Gender-Role Based Differences in Time Allocation: A Case Study of Shenzhen, China

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Abstract

Previous studies on daily time allocation have shed light on individuals' trade-offs regarding time allocation within a fixed time budget. However, interpersonal interactions of time allocation with a social network are far from being understood, largely due to limited research in this area. Further, few studies have focused on residents of China, whose population is largest in the world and whose culture is quite different from western countries. Using the data collected from 261 households in Shenzhen, this study applies structural equations models to investigate time allocation of male and female household heads on the weekday and weekend. The results show clear household activity roles of Chinese residents: men are dominant in out-of-home activities, but women dominate in-home activities. This study also offers some insightful interpersonal interactions of activity participation between household heads.

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Introduction

As an essential component of activity-based travel analysis, time-use research includes studies focusing on daily time allocation, activity episode duration, and activity timing and scheduling. Although daily time allocation research does not consider the time window when a certain activity is pursued, the duration that the activity lasts, and the sequences in which the activity is scheduled, it provides insightful understanding of individuals' trade-offs regarding time allocation within a fixed time budget – 24 hours a day and seven days a week (Bhat and Koppelman, 1999; Pendyala, 2003). For example, using the data from Washington, DC Standard Metropolitan Statistical Area, Chapin (1974) studied household time allocation on both weekdays and weekends. He found that besides sleep, work-related activities and maintenance activities were the major activities during the weekdays but leisure activities were more likely to be performed on the weekend. Bhat and Misra (1999) found that work duration during the weekdays and age are the most important predictors of discretionary time allocation