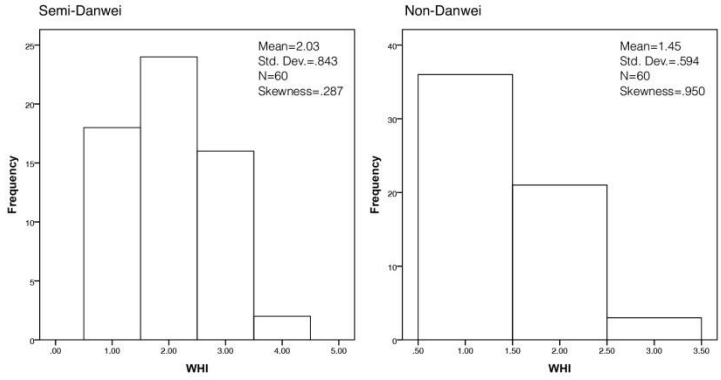
Fig. 28 reflects that the average degree of satisfaction of working hours is about 2.00 (satisfied) in semi-Danwei communities, and about 3.00 (normal) in the non-Danwei community indicating that residents of the semi-Danwei community are more satisfied with working hours than residents in the non-Danwei community.

Figure 28 Distribution of Working Hours Degree of Satisfaction (person)



The average degree of importance respondents placed on working hours of the 120 samples is 1.74. The general influence of working hours on residents' choices of employment opportunities is ranked as important. Fig. 29 indicates that residents of the non-Danwei community place a higher degree of importance on working hours than those within the semi-Danwei community.

Figure 29 Distribution of Working Hours Importance Degree (person)



According to the descriptive statistics, the relationship between job-housing relation, transport modes and commuting times is the same in the job-housing selection order scenario. Balanced job-housing relation facilitates a reduction in vehicle dependency and commuting times. Meanwhile, the descriptive statistics also indicate that higher degree of satisfaction with distance to home and working hours results in a

more balanced job-housing relation. Employees of state-owned work units represent a higher degree of satisfaction with distance to home and working hours than other types of enterprises.

Chapter 6: Methodology

There is increasing support of Structure Equation Mode for transportation research (Golob, 2003; Bollen, 1989; Wang and Law, 2007). It has been demonstrated that Structure Equation Mode is an appropriate method to measure and estimate the causality between exogenous variables and endogenous variables. It is also able to test the interrelationships between endogenous variables, a problem when working with socio-economic data.

According to the theoretical framework provided in Fig.30 and Fig.31, various socio-economic and self-selection factors are defined as exogenous variables, and commuting related issues are defined as endogenous variables. Only dichotomous and continuous variables are applicable when using SEMs and some of the included variables have been recoded into dichotomous variables.

There are six socio-economic factors classified as exogenous variables. Gender (*GE*) has two categories with male coded as "1," and female coded as "0." Marital status (*MS*) is also divided into a dichotomous variable with married coded as "1," and other status coded as "0." Education (*ED*) is separated into two groups with education levels having a bachelor or higher degree is coded as "1." Other level is coded as "0." Occupation (*OC*) is separated into two groups as well: participants employed by state-owned or collective-owned work units are coded as "1;" and those employed by other types of work units coded as "0." Age (*AG*) and income (*IN*) are treated as continuous variables.

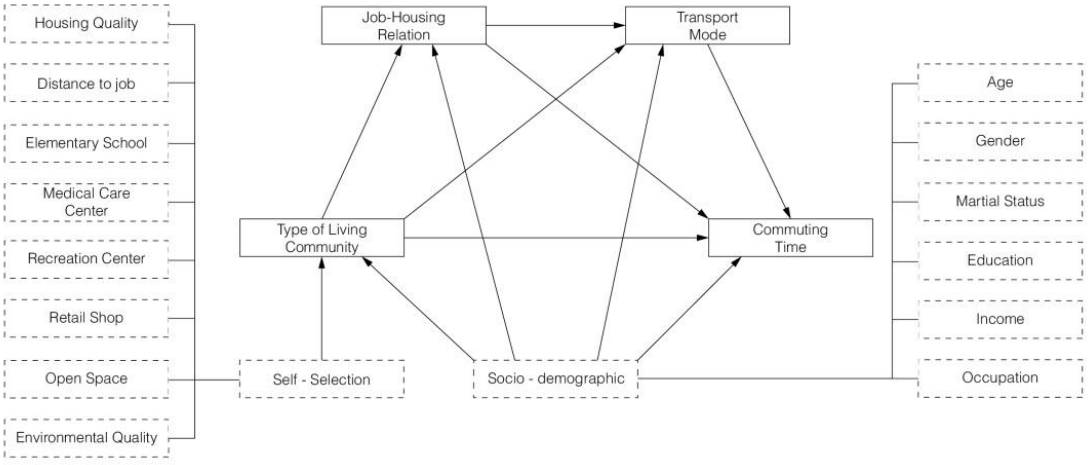
Self-selection factors are divided into two groups. One group is for the job-housing selection order scenario, and the other one is for housing-job selection order

scenario. In the job-housing selection order scenario, 11 categories are conducted for the SEM analysis including, housing quality (*HQ*), distance to job (*DJ*), elementary school (*ES*), daycare center (*DC*), medical care center (*MC*), recreation center (*RC*), retail shop (*RS*), sense of belonging, open space (*OS*) and environmental quality (*EQ*). With the exception of sense of belonging, the other nine factors are evaluated by residents into five levels including very satisfied, satisfied, normal, unsatisfied and very unsatisfied, with data collected directly from the survey. Very satisfied and satisfied evaluations were coded as "1." Normal, unsatisfied and very unsatisfied evaluations of categories are coded as "0." Sense of belonging is measured by two questions: whether you can recall 10 or more residents' name that live in the same community (*NR*); and whether you will talk with residents who live in the same community with you more than 10 times in a month (*TF*). If the answers for these two questions are yes, the answers were coded as "1." If the answers for these two question are no, the answers will be coded as "0." In the housing-job selection order scenario, four variables for the SEM were analyzed, including salary (*SA*), distance to home (*DH*), career development (*CD*) and working hours (*WH*). Similar to the factors in the job-housing selection order scenario, very satisfied and satisfied evaluations were coded as "1." Normal, unsatisfied, and very unsatisfied evaluation are coded as "0."

Types of living community (*TLC*), type of work unit (*TWU*), job-housing relation (*JHR*), travel mode (*TM*) and commuting time (*CT*) are defined as the endogenous variables with these classified into two groups according to according to which ordered scenario was chosen. In the job-housing selection order scenario, types of living community has two categories, with traditional Danwei and semi-Danwei

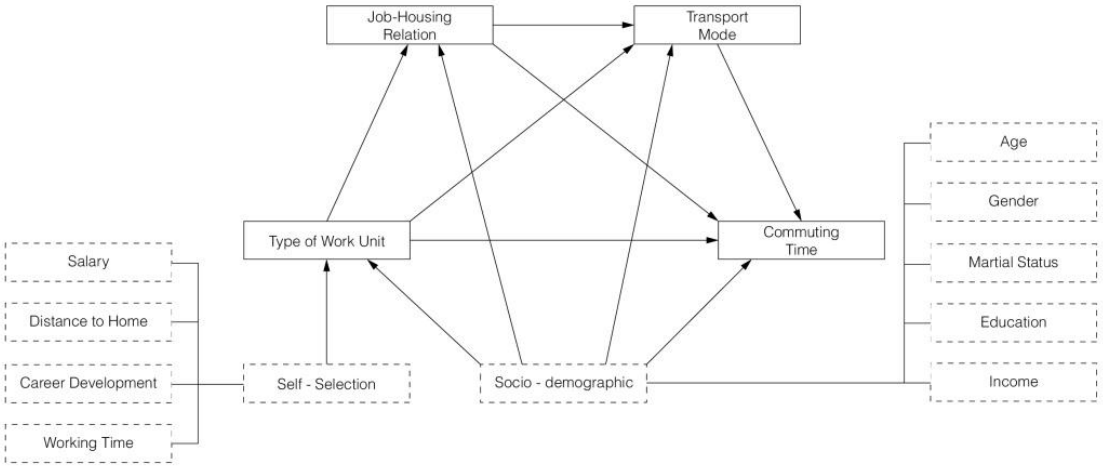
communities coded as “1.” Non-Danwei community was coded as “0.” If a resident lives and works in the same community, the job-housing relation was coded as “1.” If the locations of job and housing were not in the same community, the job-housing relation was coded as “0.” Travel mode has two categories with non-motor vehicle travel coded as “1,” and others coded as “0.” A commuting time measurement was used to directly measure the commuting times of residents. The variable was divided into five categories with less than 15 minutes (non-motor vehicle travel acceptable time), less than 30 minutes (public transportation travel acceptable time), less than one hour, less than two hours and more than two hours. Commuting times of less than 15 minutes and less than 30 minutes were coded as “1.” The others were coded as “0.” In the housing-job selection order scenario, type of work unit has two categories with stated-owned and collective-owned work units coded as “1.” Other types of work units were coded as “0.” The other three endogenous variables were coded in the same way as under the job-housing selection order scenario.

Figure 30 Theoretical Frame Work: Job-housing Selection Sequence



Source: the author

Figure 31Theoretical Frame Work: Housing-job Selection Sequence



Source: the author

In an attempt to identify the causality between the included exogenous and endogenous variables, the SEM analysis of the job-housing selection order scenario was composed of four comparison groups: 1. Traditional Danwei community – semi-Danwei community – non-Danwei community (TD-SD-ND); 2. Traditional danwei community – non-Danwei community (TD-ND); 3. Semi-Danwei community – non-Danwei community (SD-ND); and 4. Traditional Danwei community – semi-Danwei community (TD-SD). In the TD-SD model, the code of *TLC* was changed to: traditional Danwei community being coded as "1;" and semi-Danwei community residents coded as "0." The TD-SD-ND model provides a general overview of the causality among the three types of living communities. In both the TD-ND and SD-ND models, ND is the standard reference to measure the difference between the traditional Danwei and semi-Danwei communities. The TD-SD model directly reflects the differences between traditional Danwei community and semi-Danwei community. Consistent conclusions from three separate comparison groups help to demonstrate the confidence degree. In

traditional Danwei community, residents must be employed by a traditional work unit first, and then get housing through housing provision. As a consequence, the SEM analysis of the housing-job selection order scenario is just composed of comparisons between SD-ND.

Chapter 7: Modeling Results

7.1. Structure Equation Model: Job-housing Selection Order Scenario

AMOS 21, a commonly used software in SEM applications was used to analyze the data. Due to the resource of quantitative variables used in the model, a general weighted least square method was selected for model estimation. Table 16 - 19 displays the goodness-of-fit statistics of the TD-SD-ND, TD-ND, TD-SD, and SD-ND models under the job-housing selection order scenario. All the indexes indicate that the four models provide reasonably good measures of fit and are statistically significant.

7.1.1. Estimating the Interrelation between Endogenous Variables

Fig. 32 illustrates the expected interrelationships between the endogenous variables within the model. All of the effects displayed in fig. 32 are direct effects from one endogenous variable to another one. The total effects of endogenous variables on others can be summarized as follows:

$$T_{TLC-JHR} = D_a \tag{11}$$

$$T_{TLC-TM} = D_d + D_a \cdot D_b \tag{12}$$

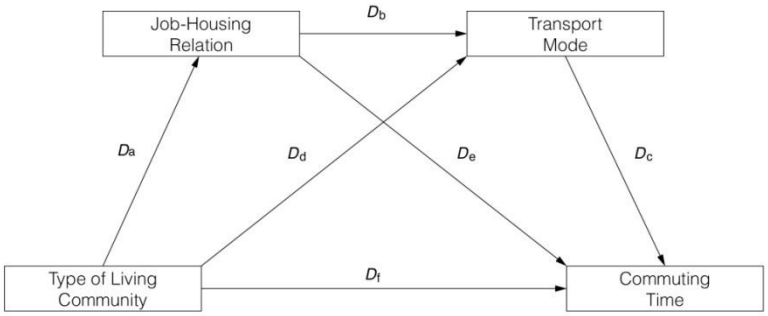
$$T_{TLC-CT} = D_f + D_a \cdot D_e + D_d \cdot D_c + D_a \cdot D_b \cdot D_c \tag{13}$$

$$T_{JHR-TM} = D_b \tag{14}$$

$$T_{JHR-CT} = D_e + D_b \cdot D_c \tag{15}$$

$$T_{TM-CT} = D_c \tag{16}$$

Figure 32 Framework of Endogenous Variables (Job-housing Selection Order)



Source: the author

7.1.1.1. The Effect of TLC on JHR

According to Fig. 32, the total effect of *TLC* on *JHR* is completely reflected by the direct effect (eq. 11). In the TD-SD-ND model (Table 20), *TLC* has a significant positive total and direct effect on *JHR*. The value of the total effect is 0.842. In the TD-ND model (Table 22), *TLC* has significant and positive total and direct effects on *JHR* as well. The value of the total effect is 0.844. Additionally, *TLC* generates significant and positive total effect on *JHR* in the SD-ND model (Table 23). The value of the effect is 0.538. The consistent significance and tendency of the total effects in the three models help to confirm the effects of *TLC* on *JHR*. Compared with the non-Danwei community, residents living in traditional and semi-Danwei communities have higher propensity to work and live in the same community. In the TD-SD model (Table 21), the total effect is not significant. The significance indicates that both the traditional Danwei and semi-Danwei communities improve residents' job-housing relation. As a consequence, there is no significant difference between the effects of *TLC* on *JHR* in these two communities.

The analysis result of the SEM is consistent with the assumption based on the provided descriptive statistics. Not only the traditional Danwei community but also the semi-Danwei community provides residents a more balanced job-housing relation. The total effect value of *TLC* on *JHR* in the TD-ND model (0.844) is larger than in the SD-ND (0.538). The comparison between the TD-ND and SD-ND models suggests that the traditional Danwei community has stronger effect on promoting job-housing balance than in the semi-Danwei community.

7.1.1.2. The Effect of TLC on TM

The total effect of *TLC* on *TM* is composed of the direct effect of *TLC* on *TM* and the indirect effect mediated by *JHR* (eq. 12). In the TD-SD-ND model (table 16), the direct effect of *TLC* on *TM* is not significant, but the indirect effect and total effect are significant and positive. The value of the indirect effect is 0.735. The value of the total effect is 0.686. In the TD-ND model (Table 22), the direct effect of *TLC* on *TM* is insignificant. Nonetheless, the indirect effect and total effect are significant and positive. The values of the indirect and total effects are 0.748 and 0.635. In the SD-ND model (Table 23), *TLC* generates an insignificant direct effect on *TM*. However, the total and indirect effects of *TLC* on *TM* are significant and positive. The values of the indirect and total effects are 0.286 and 0.332.

The three models represent an accordant tendency. The similar results of the direct effects demonstrate that not all residents living in traditional Danwei and semi-Danwei communities use non-motor vehicles for commuting. Meanwhile, all the indirect effects mediated by *JHR* are significant, indicating that residents living in

traditional and semi-Danwei communities with a balanced job-housing relation have a higher propensity to use non-motor vehicles for commuting than the non-Danwei community. The analysis result of the SEM is consistent with the assumption based on the descriptive statistic. The total effect value of *TLC* on *TM* in the TD-ND (0.635) is larger than the SD-ND (0.332). The comparison between TD-ND and SD-ND indicates that the traditional Danwei community has a stronger effect in reducing vehicle dependency than in the semi-Danwei community.

Fitness of Structure Equation Model:

Table 16 Traditional Danwei – Semi-Danwei – Non-Danwei

Degree of Adaptability	Reference Value	Values of the model
Degree of freedom		21.000
Chi-square		30.714
Probability level	$p > 0.05$	$p = 0.079$
RMSEA	< 0.05 (good adaptation)	0.051
	< 0.08 (reasonable adaptation)	
GFI	> 0.90	0.985
NFI	> 0.90	0.989
CFI	> 0.90	0.996
RMR	< 0.05	0.004

Table 17 Traditional Danwei – Non-Danwei

Degree of Adaptability	Reference Value	Values of the model
Degree of freedom		19.000
Chi-square		27.335
Probability level	$p > 0.05$	$p = 0.097$
RMSEA	< 0.05 (good adaptation)	0.061
	< 0.08 (reasonable adaptation)	
GFI	> 0.90	0.980
NFI	> 0.90	0.987
CFI	> 0.90	0.996
RMR	< 0.05	0.006

Table 18 Traditional Danwei – Semi-Danwei

Degree of Adaptability	Reference Value	Values of the model
Degree of freedom		20.000
Chi-square		26.891
Probability level	$p > 0.05$	$p = 0.138$
RMSEA	< 0.05 (good adaptation)	0.054
	< 0.08 (reasonable adaptation)	
GFI	> 0.90	0.980
NFI	> 0.90	0.986
CFI	> 0.90	0.996
RMR	< 0.05	0.005

Table 19 Semi-Danwei – Non-Danwei

Degree of Adaptability	Reference Value	Values of the model
Degree of freedom		18.000
Chi-square		28.609
Probability level	$p > 0.05$	$p = 0.053$
RMSEA	< 0.05 (good adaptation)	0.070
	< 0.08 (reasonable adaptation)	
GFI	> 0.90	0.979
NFI	> 0.90	0.988
CFI	> 0.90	0.995
RMR	< 0.05	0.003

Total, Direct and Indirect Effect of Endogenous Variables Interrelationship:
Table 20 Traditional Danwei – Semi-Danwei – Non-Danwei

	Effect	Type of Living Community	Job-housing Relation	Transport Mode
Type of Living Community	Total Effect	-	-	-
	Direct Effect	-	-	-
	Indirect Effect	-	-	-
Job-housing Relation	Total Effect	**0.842**	-	-
	Direct Effect	**0.842**	-	-
	Indirect Effect	-	-	-
Transport Mode	Total Effect	**0.686**	**0.873**	-
	Direct Effect	*-0.049*	**0.873**	-
	Indirect Effect	**0.735**	-	-
Commuting Time	Total Effect	**0.756**	**0.933**	**0.643**
	Direct Effect	*0.002*	**0.372**	**0.643**
	Indirect Effect	**0.754**	**0.561**	-

Table 21Traditional Danwei – Semi-Danwei

	Effect	Type of Living Community	Job-housing Relation	Transport Mode
Type of Living Community	Total Effect	-	-	-
	Direct Effect	-	-	-
	Indirect Effect	-	-	-
Job-housing Relation	Total Effect	*-0.128*	-	-
	Direct Effect	*-0.128*	-	-
	Indirect Effect	-	-	-
Transport Mode	Total Effect	**-0.294**	**0.862**	-
	Direct Effect	**-0.184**	**0.862**	-
	Indirect Effect	*-0.110*	-	-
Commuting Time	Total Effect	*-0.216*	**0.910**	**0.433**
	Direct Effect	*-0.020*	**0.537**	**0.433**
	Indirect Effect	*-0.196*	**0.373**	-

Notes: Effects that are not significant presented in *italic*; *Notes:* Effects that are significant presented in **Bold**; links that are not included in the model indicated by "-".

Table 22 Traditional Danwei Community – Non-Danwei

	Effect	Type of Living Community	Job-housing Relation	Transport Mode
Type of Living Community	Total Effect	-	-	-
	Direct Effect	-	-	-
	Indirect Effect	-	-	-
Job-housing Relation	Total Effect	**0.844**	-	-
	Direct Effect	**0.844**	-	-
	Indirect Effect	-	-	-
Transport Mode	Total Effect	**0.635**	**0.859**	-
	Direct Effect	*-0.113*	**0.859**	-
	Indirect Effect	**0.748**	-	-
Commuting Time	Total Effect	**0.770**	**1.022**	**0.585**
	Direct Effect	*-0.026*	**0.504**	**0.585**
	Indirect Effect	**0.796**	**0.518**	-

Table 23 Semi-Danwei Community – Non-Danwei

	Effect	Type of Living Community	Job-housing Relation	Transport Mode
Type of Living Community	Total Effect	-	-	-
	Direct Effect	-	-	-
	Indirect Effect	-	-	-
Job-housing Relation	Total Effect	**0.538**	-	-
	Direct Effect	**0.538**	-	-
	Indirect Effect	-	-	-
Transport Mode	Total Effect	**0.332**	**0.532**	-
	Direct Effect	*0.046*	**0.532**	-
	Indirect Effect	**0.286**	-	-
Commuting Time	Total Effect	**0.393**	**0.481**	**0.773**
	Direct Effect	*0.098*	**0.071**	**0.773**
	Indirect Effect	**0.295**	**0.410**	-

Notes: Effects that are not significant presented in *italic*; *Notes:* Effects that are significant presented in **Bold**; links that are not included in the model indicated by "-".

Decomposition of indirect effect:

Table 24 Traditional Danwei – Semi-Danwei – Non-Danwei

Indirect Relation	Mediating Variable	Indirect Effect
Types of living community on transport mode	Job-housing relation	0.735
Total		0.735
Types of living community on commuting time	Job-housing relation	0.313
	Transport mode	-0.032
	Job-housing relation and transport mode	0.473
Total		0.754
Job-housing relation on commuting time	Transport mode	0.561
Total		0.561

Table 25 Traditional Danwei – Semi-Danwei

Indirect Relation	Mediating Variable	Indirect Effect
Types of living community on transport mode	Job-housing relation	-0.110
Total		-0.110
Types of living community on commuting time	Job-housing relation	-0.069
	Transport mode	-0.080
	Job-housing relation and transport mode	-0.047
Total		*-0.196*
Job-housing relation on commuting time	Transport mode	0.373
Total		0.373

Notes: Effects that are not significant presented in *italic*.

Table 26 Traditional Danwei – Non-Danwei

Indirect Relation	Mediating Variable	Indirect Effect
Types of living community on transport mode	Job-housing relation	0.748
Total		0.748
Types of living community on commuting time	Job-housing relation	0.425
	Transport mode	-0.066
	Job-housing relation and transport mode	0.437
Total		0.796
Job-housing relation on commuting time	Transport mode	0.518
Total		0.518

Table 27 Semi-Danwei – Non-Danwei

Indirect Relation	Mediating Variable	Indirect Effect
Types of living community on transport mode	Job-housing relation	0.286
Total		0.286
Types of living community on commuting time	Job-housing relation	0.038
	Transport mode	0.036
	Job-housing relation and transport mode	0.221
Total		0.295
Job-housing relation on commuting time	Transport mode	0.410
Total		0.410

Notes: Effects that are not significant presented in *italic*.

7.1.1.3. The Effect of TLC on CT

According to eq. 13, the total effect of *TLC* on *CT* is composed of four components: 1. A direct effect (D_f); 2. An indirect effect mediated by *JHR* (D_a*D_e); 3. An indirect effect mediated by *TM* (D_d*D_c); and 4. An indirect effect mediated by the combination of *JHR* and *TM* (D_a*D_b*D_c).

In the TD-SD-ND model (Table 20), the direct effect of *TLC* on *TM* is not significant, but the indirect effects and total effect are significant and positive. The value of the indirect effect is 0.754, and the value of the total effect is 0.756. In the TD-ND model (Table 22), the direct effect of *TLC* on *TM* is insignificant, and the indirect effect and total effect are significant and positive. The value of indirect effect is 0.770, the value of the total effect is 0.796. In the SD-ND model (Table 23), *TLC* generates insignificant direct effect but significant and positive indirect and total effects on *TM*. The value of the indirect effect is 0.286, and the value of the total effect is 0.332.

The effects of the three models display consistent finding the coincident significance of the direct effects demonstrate that not all residents living in traditional Danwei and semi-Danwei communities have one-way commuting times less than 30 minutes. According to the decomposition of the indirect effects (Table 24-27), the indirect effects mediated by *JHR* (0.313, 0.425 and 0.038) and the indirect effects mediated by the combination of *JHR* and *TM* (0.473, 0.437 and 0.221) play the dominant role in mediating the indirect effect of *TLC* on *CT* in the TD-SD-ND, TD-ND, and SD-ND models. The decomposition reflects that residents living in traditional Danwei and semi-Danwei communities with balanced job-housing relation have a higher propensity to commute less than 30 minutes; and residents living in traditional

Danwei and semi-Danwei communities with a balanced job-housing relation and using non-motorized vehicles are more likely to commute less than 30 minutes. The analysis result of the SEM is accordant with the assumption based on the descriptive statistic. The Traditional Danwei Community forms more balanced job-housing relation than the semi-Danwei community, resulting in shorter commuting times for residents.

7.1.1.4. The Effect of JHR on TM

The total effect of *JHR* on *TM* is entirely reflected by the direct effects as estimated in equation 14. In the TD-SD-ND model (Table 20), *JHR* has a significant and positive total and direct effects on *TM*. The value of the total effect is 0.873. In the TD-ND model (Table 22), *JHR* has significant and positive total and direct effects on *TM*. The value of the total effect is 0.859. Additionally, *JHR* also generates significant and positive total effect on *TM* in the SD-ND model (Table 23). The value of the effect is 0.532. In the TD-SD model (Table 21), the total effect is positive and significant, and the value is 0.862.

Similar to other models, the consistent tendency of the total effects in the four models demonstrates the effect of *JHR* on *TM*. Residents with a balanced job-housing relation have a higher propensity to use non-motorized vehicles for commuting. Balanced individual job-housing relation at the community level generates a positive impact on reducing vehicle dependency.

7.1.1.5. The Effect of JHR on CT

The total effect of *JHR* on *CT* is composed of the direct effect of *JHR* on *CT* and the indirect effect mediated by *TM* (eq. 15). In the TD-SD-ND model (Table 20), the direct effect of *JHR* on *CT* is significant and positive with the indirect effect mediated by *TM* and the total effect being significant and positive as well. The value of the direct effect is 0.372 and the indirect effect is 0.561. The value of the total effect is 0.933. In the TD-ND model (Table 22), the direct, indirect and total effects of *JHR* on *CT* are significant and positive. In the SD-ND and TD-SD models again, the direct, indirect and total effects of *JHR* on *CT* are significant and positive.

The similar findings in the four models suggest that residents in communities with a balanced job-housing relation are more likely to have one-way commuting times of less than 30 minutes. Meanwhile, residents with a balanced job-housing relation and using non-motorized vehicles for commuting also are more likely to have commute times less than 30 minutes. The analysis result of the SEM is consistent with the assumptions based on the descriptive statistic.

The comparison between the total effect of *JHR* on *CT* in the TD-ND (1.022) and SD-ND (0.481) models demonstrates that the effect of job-housing relation on reducing commuting time in the semi-Danwei community is crippled than in the traditional Danwei community. Residents with a balanced job-housing relation in the semi-Danwei community may have a longer commuting time than residents who live in the traditional Danwei with balanced job-housing relation.

The primary conclusion of the interrelationships between the endogenous variables in the job-housing selection order scenario can be listed as follows:

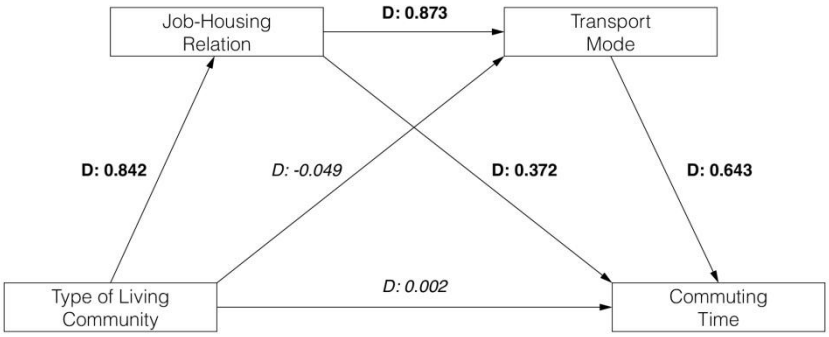
1) Individual job-housing balance at the community level contributes to reduce vehicle dependency and commuting times of residents.

2) Traditional and semi-Danwei communities provide residents with a more balanced job-housing relation, and helps to reduce vehicle dependency and commuting times of residents.

3) Compared with the traditional Danwei community, the effect of job-housing balance on reducing vehicle dependency and commuting time is crippled in the semi-Danwei community.

4) Residents of the traditional Danwei community have lower vehicle dependency and commuting times than residents of the semi-Danwei community.

Figure 33 Direct Effect of Endogenous Variables in TD-SD-ND Model



Notes: Effects that are not significant presented in *italic*; effects that are significant presented in **Bold**

Figure 34 Direct Effect of Endogenous Variables in TD-SD Model

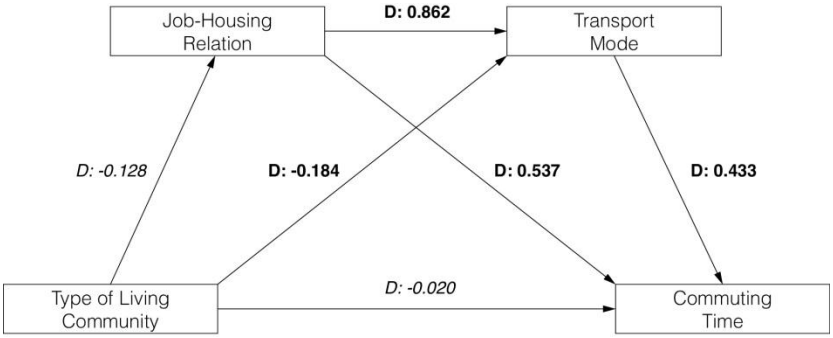


Figure 35 Direct Effect of Endogenous Variables in TD-ND Model

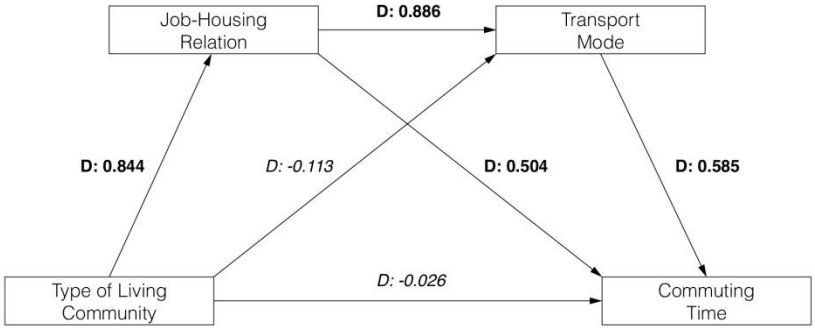
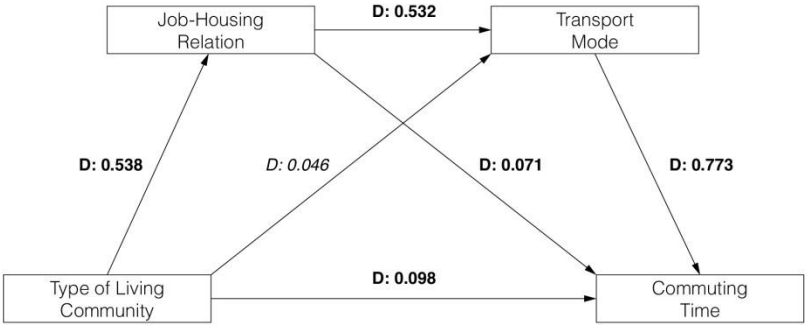


Figure 36 Direct Effect of Endogenous Variables in SD-ND Model



Notes: Effects that are not significant presented in *italic*; effects that are significant presented in **Bold**

7.1.2. The Effects of Self-selection Exogenous Variables on Endogenous Variables

Fig. 37 illustrates the direct effects of self-selection exogenous variables on endogenous variables and the interrelationship of the endogenous variables. Total effects of self-selection exogenous variables on endogenous variables are listed as follows:

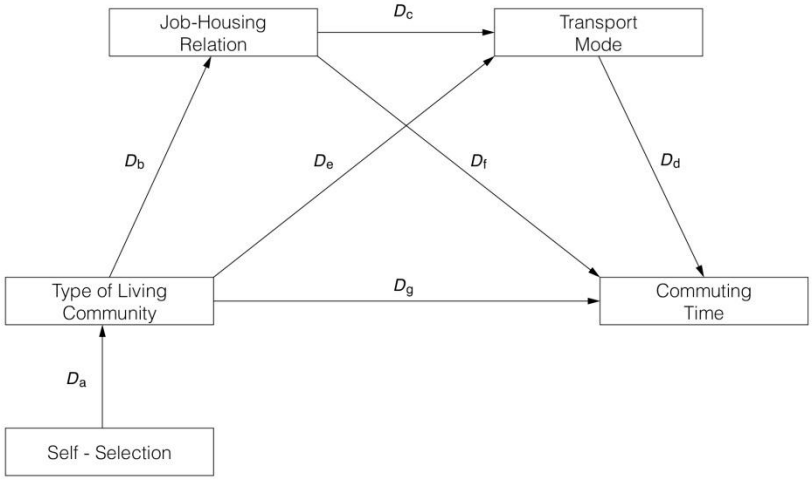
$$T_{SS-TLC} = D_a \tag{17}$$

$$T_{SS-JHR} = D_a \cdot D_b \tag{18}$$

$$T_{SS-TM} = D_a \cdot D_b \cdot D_c + D_a \cdot D_e \tag{19}$$

$$T_{SS-CT} = D_a \cdot D_g + D_a \cdot D_b \cdot D_c \cdot D_d + D_a \cdot D_b \cdot D_f + D_a \cdot D_e \cdot D_d \tag{20}$$

Figure 37 Direct Effects of Self-selection Exogenous Variables



Source: the author

According to eq. 17 18 19 and 20, self-selection exogenous variables merely generate direct effects on *TLC*. All the effects of self-selection exogenous variable on *JHR*, *TM*, and *CT* are composed of the indirect effects which are mediated by *TLC*.

7.1.2.1. The Advantages of Traditional and Semi-Danwei Communities

In the TD-SD-ND model (Table 28), distance to job (*DJ*), elementary school (*ES*), daycare center (*DC*), talk frequency (*TF*) all have significant and positive total effects on the types of living community (*TLC*) which are entirely reflected by the direct effects. The total effect values include *DJ* (0.478), *ES* (0.184), *DC* (0.125), and *TF* (0.210).

In the TD-ND model (Table 30), *DJ*, *ES*, *RC* (recreation center) and *TF* generate significant and positive total effects on *TLC* with corresponding total effect values of *DJ* (0.481), *ES* (0.185), *RC* (0.147), and *TF* (0.254).

In the SD-ND model (Table 31), the total effects of *DJ*, *ES*, *DC*, *RC*, and *TF* are significant and positively related with *TLC*. The total effect value of *DJ* is 0.485; the total effect value of *ES* is 0.292; the total effect value of *RC* is 0.278; the total effect value of *DC* is 0.208; and the total effect value of *TF* is 0.254.

The total effects of *DJ*, *ES* and *TF* display consistent significance and tendencies in the TD-SD-ND, TD-ND, SD-ND models. If residents are satisfied or very satisfied with their distance to jobs and community elementary schools, these residents have a higher propensity to live in traditional or semi-Danwei communities. If residents talk with neighbors more than 10 times each month, these residents are more likely to live in traditional or semi-Danwei communities. Residents of the semi-Danwei community illustrate a higher degree of satisfaction with their daycare centers than residents of the other two types of communities. If residents are satisfied or very satisfied with their community daycare center, these residents seem to prefer to live in the semi-Danwei

community. The advantages of traditional Danwei and semi-Danwei communities can be concluded as follow:

1) Compared with the non-Danwei community, residents of traditional Danwei and semi-Danwei communities have higher degree of satisfaction with respect to the distance to job. Meanwhile, the degree of satisfaction in the semi-Danwei community is stronger than in the traditional Danwei community.

2) Residents prefer elementary schools in traditional Danwei and semi-Danwei communities more than in the non-Danwei community. Elementary schools of the semi-Danwei community provide residents a higher degree of satisfaction than in the traditional Danwei community.

3) Compared with the non-Danwei community, residents of traditional and semi-Danwei communities have higher monthly talk frequencies with their neighbors. This suggests that residents of these two types of communities develop a stronger regional sense of belonging with each other. Additionally, the regional sense of belonging in the traditional Danwei is relatively stronger then the other.

4) The daycare center in the semi-Danwei community provides residents with a higher degree of satisfaction compared to residents in traditional Danwei and non-Danwei communities.

7.1.2.2. The Deficiencies of Traditional and Semi-Danwei Communities

Table 28 provides the results for the TD-SD-ND model. Housing quality (*HQ*), medical care center (*MC*), and open space (*OS*) have significant and negative total effects on the types of living community (*TLC*) which are estimated by the direct effects.

The total effect value of *HQ* is -0.299; the total effect value of *MC* is -0.154; and the total effect value of *OS* is -0.093.

In the TD-ND model (Table 30), only *HQ* has a significant and negative total effect on *TLC*. The total effect value of *HQ* is -0.271.

In the SD-ND model (Table 31), the total effects of *HQ* and *OS* are significant and negative on *TLC*. The total effect value of *HQ* is -0.169; and the total effect value of *OS* is -0.081.

The total effect of *HQ* has similar significance across the three models. If residents are satisfied or very satisfied with respect to their housing quality, these residents have a higher propensity to live in the non-Danwei community. The open space of semi-Danwei community displays significant weakness than traditional Danwei and non-Danwei communities. If residents are satisfied or very satisfied with open space in their communities, these residents are more likely to live in traditional Danwei or non-Danwei communities. The total effect value of *MC* is only significant in the TD-SD-ND model, and does not achieve consistency in the three models. As a consequence, the impact of medical centers on the satisfaction of residents is treated as insignificant in this study. According to the SEM analysis results, the deficiencies of traditional Danwei and semi-Danwei communities can be listed as follow:

1) Compared with traditional and semi-Danwei communities, housing quality in non-Danwei community is more superior. Housing quality of semi-Danwei community (-0.169) is better than traditional Danwei community (-0.271).
2) The open spaces of traditional Danwei and non-Danwei communities are more satisfied by residents than semi-Danwei community.

7.1.3. The Effects of Socio-economic Exogenous Variables on Endogenous Variables

Fig. 38 illustrates the direct effects of socio-economic exogenous variables on endogenous variables and the interrelation of endogenous variables. The total effects of socio-economic exogenous variables on endogenous variables are listed as follows:

$$T_{SE-TLC} = D_a \tag{21}$$

$$T_{SE-JHR} = D_e + D_a \cdot D_b \tag{22}$$

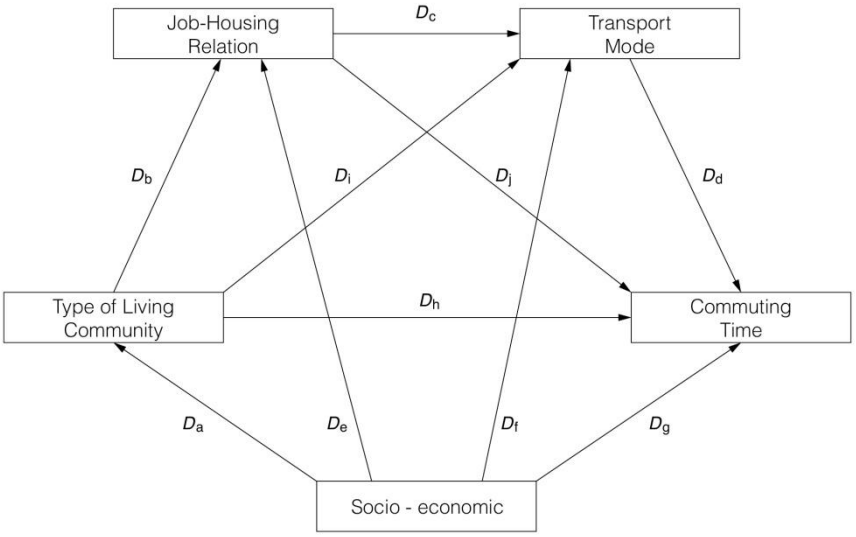
$$T_{SE-TM} = D_f + D_a \cdot D_b \cdot D_c + D_a \cdot D_i + D_e \cdot D_c \tag{23}$$

$$T_{SE-CT} = D_g + D_a \cdot D_b \cdot D_c \cdot D_d + D_a \cdot D_b \cdot D_j + D_a \cdot D_i \cdot D_d + D_e \cdot D_j + D_e \cdot D_c \cdot D_d + D_f \cdot D_d + D_a \cdot D_h \tag{24}$$

The total effect of *SE* (socio-economic factors) on *TLC* is composed of the direct effect. The total effects of *SE* on JHR is composed of the direct effects and indirect effects mediated by *TLC*. The total effects of *SE* on *TM* are composed of the direct effects and the indirect effects as mediated by *TLC*, *JHR* and the combination of *TLC* and *JHR*. The total effects of *SE* on *CT* are composed of the direct effects and indirect effects comprehensively mediated by *TLC*, *JHR* and *TM*.

In the comparison between the TD-SD-ND, TD-SD, TD-ND and SD-ND models (Table 28, 29, 30 and 31), only the effects of *IN* (income) and *AG* (age) on *JHR* have consistent correlations and measures of significance. *IN* has significant and negative total and direct effects on *JHR*. Residents with higher income have a lower propensity to live and work in the same community. *AG* has significant and positive total and direct effects on *JHR*. As respondents age increase, they have a higher propensity to live and work in the same community.

Figure 38 Direct Effects of Socio-economic Exogenous Variables



Source: the author

In the comparison between the four models, only *IN* and *AG* have consistent significance and correlation of effects on *JHR*. These correlations are consistent with the analysis results of Wang and Chai (2009). Nonetheless, the research of Wang and Chai also concludes that gender, marital status and education generate significant effects on the job-housing relation of residents. In this research, these three exogenous variables do not have consistent significance and correlations in the four types of models.

Total, Direct and Indirect Effects of Exogenous Variables on Endogenous Variables

Table 28 Traditional Danwei - Semi-Danwei - Non-Danwei Comparison

	Effect	AG	GE	MS	ED	IN	HQ	DJ	ES	DC	MC	RC	RS	TF	OS	EQ
TLC	Total effect	*0.000*	**0.068**	*-0.008*	*-0.008*	*0.003*	**-0.299**	**0.478**	**0.184**	**0.125**	**-0.154**	*0.018*	*-0.040*	**0.210**	**-0.093**	0.074
	Direct effect	*0.000*	**0.068**	*-0.008*	*-0.008*	*0.003*	**-0.299**	**0.478**	**0.184**	**0.125**	**-0.154**	*0.018*	*-0.040*	**0.210**	**-0.093**	0.074
	Indirect effect	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	-	-	-	-	-	-	-	-	-	-
JHR	Total effect	**0.009**	**-0.062**	*-0.033*	*-0.035*	**-0.012**	**-0.251**	**0.402**	**0.155**	**0.105**	**-0.129**	*0.015*	*-0.033*	**0.177**	**-0.079**	**0.062**
	Direct effect	**0.009**	**-0.119**	*-0.027*	*-0.028*	**-0.015**	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.000*	**0.057**	*-0.006*	*-0.007*	**0.003**	**-0.251**	**0.402**	**0.155**	**0.105**	**0.129**	*0.015*	*-0.033*	**0.177**	**-0.079**	**0.062**
TM	Total effect	**0.005**	*-0.011*	*0.022*	**-0.188**	*-0.008*	**-0.205**	**0.328**	**0.126**	**0.085**	**-0.105**	*0.012*	*-0.027*	**0.144**	**-0.064**	**0.051**
	Direct effect	*-0.003*	*0.047*	*0.050*	**-0.158**	*0.003*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	**0.008**	*-0.058*	*-0.028*	***-0.030***	**-0.011**	**-0.205**	**0.328**	**0.126**	**0.085**	**-0.105**	*0.012*	*-0.027*	**0.144**	**-0.064**	**0.051**
CT	Total effect	*0.005*	*-0.020*	*-0.025*	**-0.205**	*-0.007*	**-0.226**	**0.362**	**0.139**	**0.094**	**-0.116**	*0.014*	*-0.030*	**0.159**	**-0.071**	**0.056**
	Direct effect	*-0.001*	*0.010*	*-0.026*	**-0.072**	*0.002*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	**0.006**	*-0.030*	*0.001*	**-0.133**	**-0.009**	**-0.226**	**0.362**	**0.139**	**0.094**	**-0.116**	*0.014*	*-0.030*	**0.159**	**-0.071**	**0.056**

Note: *TLC*: type of living community; *JHR*: job-housing relation; *TM*: transport mode; *CT*: commuting time; *AG*: age; *GE*: gender; *MS*: marital status; *ED*: education; *IN*: income; *HQ*: housing quality; *DJ*: distance to job; *ES*: elementary school; *DC*: daycare center; *MC*: medical care center; *RC*: recreation center; *RS*: retail shop; *TF*: talk frequency; *OS*: open space; *EQ*: environmental quality
Effects that are not significant presented in italic; Effects that are significant presented in Bold; links that are not included in the model indicated by "-"

Table 29 Traditional Danwei - Semi-Danwei Comparison

	Effect	AG	GE	MS	ED	IN	HQ	DJ	ES	DC	MC	RC	RS	TF	OS	EQ
TLC	Total effect	**0.009**	*0.093*	*-0.140*	*0.065*	*-0.007*	*-0.122*	*-0.058*	*-0.162*	*0.033*	*-0.252*	**-0.714**	**-0.136**	**-0.341**	**0.685**	*-0.325*
	Direct effect	**0.009**	*0.093*	*-0.140*	*0.065*	*-0.007*	*-0.122*	*-0.058*	*-0.162*	*0.033*	*-0.252*	**-0.714**	**-0.136**	**-0.341**	**0.685**	*-0.325*
	Indirect effect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JHR	Total effect	*0.012*	**-0.147**	*-0.030*	*0.005*	**-0.016**	*0.016*	*0.007*	*0.021*	*-0.004*	*0.032*	*0.091*	*0.017*	*0.044*	*-0.088*	*0.042*
	Direct effect	*0.013*	*-0.135*	*-0.048*	*0.013*	**-0.017**	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*-0.001*	*-0.012*	*0.018*	*-0.008*	*0.001*	*0.016*	*0.007*	*0.021*	*-0.004*	*0.032*	*0.091*	*0.017*	*0.044*	*-0.088*	*0.042*
TM	Total effect	**0.014**	**-0.162**	*0.052*	*-0.040*	**-0.017**	*0.036*	*0.017*	**0.048**	*-0.010*	*0.074*	**0.210**	**0.040**	**0.100**	**-0.202**	**0.096**
	Direct effect	**0.005**	*-0.018*	*0.052*	*-0.032*	*-0.004*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.009*	**-0.144**	*0.000*	*-0.008*	**-0.013**	*0.036*	*0.017*	**0.048**	*-0.010*	*0.074*	**0.210**	**0.040**	**0.100**	**-0.202**	**0.096**
CT	Total effect	**0.013**	**-0.162**	*-0.003*	*0.000*	**-0.015**	*0.026*	*0.013*	*0.035*	*-0.007*	*0.055*	*0.154*	*0.029*	*0.074*	*-0.148*	*0.070*
	Direct effect	*0.001*	*-0.012*	*-0.012*	*0.016*	*0.001*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	**0.012**	**-0.150**	*0.009*	*-0.016*	**-0.016**	*0.026*	*0.013*	*0.035*	*-0.007*	*0.055*	*0.154*	*0.029*	*0.074*	*-0.148*	*0.070*

Note: *TLC*: type of living community; *JHR*: job-housing relation; *TM*: transport mode; *CT*: commuting time; *AG*: age; *GE*: gender; *MS*: marital status; *ED*: education; *IN*: income; *HQ*: housing quality; *DJ*: distance to job; *ES*: elementary school; *DC*: daycare center; *MC*: medical care center; *RC*: recreation center; *RS*: retail shop; *TF*: talk frequency; *OS*: open space; *EQ*: environmental quality
Effects that are not significant presented in italic; Effects that are significant presented in Bold; links that are not included in the model indicated by "-"

Table 30 Traditional Danwei - Non-Danwei Comparison

	Effect	AG	GE	MS	ED	IN	HQ	DJ	ES	DC	MC	RC	RS	TF	OS	EQ
TLC	Total effect	*0.002*	*0.100*	*-0.056*	*-0.007*	*0.004*	**-0.271**	**0.481**	**0.185**	*0.036*	*-0.002*	**0.147**	*-0.089*	**0.254**	*-0.071*	*0.139*
	Direct effect	*0.002*	*0.100*	*-0.056*	*-0.007*	*0.004*	**-0.271**	**0.481**	**0.185**	*0.036*	*-0.002*	**0.147**	*-0.089*	**0.254**	*-0.071*	*0.139*
	Indirect effect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JHR	Total effect	**0.009**	*-0.018*	*-0.004*	*0.002*	**-0.012**	**-0.229**	**0.406**	**0.156**	*0.031*	*-0.001*	**0.124**	*-0.075*	**0.214**	*-0.060*	**0.117**
	Direct effect	**0.008**	*-0.102*	*0.043*	*0.008*	**-0.016**	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.001*	*0.084*	*-0.047*	*-0.006*	**0.004**	**-0.229**	**0.406**	**0.156**	*0.031*	*-0.001*	**0.124**	*-0.075*	**0.214**	*-0.060*	**0.117**
TM	Total effect	*0.005*	*0.050*	*0.048*	*-0.218*	*-0.006*	**-0.172**	**0.305**	**0.117**	*0.023*	*-0.001*	**0.093**	*-0.056*	**0.161**	*-0.045*	**0.088**
	Direct effect	*-0.002*	*0.077*	*0.045*	**-0.220**	*0.005*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.007*	*-0.027*	*0.003*	*0.002*	**-0.011**	**-0.172**	**0.305**	**0.117**	*0.023*	*-0.001*	**0.093**	*-0.056*	**0.161**	*-0.045*	**0.088**
CT	Total effect	*0.003*	*0.033*	*0.026*	*-0.246*	*-0.006*	**-0.209**	**0.370**	**0.142**	*0.028*	*-0.001*	**0.113**	*-0.068*	**0.196**	*-0.055*	**0.107**
	Direct effect	*-0.004*	*0.016*	*-0.002*	**-0.120**	*0.004*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.007*	*0.017*	*0.028*	*-0.126*	**-0.010**	**-0.209**	**0.370**	**0.142**	*0.028*	*-0.001*	**0.113**	*-0.068*	**0.196**	*-0.055*	**0.107**

Note: *TLC*: type of living community; *JHR*: job-housing relation; *TM*: transport mode; *CT*: commuting time; *AG*: age; *GE*: gender; *MS*: marital status; *ED*: education; *IN*: income; *HQ*: housing quality; *DJ*: distance to job; *ES*: elementary school; *DC*: daycare center; *MC*: medical care center; *RC*: recreation center; *RS*: retail shop; *TF*: talk frequency; *OS*: open space; *EQ*: environmental quality
Effects that are not significant presented in italic; Effects that are significant presented in Bold; links that are not included in the model indicated by "-"

Table 31 Semi-Danwei - Non-Danwei Comparison

	Effect	AG	GE	MS	ED	IN	HQ	DJ	ES	DC	MC	RC	RS	TF	OS	EQ
TLC	Total effect	*-0.003*	*0.024*	**0.099**	*-0.006*	*0.001*	**-0.169**	**0.485**	**0.292**	**0.208**	*-0.053*	**0.278**	*-0.001*	**0.200**	**-0.081**	*-0.038*
	Direct effect	*-0.003*	*0.024*	**0.099**	*-0.006*	*0.001*	**-0.169**	**0.485**	**0.292**	**0.208**	*-0.053*	**0.278**	*-0.001*	**0.200**	**-0.081**	*-0.038*
	Indirect effect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JHR	Total effect	**0.008**	*-0.051*	*-0.071*	*-0.029*	**-0.008**	**-0.091**	**0.261**	**0.157**	**0.112**	*-0.028*	**0.149**	*-0.001*	**0.108**	**-0.044**	*-0.021*
	Direct effect	**0.009**	*-0.064*	**-0.124**	*-0.026*	**-0.008**	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*-0.001*	*0.013*	**0.053**	*-0.003*	*0.000*	**-0.091**	**0.261**	**0.157**	**0.112**	*-0.028*	**0.149**	*-0.001*	**0.108**	**-0.044**	*-0.021*
TM	Total effect	*0.001*	*0.064*	*-0.172*	**-0.172**	*0.006*	**-0.056**	**0.161**	**0.097**	**0.069**	*-0.018*	**0.092**	*0.000*	**0.067**	**-0.027**	*-0.013*
	Direct effect	*-0.003*	*0.090*	*-0.120*	**-0.156**	*0.010*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.004*	*-0.026*	*-0.033*	*-0.016*	**-0.004**	**-0.056**	**0.161**	**0.097**	**0.069**	*-0.018*	**0.092**	*0.000*	**0.067**	**-0.027**	*-0.013*
CT	Total effect	*0.002*	*0.042*	**-0.219**	**-0.219**	*0.001*	**-0.067**	**0.191-**	**0.115**	**0.082**	*-0.021*	**0.109**	*-0.001*	**0.079**	**-0.032**	*-0.015*
	Direct effect	*0.001*	*-0.007*	*-0.039*	**-0.083**	*-0.003*	-	-	-	-	-	-	-	-	-	-
	Indirect effect	*0.001*	*0.049*	*-0.113*	-0.136	*0.004*	**-0.067**	**0.191**	**0.115**	**0.082**	*-0.021*	**0.109**	*-0.001*	**0.079**	**-0.032**	*-0.015*

Note: *TLC*: type of living community; *JHR*: job-housing relation; *TM*: transport mode; *CT*: commuting time; *AG*: age; *GE*: gender; *MS*: marital status; *ED*: education; *IN*: income; *HQ*: housing quality; *DJ*: distance to job; *ES*: elementary school; *DC*: daycare center; *MC*: medical care center; *RC*: recreation center; *RS*: retail shop; *TF*: talk frequency; *OS*: open space; *EQ*: environmental quality
Effects that are not significant presented in italic; Effects that are significant presented in Bold; links that are not included in the model indicated by "-"

7.2. Structure Equation Model: Housing-job Selection Order Scenario

In the housing-job selection order scenario, all participants select houses first, and then find employment opportunities. Residents living in the traditional Danwei communities must be employed by Danwei first, and then get houses from the housing provision system. As a consequence, this research only constructs a model between semi-Danwei and non-Danwei communities for comparison (SD-ND) in the housing-job selection order scenario. Table 28 displays the goodness-of-fit statistics of the housing-job selection order scenario model. All the indexes indicate that the model is a reasonable fit to the data and statistically significant.

7.2.1. Interrelation between Endogenous Variables

Fig.39 displays the interrelationships between endogenous variables of the model. All the effects displayed in Fig.39 are direct effects from one endogenous to another one. Total effects of endogenous variables on others can be listed as follows:

$$T_{TWU-JHR} = D_a \tag{25}$$

$$T_{TWU-TM} = D_d + D_a \cdot D_b \tag{26}$$

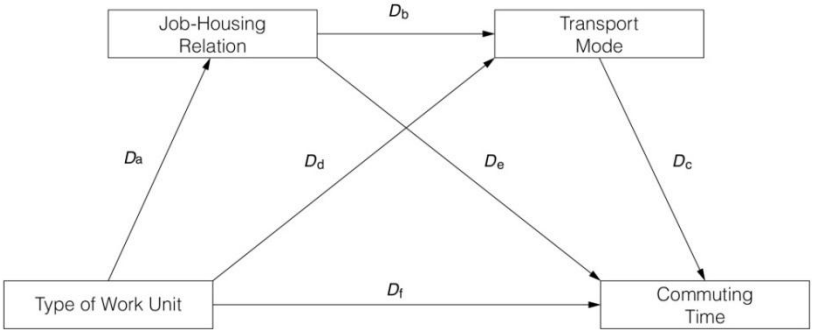
$$T_{TWU-CT} = D_f + D_a \cdot D_e + D_d \cdot D_c + D_a \cdot D_b \cdot D_c \tag{27}$$

$$T_{JHR-TM} = D_b \tag{28}$$

$$T_{JHR-CT} = D_e + D_b \cdot D_c \tag{29}$$

$$T_{TM-CT} = D_c \tag{30}$$

Figure 39 Framework of Endogenous Variables (Housing-job Selection Order)



Source: the author

7.2.1.1. The Effect of TWU on JHR

According to Fig.39, the total effect of *TWU* on *JHR* is entirely composed by the direct effect (eq. 25). In SD-ND model (Table 33), the total effect of *TWU* on *JHR* is significant and positive. The value of the total effect is 0.743. Compared with other types of enterprises, residents employed by state-owned or collective-owned work units have higher propensity to work and live in the same community.

7.2.1.2. The Effect of TWU on TM

The total effect of *TWU* on *TM* is composed by the direct effect of *TWU* on *TM* and the indirect effect mediated by *JHR* (eq. 26). In the SD-ND model (Table 33), *TWU* generates significant and positive total and indirect effects on *TM*. Nonetheless, the direct effect is not significant. The value of the indirect effect is 0.645. The value of the total effect is 0.540.The insignificant direct effect implies that not all residents employed by state-owned or collective-owned work units will use non-motor vehicles for commuting. Meanwhile, the significant indirect effect indicates that residents

employed by state-owned or collective-owned work units with balanced job-housing relation are more likely to use non-motor vehicles for commuting.

7.2.1.3. The Effect of TWU on CT

According to eq. 27, the total effect of *TWU* on *CT* is composed of four components: 1. direct effect (D_f); 2. Indirect effect mediated by *JHR* (D_a*D_e); 3. Indirect effect mediated by *TM* (D_d*D_c); and 4. Indirect effect mediated by the combination of *JHR* and *TM* (D_a*D_b*D_c). In the SD-ND model (Table 33), the direct effect of *TWU* on *CT* is not significant. The significance of the direct effect demonstrates that not all residents employed by state-owned or collective-owned work units will have a one-way commuting time less than 30 minutes. According to the decomposition of the indirect effect, the indirect effect mediated by *JHR* (0.169) and the indirect effect mediated by the combination of *JHR* and *TM* (0.396) are the primary mediation of the indirect effect of *TWU* on *CT*. The decomposition indicates that residents employed by state-owned or collective-owned work units with balanced job-housing relation have higher propensity to commute less than 30 minutes; and residents employed by state-owned or collective-owned work units with balanced job-housing relation and using non-motor vehicles are more likely to commute less than 30 minutes.

7.2.1.4. The Effect of JHR on TM

The total effect of *JHR* on *TM* is completely composed by the direct effect (eq. 28). In the SD-ND model (Table 33), *JHR* has significant and positive total and direct effects on *TM*. The value of the total effect is 0.868. Individual job-housing balance at

community level increases the propensity that residents use non-motor vehicles for commuting.

7.2.1.5. The Effect of JHR on CT

The total effect of *JHR* on *CT* is composed by the direct effect of *JHR* on *CT* and the indirect effect mediated by *TM* (eq. 30). In the SD-ND model (Table 33), the direct effect is not significant. Nonetheless, the indirect effect and total effect is positive and significant. The value of the total effect is 0.762. The total effect indicates that residents with balanced job-housing relation at community level are more likely to have one-way commuting time less than 30 minutes. Meanwhile, the insignificant direct effect indicates that residents with an imbalanced job-housing relation still may commute less than 30 minutes.

The primary conclusion of the interrelationship between endogenous variables in the housing-job selection order scenario can be listed as follows:

1) Consistent with the conclusion of the job-housing selection order scenario, individual job-housing balance at community level contributes to reduce vehicle dependency and commuting time of residents.
2) Residents with imbalanced job-housing relation still may commute less than 30 minutes.
3) State-owned and collective-owned work units provide residents more balanced job-housing relation, and further reduce the vehicle dependency and commuting time of residents.

Table 32 Fitness of Structure Equation Model

Degree of Adaptability	Reference Value	Values of the model
Degree of freedom		5.000
Chi-square		6.541
Probability level	$p > 0.05$	$p = 0.257$
RMSEA	< 0.05 (good adaptation)	0.051
	< 0.08 (reasonable adaptation)	
GFI	> 0.90	0.992
NFI	> 0.90	0.993
CFI	> 0.90	0.998
RMR	< 0.05	0.005

Table 33 Effects of Endogenous Variables Interrelationship

	Effect	Type of Work Unit	Job-housing relation	Transport Mode
Type of Work Unit	Total Effect	-	-	-
	Direct Effect	-	-	-
	Indirect Effect	-	-	-
Job-housing Relation	Total Effect	**0.743**	-	-
	Direct Effect	**0.743**	-	-
	Indirect Effect	-	-	-
Transport Mode	Total Effect	**0.540**	**0.868**	-
	Direct Effect	*-0.105*	**0.868**	-
	Indirect Effect	**0.645**	-	-
Commuting Time	Total Effect	**0.235**	**0.762**	**0.613**
	Direct Effect	-0.266	*0.228*	**0.613**
	Indirect Effect	**0.501**	**0.532**	-

Notes: Effects that are not significant presented in *italic*; *Notes:* Effects that are significant presented in **Bold**; links that are not included in the model indicated by "-"

Figure 40 Direct Effect of Interrelated Endogenous Variables

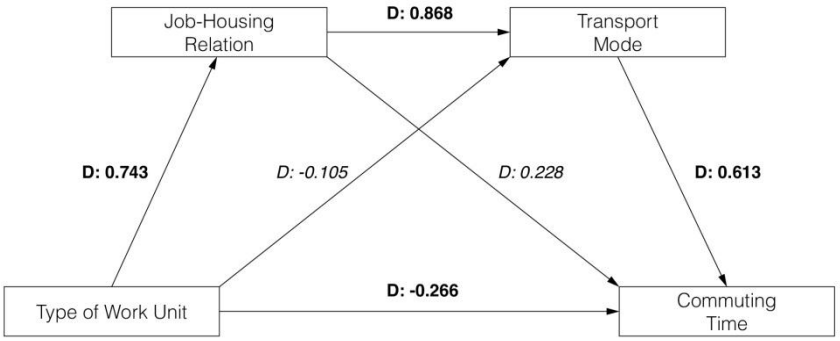


Table 34 Decomposition of Indirect Effect

Indirect relation	Mediating variable	Indirect effect
Type of work unit on transport mode	Job-housing relation	0.645
Total		0.645
Type of work unit on commuting time	Job-housing relation	0.169
	Transport mode	-0.064
	Job-housing relation and transport mode	0.396
Total		0.501
Job-housing relation on commuting time	Transport mode	0.532
Total		0.532

Notes: Effects that are not significant presented in *italic*.

7.2.2. The Effect of Self-selection Exogenous Variables on Endogenous Variables

Fig.41 displays the direct effects of self-selection exogenous variables on endogenous variables and the interrelation of endogenous variables. Total effects of self-selection exogenous variables on endogenous variables can be listed as follow:

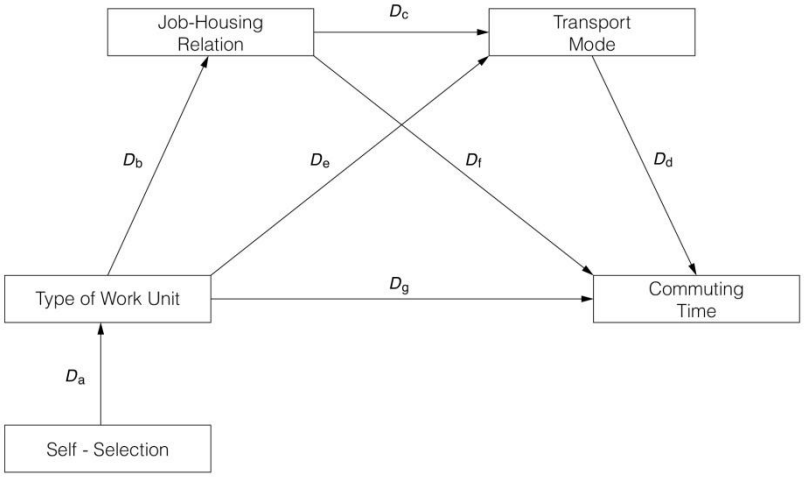
$$T_{SS-TWU} = D_a \tag{31}$$

$$T_{SS-JHR} = D_a \cdot D_b \tag{32}$$

$$T_{SS-TM} = D_a \cdot D_b \cdot D_c + D_a \cdot D_e \tag{33}$$

$$T_{SS-CT} = D_a \cdot D_g + D_a \cdot D_b \cdot D_c \cdot D_d + D_a \cdot D_b \cdot D_f + D_a \cdot D_e \cdot D_d \tag{34}$$

Figure 41 Direct Effects of Self-selection Exogenous Variables



Source: the author

According to the eq. 31 32 33 and 34, self-selection exogenous variables only generate direct effects on *TWU*. All the effects of self-selection exogenous variable on *JHR*, *TM*, and *CT* are composed by indirect effects which are mediated by *TWU*.

In the housing-job selection order scenario model (Table 35), distance to home (*DH*) and working hours (*WH*) have significant and positive total and direct effects on type of work unit (*TWU*). The total effect value of *DH* is 0.284. The total effect value of *WH* is 0.445. If residents are satisfied or very satisfied to the distance to home and working hours, these residents have higher propensity to be employed by state-owned or collective-owned work units.

Based on Table 14 and 15, more than 80% of participants of the housing-job selection order scenario consider that distance from work place to home and working hours are important or very important when select employment opportunities. Residents

have strong demands for short commuting distance, higher salary, better career development chance, and shorter working hours. SEM analysis results have demonstrated that state-owned and collective owned work units provide employees closer distance to home and shorter working hours. Residents have higher propensity to choose the employment opportunities of state-owned and collective-owned work units to meet their requirements. Additionally, SEM analysis results prove that residents of state-owned and collective-owned work units have lower vehicle dependency and less commuting time. As a consequence, residents choosing stated-owned or collective-owned work units for closer distance to home and less working hours will have higher propensity to benefit from lower vehicle dependency and shorter commuting time.

The total and direct effects of *SA* (salary) and *CD* (career development) are insignificant on *TWU*. The insignificant effects indicates that employees of state-owned, collective-owned, and other types of work units do not represent significantly different satisfaction to the career development chance and salary provided by their work units. Even though residents have strong requirement for higher salary and better career development chances, these two variables will not generate significant impact on residents' choice of work units.

7.2.3. The Effect of Socio-economic Exogenous Variables on Endogenous Variables

Fig.42 displays the direct effects of socio-economic exogenous variables on endogenous variables and the interrelation of endogenous variables in the housing-job selection order scenario. The total effects of socio-economic exogenous variables on endogenous variables can be listed as follows:

$$T_{SE-TWU} = D_a \tag{35}$$

$$T_{SE-JHR} = D_e + D_a \cdot D_b \tag{36}$$

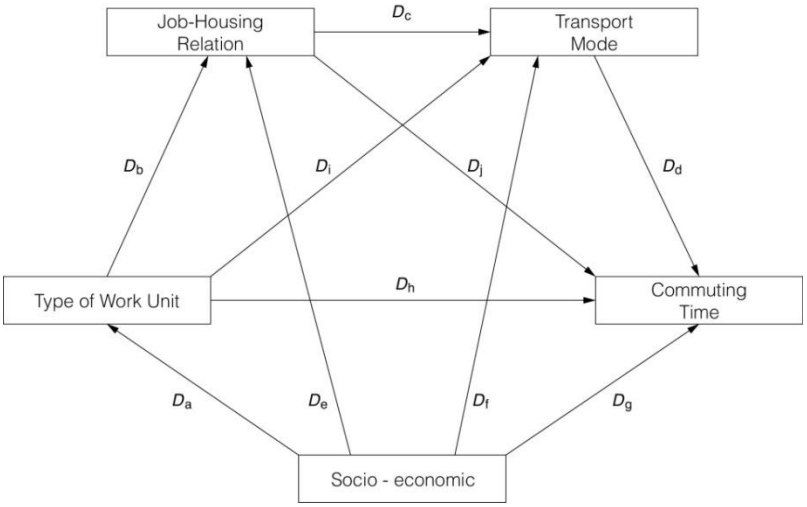
$$T_{SE-TM} = D_f + D_a \cdot D_b \cdot D_c + D_a \cdot D_i + D_e \cdot D_c \tag{37}$$

$$T_{SE-CT} = D_g + D_a \cdot D_b \cdot D_c \cdot D_d + D_a \cdot D_b \cdot D_j + D_a \cdot D_i \cdot D_d + D_e \cdot D_j + D_e \cdot D_c \cdot D_d + D_f \cdot D_d + D_a \cdot D_h \tag{38}$$

The total effects of *SE* (socio-economic factors) on *TWU* are composed by the direct effects. The total effects of *SE* on *JHR* are composed by the direct effects and indirect effects mediated by *TWU*. The total effects of *SE* on *TM* are composed by the direct effects and indirect effects mediated by *TWU*, *JHR* and the combination of *TWU* and *JHR*. The total effects of *SE* on *CT* are composed by the direct effects and indirect effects comprehensively mediated by *TWU*, *JHR* and *TM*.

In the housing-job selection order scenario model, income (*IN*) has significant and negative total and on job-housing relation (*JHR*). Residents with higher income will have lower propensity to live and work in the same community. This result is corresponded to the conclusion of the job-housing selection scenario models. The difference of salary between state-owned, collective-owned and other types of work units results in the inversely proportional job-housing relations. According to the effect of *IN* on *JHR*, *IN* further affects *TM* and *CT* with *JHR* as mediation. Residents with higher annual income will have lower propensity to use non-motor vehicles for commuting, and commuting less than 30 minutes. Education (*ED*) has significant and negative total effects on *TM* and *CT*. Residents with bachelor or higher degree will prefer to choose motor vehicle travel for commuting, and the commuting time will be more than 30 minutes.

Figure 42 Direct Effects of Socio-economic Exogenous Variables



Source: the author

In housing-job selection order scenario model, age (*AG*) has insignificant total effect on *TWU* and *JHR*. In the housing-job selection order scenario, all participants purchase houses first, and then find employment opportunities. Nonetheless, housing properties are completely tradable in housing market after Housing Reform in 1998. Before 1998, participants of job-housing selection order scenario models who had already been employed must get houses from Danwei housing welfares. Meanwhile, these participants are relatively elder than the participants of the housing-job selection order scenario. All participants of the housing-job selection order scenario purchase their housing properties after Housing Reform, and then found employment opportunities. It can be concluded that the age of these participants are relatively young without a large difference. As a consequence, *AG* is not able to significantly predict the selection of residents for *TWU*, *JHR*, *TM* and *CT*.

According to the analysis results of the housing-job selection order scenario model, the characteristics of communities and residents preferences can be listed as follows:

1) Employees that work in state-owned and collective-owned work units have higher propensity to live and work in the same community, utilize non-motor vehicles, and commute less than 30 minutes.

2) Job-housing balance contributes to decrease vehicle dependency and reduce commuting time.

3) State-owned and collective-owned work units provide employees closer distance to their living places; and shorter working hours than other types of work units. Residents who concerned about distance to home and working hours have higher propensity to be employed by state-owned and collective-owned work units.

4) The Housing-job selection order scenario is completely based on market-economic housing market. Housing selection of residents is entirely decided by the income, individual preference and life style of residents.

Table 35 Effects of Exogenous Variables on Endogenous Variables

	Effect	AG	GE	MS	ED	IN	SA	DH	CD	WH
TWU	Total effect	*0.025*	*0.098*	*-0.013*	*0.094*	*-0.013*	*0.036*	**0.284**	*0.105*	**0.445**
	Direct effect	*0.025*	*0.098*	*-0.013*	*0.094*	*-0.013*	*0.036*	**0.284**	*0.105*	**0.445**
	Indirect effect	-	-	-	-	-	-	-	-	-
JHR	Total effect	*0.031*	*-0.011*	*-0.160*	*0.238*	**-0.029**	*0.026*	**0.211**	*0.078*	**0.330**
	Direct effect	*0.012*	*-0.083*	*-0.150*	*0.168*	*-0.019*	-	-	-	-
	Indirect effect	*0.019*	*0.072*	*-0.010*	*0.070*	*-0.010*	*0.026*	**0.211**	*0.078*	**0.330**
TM	Total effect	*0.063*	*0.038*	*0.090*	**1.352**	**-0.102**	*0.019*	**0.154**	*0.056*	**0.240**
	Direct effect	*0.039*	*0.058*	*0.225*	**1.155**	**-0.079**	-	-	-	-
	Indirect effect	*0.024*	*-0.020*	*-0.138*	**0.197**	**-0.024**	*0.019*	**0.154**	*0.056*	**0.240**
CT	Total effect	*0.056*	*-0.051*	*0.230*	**1.098**	**-0.085**	*0.008*	**0.067**	*0.025*	**0.105**
	Direct effect	*0.017*	*-0.046*	*0.208*	*0.240*	*-0.019*	-	-	-	-
	Indirect effect	*0.039*	*-0.005*	*0.022*	**0.859**	**-0.066**	*0.008*	**0.067**	*0.025*	**0.105**

Note: *TLC*: type of work unit; *JHR*: job-housing relation; *TM*: transport mode; *CT*: commuting time; *AG*: age; *GE*: gender; *MS*: marital status; *ED*: education; *IN*: income; *SA*: salary; *DH*: distance to home; *CD*: career development; *WH*: working hours;
Effects that are not significant presented in italic; Effects that are significant presented in Bold; links that are not included in the model indicated by "-"

Chapter 8: Causality Explanation

8.1. Job-housing Selection Order scenario

8.1.1. Job-housing Relation of the Three Communities

According to the comparison between three types of communities, there are more residents working and living in the same community in traditional and semi-Danwei communities. Meanwhile, these residents have lower vehicle dependency and shorter daily commuting time.

The housing resource of traditional Danwei residents is still based on conventional housing welfare provision, and most of the residential buildings are located within the community where the work unit is. The housing provision mechanism facilitates the balance of job-housing relation (Logan and Bian, 1993; Bjorklund, 1986). Nonetheless, the benefit of housing provision on job-housing balance is crippled by household structures. The job-housing relation of families with a single worker, or two workers working in the same work unit are benefited from the housing provision. In a two workers family working in different work units, only one resident has balanced job-housing relation. The working place of the other family member is outside the community. According to the survey data, more than 65% of the families are two worker families working in different work units. This study considers that the effect of housing provision on promoting job-housing balance does existed but relatively limited.

In the semi-Danwei community, housing welfares had been canceled since 1998, and semi-Danwei housing properties must be purchased from housing markets. Nevertheless, there are still large numbers of semi-Danwei employees who prefer to

keep living in the original semi-Danwei houses. As a consequence, these residents purchase housing property and maintain their balanced job-housing relation in the community. On the contrary, some families move to the houses of non-Danwei community, but one family member or both of them still employed by the work unit within semi-Danwei community resulted in imbalanced job-housing relation. Additionally, housing property accessibilities in free housing markets also attract non-semi-Danwei employed residents as well. These new settlers live in the semi-Danwei community, but work in different districts of the city. Comparing with the traditional Danwei community, the semi-Danwei community maintains the same spatial pattern integrating working and living places in the same compound as well. However, the revolution of housing allocation mechanism results in different status of job-housing relation. Job-housing balance of the semi-Danwei community is relatively weaker due to the non-semi-Danwei employed residents and the move out semi-Danwei employees. Additionally, the job-housing balance of semi-Danwei community is crippled by the household structure as well, which is similar to the traditional Danwei community.

The Non-Danwei community is different from the other two types of communities. The construction, sale and maintain of the non-Danwei community are all relied on free housing markets. Consequently, there is no work unit or enterprise in the conventional sense which leads to the imbalanced job-housing relation of residents.

This study agrees with the view that Danwei provide residents more balanced job-housing relation than modern residential neighborhoods. However, this effect still exists but crippled due to the dismantling of Danwei after Housing Reform (Zhou et al, 2014a; Zhou et al, 2014b; Wang and Chai, 2009; Zhou et al, 2013). According to the

conclusion of existing studies, this research further categorized Danwei into traditional Danwei and semi-Danwei communities. Traditional Danwei communities provide balanced job-housing relation to partial residents. Nevertheless, this positive effect is whittled not only by the dismantling of traditional Danwei but also by the two workers family working in different work units.

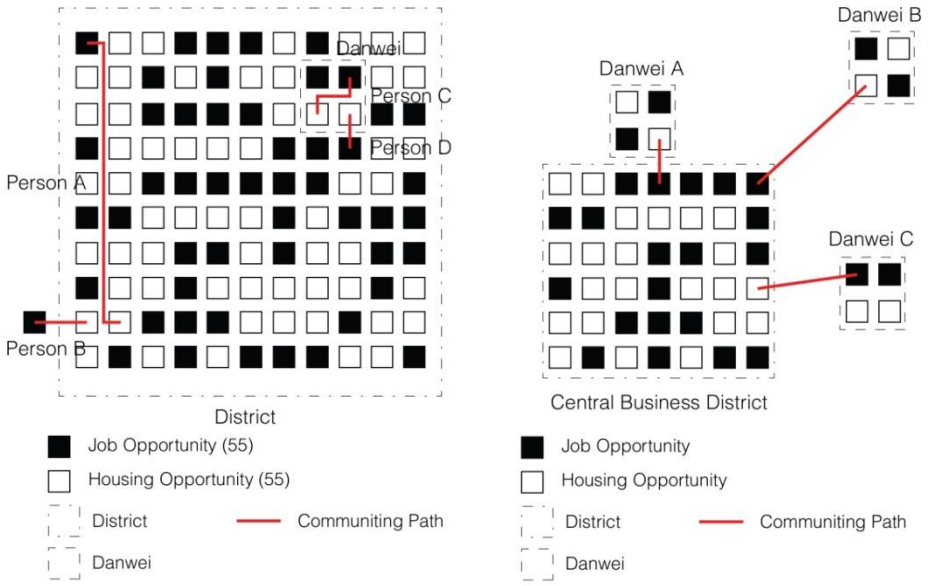
Partial traditional Danwei communities were transformed to semi-Danwei communities rather than completely dismantled. The transformation changes the traditional Danwei communities to be livable, accessible, integrated and sustainable in the post-socialist era of China (Zhang and Chai, 2014). The survived semi-Danwei communities inherit the job-housing pattern of traditional Danwei. Nonetheless, the revolution of housing allocation provides semi-Danwei housing accessibility to non-Danwei employed residents. These new settlers impair the positive effect of Danwei on job-housing balance as well.

This study concludes that traditional Danwei communities promote the job-housing balance of residents, but this positive effect is crippled by the household structure at same time. Housing Reform impairs the positive effect of the traditional Danwei community on job-housing balance. However, the effect is partially inherited by semi-Danwei communities. Household structure and the immigration of non-Danwei employed residents weaken the benefit in semi-Danwei community at the same time. The widespread and adoption of non-Danwei communities further intensify imbalanced job-housing relation under a free housing market mechanism.

8.1.2. The Effect of Job-housing Balance on Commuting

Danwei is a unique production of socialist states. It organizes working and living places at the community level. In respond to avoid the potential underestimation of the effect on commuting, this research defines the job-housing balance at the community level rather than the district level (Zhou et al, 2014a; Zhou et al, 2014b; Zhou et al, 2013) or county level (Cervero, 1989a; Margolis, 1973). The result of the SEM indicates that residents with balanced job-housing relation have a higher propensity to use non-motor vehicle methods and have a one-way commuting time less than 30 minutes. Danwei-format community integrates working and living places at the community level which is pedestrian and bicycling friendly. As a consequence, residents with balanced job-housing relation will have lower vehicle dependency and shorter commuting time. Meanwhile, the promotion result from job-housing balance at community is more reliable than the balance at district and county level. For example (Fig.43), job-housing balance at district level still may result in much further commuting distance (person A) than imbalanced relation (person B). This conclusion proposes a special scenario conflicted with the view that equal numbers of houses and employment opportunities at the county level will reduce commuting distance (Cervero, 1989a; Margolis, 1973; White, 1988; Horner, 2002, 2007; Sultana, 2002). On the contrary, the effect of job-housing balance on commuting is more reliable (person C) even when compared with a relatively short commuting distance with imbalanced relation at the community level.

Figure 43 Job-housing Balance at Community and District Level



Source: the author

Nonetheless, this positive effect is crippled by the monocentric spatial structure of Beijing (Fig.7). The second Ring Road can be regarded as the edge of the Central Business District of Beijing. Large numbers of employment opportunities are integrated inside the second Ring Road, therefore a closer distance from home to the central area will result in shorter commuting time. Compared with Bei Ji Si sanatorium (2.24 mile) and Sun Palace community (2.56 mile), Liu Pu Kang community is much closer to the central area of Beijing (0.48mile). Consequently, the non-Danwei employed residents of Liu Pu Kang community displays shorter commuting time than the other two communities. These residents still may have a relative short commuting time compared with residents with balanced job-housing relation. The monocentric structure and the location of three communities result in the lower total effect of job-housing balance on vehicle dependency and commuting time in the SEM of semi-Danwei community.

This research defines job-housing balance as working and living in the same community rather than equal numbers of housing and employment opportunities in single district or county (Cervero, 1989a; Margolis, 1973; Zhou et al, 2014a, b; Zhou et al, 2013). Job-housing balance is defined by the number of jobs and houses and neglects the influence of individual preference and socio-economic attributes (Sermons and Koppelman, 2001; Bothe et al, 2009; Cao et al, 2009; Schwanen and Patricia, 2005). Equal numbers of working and living places only provide residents an option of shorter commuting distance. If distance to work place is not the first priority when selecting houses, residents may refuse to choose the houses and jobs in the district at the same time. Measuring the job-housing relation by living and working places avoids the potential bias. Additionally, it suggests the influence of individual preference and socio-economic factors on the choice of living community and job-housing relation.

This study demonstrates that balanced job-housing relation at the community level will reduce vehicle dependency and commuting time of residents. However, the positive effect of job-housing balance on reducing commuting time is crippled by the monocentric structure and closer distance to CBDs. This study also amends the view that Danwei residents have a shorter commuting time than free market house living residents (Zhou et al 2014a, b; Zhou et al 2013; Zhao et al, 2011). The SEM models prove that traditional and semi-Danwei communities provide more balanced job-housing relation to residents, and job-housing balance reduces the vehicle dependency and commuting time of these residents. Traditional Danwei or semi-Danwei residents without balanced job-housing relation still have high propensity to suffer from long commuting time with motor vehicle travel method.

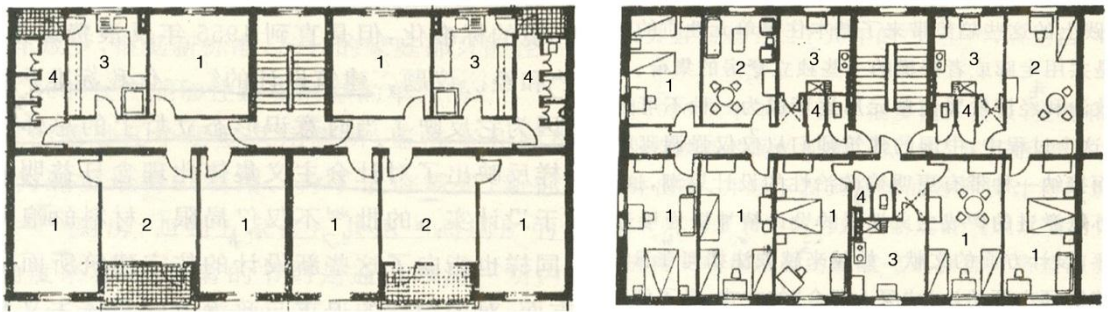
8.1.3. Effects of Individual Preference and Life Style on the Choice of Community

Existing studies have demonstrated that individual preference and lifestyle will affect residents' choice of housing and commuting time (Bothe et al, 2009; Cao et al, 2009; Schwanen and Patricia, 2005). This study finds that housing quality, elementary school, daycare center, distance to work place and talk frequency significantly impact on the choice of living community. This research implements satisfaction degree to reflect the quality of the attributes; and importance degree to measure the requirement of residents to the attributes.

8.1.3.1. Housing Quality

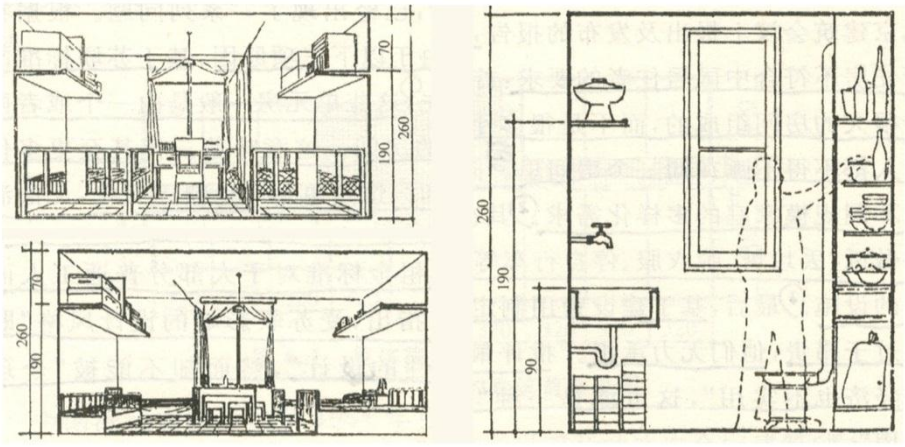
The SEM result indicates that traditional and semi-Danwei residents represent lower satisfaction to their houses. It suggests that housing qualities of traditional and semi-Danwei communities is lower than the non-Danwei community. During the design phase of the traditional Danwei community since 1955, architects and planners had to meet the housing demand of residents with limited funds provided by governments. As a consequence, the per capita living space was reduced from $9m^2$ which was suggested by the soviet architects to $4m^2$. Seventy percent of families were able to live in one-bedroom apartments without a kitchen or restroom, and only 20% of families can live in multi-bedroom apartments (Bray, 2014). The area of each one-bedroom apartment is about $19.2m^2$ (width: 3.2m x depth: 6m). Each floor had a rest room and kitchen for public use (Fig.44 and Fig.45). Traditional Danwei housing displays smaller size, inconvenient layout and elder condition, therefore residents evaluated a lower satisfaction degree.

Figure 44 Floor Plan of Traditional Danwei Houses



Notes: 1. Bedroom (each family lives in one bedroom); 2. Living room; 3. Kitchen; 4. Bathroom.
Left: dormitory, every three families shares one public kitchen, one public living room, and one public bathroom. Right: apartment

Figure 45 Spatial Composition of Traditional Danwei Housing (centimeter)



Source: Bray, 2005

The Semi-Danwei community is transformed from the traditional Danwei community. The majority of buildings with elder condition are maintained as well (Fig.46). Only parts of old buildings were reconstructed to new residential buildings from the 1980s to 1990s. The interior areas of apartments in Liu Pu Kang community are from $40m^2$ to $95m^2$. The house types of the apartments include one-bedroom apartment, two-bedroom apartment and three-bedroom apartment with private bathroom

and kitchen (Fig.47). Compared with the Danwei housing designed in 1950s, these reconstructed residential buildings offer residents relatively larger living space and more convenient life. Nevertheless, the conditions of these reconstructed residential buildings are limited compared with non-Danwei community (Fig.46).

Figure 46 Building Conditions in Liu Pu Kang and Sun Palace Communities



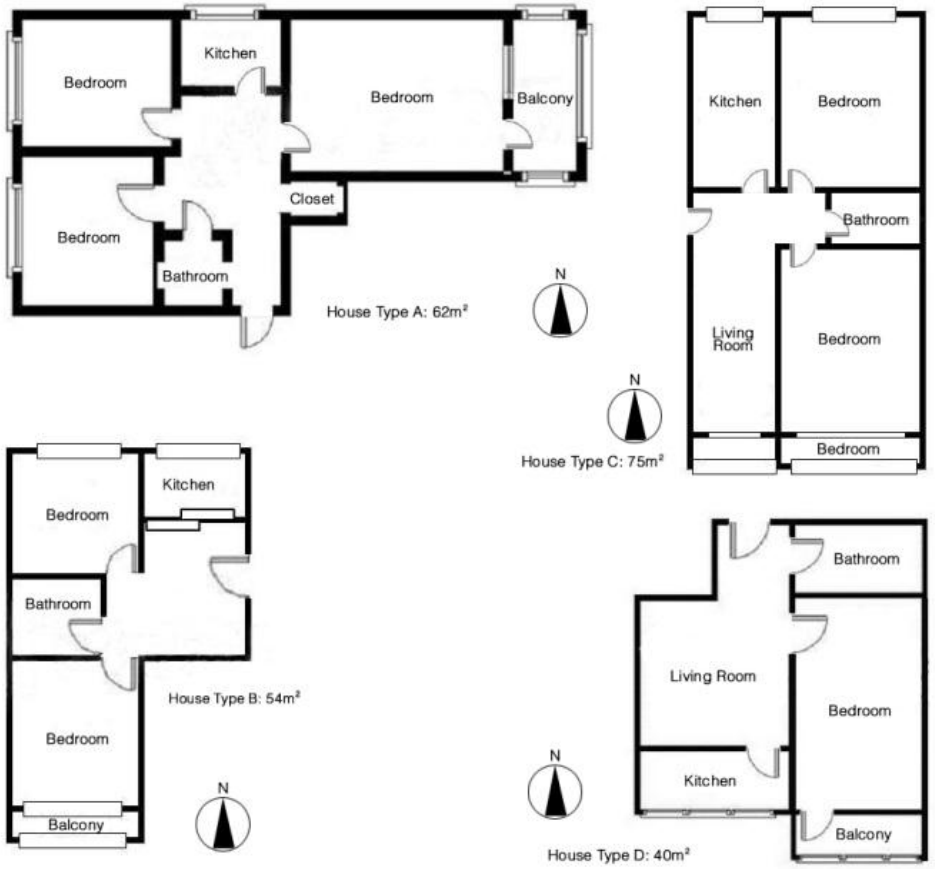
Note: a to d represent the residential building constructed in 1950s, 1980s, and after 1990s in Liu Pu Kang community. e and f are residential buildings of Sun Palace community

Source: the author

Non-Danwei communities are constructed under the guidance of free housing market since Housing Reform in 1998. The dominant right of housing allocation is transformed from Danwei to customers. Purchasing capacity of residents directly decides the quality of housing. Developers prefer to design and construct new residential buildings with larger interior area and more convenient spatial layout. The interior areas of apartments in Sun palace are from $94m^2$ to $246m^2$ which are much larger than the apartments of Liu Pu Kang community (Fig.48). Meanwhile, the house

types of the apartments are increased to four bedroom apartment or five bedroom apartment. The dining room, cloakroom and study are added into the spatial layout.

Figure 47 Floor Plans of Apartments in Liu Pu Kang Community

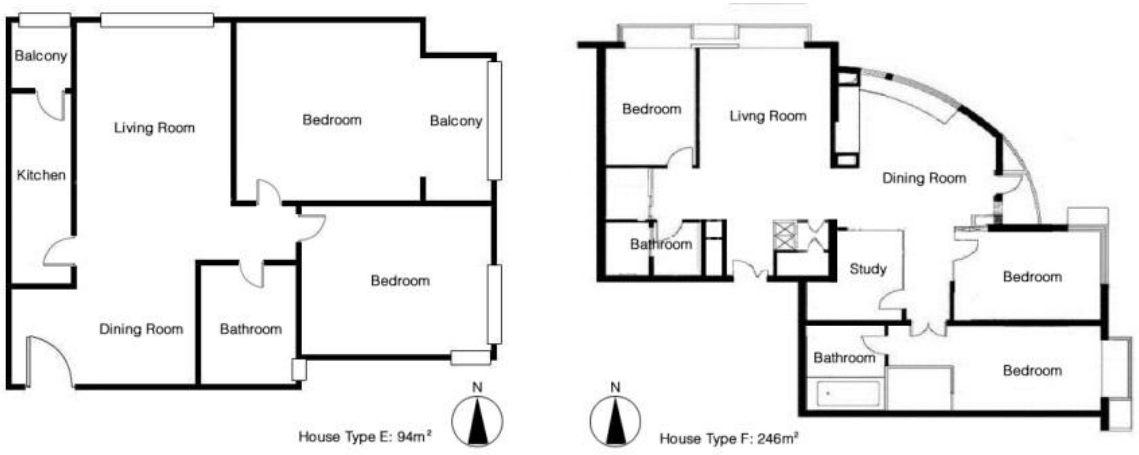


Source: http://bj.5i5j.com/exchange/112001537; http://bj.5i5j.com/exchange/123263280 http://bj.5i5j.com/exchange/124924797;http://bj.5i5j.com/exchange/126457950

The larger interior area, more convenient spatial layout and better condition of the buildings win higher satisfaction of non-Danwei residents than traditional and semi-Danwei residents. It results in a different requirement degree to housing quality in the three types of community at the same time. According to the descriptive statistic, more than 95% of participants in the three communities consider that housing quality is important or very important when purchase a new house. The quality of housing will

affect residents' choice of living community. Residents of traditional and semi-Danwei communities represent higher importance degree to housing quality. It reflects a stronger requirement of the residents for houses with larger size, better condition and more convenient layout. It also can be concluded that housing quality is the defect of traditional and semi-Danwei communities. Residents will prefer to live in non-Danwei community for better housing quality, and further result in imbalanced job-housing relation. This result supports the view that preference of special housing characteristic may take the place of distance to job becoming the first consideration when selecting housing location (Bohte et al, 2009; Cao et al, 2009).

Figure 48 Floor Plans of Apartments in Sun Palace Community



Source: http://bj.5i5j.com/exchange/125070515; http://bj.5i5j.com/exchange/121791671

8.1.3.2. Distance to Job

This study has demonstrated that the integration of working and living places at the community level provides residents of traditional and semi-Danwei communities shorter commuting time. The average commuting time of traditional and semi-Danwei communities (25.6 min and 27.8 min) do not display a large difference. On the contrary,

the average commuting time of non-Danwei community (76.4min) is about three times longer than traditional and semi-Danwei communities. It is consistent with the result of SEM that traditional and semi-Danwei residents have higher propensity to commute less than 30 minutes. Consequently, these residents represent higher average satisfaction degree to the distance from home to work place.

More than 90% of participants in the three communities consider distance to job is important or very important when purchasing a new house. Due to the household structure and tradable housing properties, not only non-Danwei residents but also parts of the traditional and semi-Danwei residents represent strong requirements for shorter commuting distance to work place. According to the data of the research, there are more than 25% of participants in traditional and semi-Danwei communities, and more than 60% of participants in the non-Danwei community that have one-way commuting time longer than one hour. Bus, metro and private vehicle are the first preference of these residents for commuting. Nonetheless, the total annual volume of passengers by bus and metro in Beijing is increased from 4423.45 million person time in 2005 to 4843.06 million person time in 2013. The total volume of private vehicle in Beijing is increased from 1.54 million in 2005 to 4.23 million in 2013 (Statistical Yearbook of Chinese Cities, 2014). More residents in China's megacities have accepted "urban working and suburban living" (Chen & Pu, 2002). Further commuting distance enlarges the commuting volumes and vehicle dependency which outpace the capacity of urban transportation, and leads to the deterioration of congestion and crowed public transportation. The crowed travel condition and over long waiting time results in the stronger requirement for shorter distance to work place (Fig.49). Residents the of non-

Danwei community display a stronger requirement than traditional and semi-Danwei communities. It can be concluded that residents will be attracted to live in traditional and semi-Danwei communities for shorter commuting distance.

Figure 49 Over Capacity of Public Transportation and Ground Traffic



Source: http://tech.gmw.cn/2013-09/19/content_8952429.htm
http://money-hzrb.hangzhou.com.cn/system/2013/01/07/012272013.shtml
http://bbs.tiexue.net/post2_6838465_1.html

Note: the first picture describes the congestion part of the 3rd Ring Road near the Sun Palace community. The second picture is the metro station of Beijing's No. 10 line where the Sun Palace located. The last picture is the bus station on the 3rd Ring Road.

8.1.3.3. Elementary School and Daycare Center

This study proves the view that not only distance to job but also requirement for education will result in different housing choices and commuting patterns (Wachs et al, 1993). The majority of education resource allocation in China is based on the Hukou system and the service radius of elementary schools and daycare centers. Each resident has a hukou which records the permanent address of the resident. If the permanent address is located within the service radius of elementary school or daycare center, this resident is qualified to receive education in the school or daycare center. As a consequence, the houses located within the service radius of key elementary school and daycare center becomes the scarce approaches to superior education resource. Residents who require superior education for their children will prefer to live in these school district houses. Parents also prefer the houses within the walk zone of school for closer

distance to school for their children (La, 2015). Meanwhile, the allocation of school with high popularity ranking is accorded to the economic values of houses within 1-km school zone (Agarwal, 2016).

According to the descriptive statistic and the result of SEM, residents of Liu Pu Kang community represent higher degrees of satisfaction to the elementary school and daycare centers than residents of Bei Ji Si Sanatorium and Sun Palace. Liu Pu Kang community is located within the service radius of the Primary School Affiliated to the Normal School of Xicheng District of Beijing (NS primary school); Bei Ji Si Sanatorium is covered by the service radius of the Primary School Affiliated to the Beijing Medical University (BMU primary school); and Sun Palace community is within the service radius of RDFZ Chaoyang Primary School (RDFZ primary school). There are in total 60 primary schools in Xicheng District, and NS primary school is ranked 4th in comprehensive education quality; BMU primary school is ranked 22th in the 97 primary schools of Haidian District; and there are in total 86 primary schools in Chaoyang District, and RDFZ primary school is not classified as key school in the district (Beijing Municipal Education Commission, 2015). Compared with the other two elementary schools, NS primary school is not only classified as a key school but also ranked as a top school. The title and status reflects the superior quality of education which results in higher evaluation of the residents. All the daycare centers of the three communities are not ranked as key kindergartens by the Beijing Municipal Education Commission. Nonetheless, the daycare center of Liu Pu Kang is authorized, financially supported and operated by the China National Petroleum Corporation (CNPC) which is ranked as the 2nd of China's top ten enterprise, and 4th of FORTUNE 500 firms

(FortuneChina, 2015). The daycare center is the primary service for the children of the employees of CNPC. The abundant funds and strict management provided by CNPC will guarantee the quality, environment and facilities of education for children. Consequently, residents of Liu Pu Kang community represent higher satisfaction to the elementary school and daycare center than the other two communities.

It is generally believed by Chinese parents that enter a key elementary school and daycare center is an essential foundation for children to enter key high schools and universities, and further achieve the success of career development. The average price of school district house is 69,000 RMB per square meter in Xicheng District and 64,000 RMB per square meter in Haidian District which maintains growth tendency since 2013 (FOCUS, 2016). The increasing prices of school district houses reflect the demand of parents for the key elementary school and daycare center for their children. Consequently, the choice of houses will be affected not only by distance to the school but also for the level of education. Most of the daycare centers and elementary schools supported by Danwei have longer history, more sufficient funds and more prominent teachers than newly-built non-publicly funded schools. Hence, residents of the non-Danwei community displays a stronger demand for better elementary schools and daycare centers than the other two types of communities. Residents of the non-Danwei community will prefer to live in traditional and semi-Danwei communities for the school district houses and the qualification of their Children to enter key schools and kindergartens.

8.1.3.4. Sense of Belonging

The result of SEM indicates that residents of traditional Danwei community have higher talk frequency than semi-Danwei community. Meanwhile, the talk frequency of non-Danwei community residents is much lower than the previous two. The different talk frequencies are resulted from the sense of belonging to the communities.

Social life within traditional Danwei always attempt to occur within or around working and residential areas where informal contact happen and fill the gap between working and residential areas (Bjorklund, 1986). The high self-sufficiency and walling space create the collectivized social life within tradtional Danwei. Employees are highly possible to contact their colleagues in service and living areas. Meanwhile, the walling spatial and access control prevent the entrance of non-Danwei residents which increase the contact possibility as well. The collectivized social life is occurred at apartment level, cluster level and Danwei level (Bray, 2005). At the basic level, residents in each floor of the apartment share the public bathrooms and kitchens; residents of every two or three apartments share laundries, bicycles sheds and open spaces at cluster level; and all residents of the compound share the service facilities such as dining hall, recreation center, medical care center and primary school at Danwei level. The service provided by Danwei and the communication between residents form the trust and reliance of residents to tradtional Danwei, and further transform to the sense of belonging. Sense of belonging is hard to be defined to every resident. It is also difficult to be measured. Talk frequency is an appropriate indicator to describe the intensity of sense of belonging.

Hence, residents of traditional Danwei community have higher talk frequency than the other two communities.

Housing Reform reconstructs partial of the original apartments and provides more private kitchens and bathrooms to the families in the new residential buildings. These private spaces decrease the possibility of the contact and communication between residents. Additionally, the moving in of non-Danwei employed residents reduces the possibility of contact as well. Nonetheless, the integration of working and living areas, and the facility sharing at cluster and community level still maintain the sense of belonging to some degree. As a consequence, residents of semi-Danwei community will have relative lower talk frequency with neighbors than traditional Danwei community. There is no integration between working and living areas in the non-Danwei community. All the communication and contact are only based on the facility sharing but without contact in working areas. The lack of the contact results in the lowest talk frequency of non-Danwei community.

The research data indicates that more than 80% of the 180 participants consider that talk frequency is important or very important when purchasing new houses. A sense of belonging is negatively correlated with loneliness and acts as a protective role to prevent the experience of loneliness (Prieto-Flores, 2011). Non-Danwei residents represent the strongest requirement for higher talk frequency with neighborhoods. The requirement for a sense of belonging is relatively lower than the previous four self-selection attributes. This result still proves the requirements of residents for social life and reliance, especially for non-Danwei residents. Residents will prefer to live in traditional and semi-Danwei communities for a stronger sense of belonging.

8.1.4. Effects of Socio-economic Factors on the Choice of Community

The result of SEM indicates that the elderly have higher propensity to live and work in the same community, females have higher propensity to work and live in the same community, and residents with higher annual income have lower propensity to achieve job-housing balance. Only these three relationships are consistent in the four models, and support the view of Wang and Chai (2009).

The salary offered by the state-owned work units and collective-owned work units are relatively lower than other kinds of enterprises such as Limited Liability Corporations and Share Holding Corporations. As a consequence, residents with higher income are able to purchase new constructed houses within non-Danwei communities, which results in an imbalanced job-housing relation.

Both traditional and semi-Danwei communities provide housing welfare to employees before Housing Reform in 1998. Elderly residents employed by Danwei before 1998 have higher propensity to acquire Danwei housing through housing welfare mechanism.

Wang and Chai (2009) also demonstrate that marital status, education background and occupation affect the job-housing relation of residents. Nonetheless, these three relationships are not significant in the SEM models of this research. The research of Wang and Chai (2009) is based on the data collected in 2001, three years after the Housing Reform policy was carried out. The data of this research is collect from June to December 2015. Before Housing Reform, housing allocation in traditional Danwei was a queuing process based on formal point system. Marital status, seniority and occupational skill level are utilized to evaluate the ranks of employees which

decided the size, condition and location of the allocated houses (Logan and Bian, 1993; Bjorklund, 1986). In 2001, even though Housing Reform had been implemented for three years, residents' attitudes to housing and life styles still partially remained in the plan-economy era. In 2015, Housing Reform had been implemented for 17 years. Income is highly correlated to the purchasing power of residents which becomes the dominant factor deciding the availability and affordability to houses. Meanwhile, Beijing experienced fast urbanization with changes of spatial structure, transportation capacity, and economic development. The progress affected the attitudes and preferences of residents to choose houses.

The invalidation of primary socio-economic factors on housing resource reflects the completed transformation of the housing allocation mechanism from the Danwei housing provision based to the free housing market based.

8.2. Housing –job selection order

In the housing-job selection order scenario, the result of SEM displays the same tendency that residents with balanced job-housing relation will be more likely to prefer non-motor vehicle for commuting, and commute less than 30 minutes as job-housing selection order scenario. It certifies that integrating working and living places at the community level effectively reduces vehicle dependency and commuting time of residents.

State-owned work units provide residents more balanced job-housing relation than Limited Liability Corporation and Joint Ownership Corporation. Nonetheless, this positive effect is crippled in the opposite selection order. In the job-housing selection

order, the housing provision mechanism of state-owned work units guarantee that working and living places of employees are located in the same communities. Even though purchasing houses through free housing markets, it is still easier for residents to purchase houses surrounding their work places than finding employment opportunities surrounding their living places. There are more abundant high quality houses than employment opportunities. The integration of working and living places in semi-Danwei communities still provides residents the possibility to find appropriate jobs close to their houses. However, the limited amount of employment opportunities which matches the preference of residents weakens the job-housing balance of residents who purchase houses in semi-Danwei communities.

Residents' preference to employments opportunities significantly affects job-housing relation mediated by the type of work unit. Residents who feel satisfied or very satisfied to their commuting distance to home and working hours have higher propensity to be employed by state-owned work units. As the discussion above notes, urban sprawl, crowed travel conditions, and congestion result in the requirement for a shorter distance to work place. Therefore, employees of state-owned work units with a balanced job-housing relation represent higher satisfaction to the distance to home. Additionally, employees of Limited Liability Corporation and Joint Ownership Corporation may suffer from longer daily commuting distance, and display a stronger requirement to reduce it.

Employees of state-owned work units represent shorter daily working hours than Limited Liability Corporation and Joint Ownership Corporation. It has been demonstrated that longer working hours are the dominant risk factor of work accident

and health decline of employees (Lee, 2016). Meanwhile, extra working hours prevent female employees from their family obligations (Hjorthol and Vågane, 2014). Consequently, employees of Limited Liability Corporation and Joint Ownership Corporation display a stronger requirement for shorter daily working hours.

The relationship between salary and job-housing relation is accordant with the job-housing selection order scenario. State-owned work units provide employees relatively lower salary. Meanwhile, employees of state-owned work units represent a more balanced job-housing relation. Hence, employees with lower salary have higher propensity to achieve job-housing balance.

Chapter 9: Discussion and Conclusion

This research examines commuting behaviors and demands for three types of communities in Beijing, China. The research supports the conclusion that the job-housing relation in traditional Danwei is more balanced than that in non-Danwei (Zhou et al, 2013; Zhao et al, 2011). Additionally, this research finds that Semi-Danwei maintains the spatial pattern found in traditional Danwei, and operates with relatively less balanced job-housing relation under the free housing market condition. This research also resonates with the existing studies concluding that the dismantling of traditional Danwei communities will cripple the benefits to the job-housing balance. When traditional Danwei communities are phased out, there will be a predictable increase in vehicle travel demands for daily commuting (Wang and Chai, 2009; Zhou et al, 1989a, b). This study demonstrates that semi-Danwei communities partially inherit the benefit of traditional Danwei on commuting demands rather than absolutely eliminated.

This study also supports the view that balanced job-housing relation contributes to lower vehicle dependency and shorter commuting time (Horner, 2002; Sultana, 2002, 2007; Levinson, 1998). This study defines job-housing balance at the community level, and hence, alleviates the bias caused by cross-district short distance commuting rather than the definition of balance at the district or county level (Cervero, 1989a; Margolis, 1973). Nonetheless, the positive effect of job-housing balance will be weakened due to the closer distance from home to CBDs as employment centers within a monocentric city.

The research results confirm that Beijing's housing allocation mechanism has substantially transformed from a planned economy to a market economy. In the planned economy era, traditional Danwei takes the full responsibility to the housing demand for employees. The housing allocation is implemented through a rank system based on the assessment of individual characteristics including education, occupational standing, marital status and political position (Logan and Bian, 1993; Bray, 2005). After the Housing Reform in 1998, purchase power reflected by annual income replaces the housing allocation rank system, and largely determines the housing choices to residents. The decisions of housing locations and types of living communities in China are primarily affected by individual preferences and life styles rather than socio-economic attributes.

This research also supports the view that commuting behaviors are not only affected by urban form but also by individual preferences and life styles (Guilano and Small, 1993, Bothe et al, 2009; Cao et al, 2009; Schwanen and Patricia, 2005). Housing quality, distance to job, elementary school, daycare center and sense of belonging significantly affect residents' choice of community type. Traditional and semi-Danwei communities represent higher qualities of primary school and daycare centers, shorter commuting distance and stronger sense of belonging, but are also associated with lower housing quality than non-Danwei communities. Residents of non-Danwei communities display stronger requirements for the improvement of the above mentioned four attributes, and prefer traditional and semi-Danwei communities when purchasing new houses. This preference will further lead to more balanced job-housing relation, lower vehicle dependency, and shorter commuting time. Relatively speaking though, residents

of traditional and semi-Danwei communities may select non-Danwei communities for better housing quality, and result in the increasing of vehicle dependency and commuting time.

This research result also indicates that different employment and housing opportunities selection order can lead to various commuting behaviors and demands. If residents purchase houses first, residents employed by state-owned work units have higher possibility to achieve job-housing balance than other types of enterprises. Nevertheless, this positive effect on job-housing balance is lower than the effect of traditional and semi-Danwei housing on job-housing balance in the job-housing selection order scenario.

The fast urbanization draws a large population base to China's megacities, and exacerbates the urban sprawl which forms the suburban living - central working commuting pattern within monocentric structures. This research indicates the factors that affect residents' choices of living community, and influence the job-housing relation and commuting behaviors. These findings offer guidance and criteria to planners and architects for the land use and residential community planning to reduce commuting time and vehicle dependency.

The integration of working and living places at the community level effectively encourages non-motor vehicle commuting and reduces the commuting demand. The housing provision mechanism of traditional-Danwei and semi-Danwei before 1998 provides Danwei employees the feasibility to work and live in the same communities. After the Housing Reform, free housing market provides Danwei employees alternatives based on their individual preferences. Danwei residents may purchase

houses from free market residential communities for better housing quality. In response to detaining Danwei employees kept living in Danwei communities for balanced job-housing relation, more attention should be paid to the reconstruction of residential buildings during the redevelopment and renewal of traditional and semi-Danwei communities. Large usable floor areas, better layouts with more convenient functions and conditions of new houses will retain higher satisfaction from employees, and encourage them to work and live in the same communities.

In non-Danwei communities, the free housing market substitutes for housing provision, and disrupts the integration of jobs and houses at the community level. It is hard for planners to refine commuting distance at the community level unless distance to job becomes the first priority of residents when purchasing houses. Danwei based spatial pattern and land use offer a successful example to achieve job-housing balance and reduce the commuting demand. This research roughly assumes that a new type of community aims to reducing commuting demand and vehicle dependency. From the residential planning and design perspective alone, free housing market communities should imitate a Danwei based spatial pattern and land use. The balance between the numbers of houses and employment opportunities at the community level can be similar as the spatial job-housing balance at the county level (Cervero, 1989a; Margolis, 1973). Nonetheless, depending only on spatial job-housing balance probably generates limited or no effect on reducing commuting time (Guiliano and Small, 1993; Wachs et al, 1993; Suziki and Lee, 2012). Residents still may not be willing to live and work in this new type of community due to various individual preferences and lifestyles unless the residents who take commuting distance as their first priority.

According to the modeling result of this research, residents of non-Danwei communities express strong requirements for reducing commuting distance, intensifying the sense of belonging to communities, and improving the qualities of elementary schools and daycare centers. If the new type of community meets the demand of residents to these four attributes, residents will prefer to live in this new type of community, and achieve individual job-housing balance. The integration of working and living places at the community level forms not only the foundation for individual job-housing balance but also the sense of community belonging. Social activities within traditional Danwei always attempt to occur within or around working and residential areas where informal contacts happen, and thus fill the gap between working and residential areas (Bjorklund, 1986). The integration provides employees more possibilities to get in touch with their colleagues after work. The termination of living welfare such as dining hall and public bath houses impairs the collectivized social life style. Their identities transform from employees to residents with in the same community. The overlap between their working behaviors in working hours and social habits in their spare time reinforces the reliance to the community.

Child education is very important to Chinese parents. Because the hukou system largely determines the accessibility to education resources, community elementary schools and daycare centers may be the first priority to consider when purchasing new houses. High quality of primary school and kindergarten is necessary to attract employees to live in the houses provided by any new community. Education quality is comprehensively evaluated according to professional level of teachers (teaching quality), number of high quality teachers, capital for education, and condition of classrooms and

facilities. The improvement of building and facility qualities can be achieved during planning and design phase of the community. However, the distribution of funds and deploy of teachers are determined by city education bureaus and the Chinese Ministry of Education. The contribution of planners and architects to the improvement of satisfaction to the community school and kindergarten is limited.

The results from SEM also indicate that housing quality will affect residents' selection of houses. Residents of non-Danwei communities represent high satisfaction to housing qualities. The residential building design of a new type of community needs to maintain a similar size, condition and layout of non-Danwei community house styles.

Five attributes of individual preferences affect residents' choice of houses and communities. Nevertheless, this research also demonstrates that housing price and purchase power ultimately determines the houses they preferred. Even though all the attributes of the new type of community meet the requirements of residents' preferences, affordability still may prevent residents from working and living in this new type of community. A new housing system matched with the new type of community is necessary to remove the obstacle to affordability.

This research is only the initial phase to evaluate the impact of the three types of communities on commuting and vehicle dependency. In the planned economy era, Danwei communities are designed with various working units such as factory, university, hospital, military and governmental departments. Also, this research selects hospital and governmental departments for case study. In the future, there should be more comprehensive case studies including other types of work units to measure the relationship between socio-economic, self-selection and commuting status. Moreover,

this research focuses the effect of three types of communities on commuting at the community level. Since community is one of the basic units that composes a city, a simulation over a city composed by traditional, semi and non-Danwei communities may be an effective way to measure and compare the effects of different communities on commuting at the city level. Finally, in order to achieve job-housing balance at the community level in the market economy era, this research considers that a new housing allowance is necessary. Additional research is needed to test the feasibility and rationality of this new mechanism based on different housing prices and real estate development stages.

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Appendix A: Questionnaire Paper

What is your Age: _____

What is your Gender: Male / Female

What is your Education Background: High School / Bachelor / Master / Ph. D. / Other_____

What is your Marital Status: Single / Married / Divorced / Widowed

What is your annual income (RMB): _____

What type of work unit are you employed?

State-owned / Collective-owned / Cooperative / Joint ownership / Limited Liability Corporation

Please describe the people who live in your household:

Single worker family / Two-worker family, work in the same work unit / Two-worker family, work in different work units

What was the order of employment and housing selection for you:

find job first and then find housing

find housing or already have housing and then find job

1). How long does it take to travel from your home to your work place?

A. Less than 15 min B. 15 – 30 min C. 30 – 60 min D. 1 – 2 hours E. More than 2 hours

2). How do you get to go to your work place?

A. Walking B. Bicycling C. Bus and metro D. Taxi E. Private Car

3). Is your work place in the community where you live?

A. Yes B. No

4). What percentage of your transportation time is for commuting to work?

A. Less than 20% B. 20% - 40% C. 40% - 60% D. More than 60%

5). In one month, how often do you talk with the people who live in the same living community?

A. 0 B. 1 C. 2 – 4 D. 5-10 E. More than 10

6). Would you be able to tell me the names of 10 residents' name that live in the same living community as you?

A. Yes B. No

7). Compared to other living communities, Do you feel more or less pride in your living community?

A. More B. Less

8). Where do you prefer to shop for your food?

A. Retail shop or super market in your living community B. Retail shop or super market outside your living community C. Other

9). How do you travel to buy food?

A. Walking B. Bicycling C. Bus and metro D. Taxi E. Private Car

10). If you are going to exercise, you will go to an_____

A. Openspace, park or gym in the living community where you live

B. Openspace, park or gym around the living community where you live

C. Others

11). How do you travel to exercise?

A. Walking B. Bicycling C. Bus and metro D. Taxi E. Private Car

12). The elementary school you choose for your children is _____ (If your do not have a child yet, or your child is not at the age for school yet, the elementary school you plan to choose for your child is)

A. In your living community B. Around your living community C. Others

13). How will you (or plan to) take your children to school?

A. Walking B. Bicycling C. Bus and metro D. Taxi E. Private Car

Please describe how satisfied you are with the ability you have to do these activities in your living community. If your living community does not offer these activities, please select N/A (Not Offered).

	N/A	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
Housing quality						
Distance from home to job						
Elementary school						
Day care center						
Medical care center						
Recreation center						
Retail shop						
Open space or Park						
Environmental quality						
Salary of your job						
Career development in your work unit						
Working time of your work						

If you could move to a new living community in one year, how important would these things be in your decision about where to live?

	Very important	**Important**	**Neutral**	**Unimportant**	**Very Unimportant**
Housing quality					
Distance from home to job					
Elementary school					
Day care center					
Medical care center					
Recreation center					
Retail shop					
Open space or Park					
Environmental quality					
Salary of your job					
Career development in your work					
Working time of your work					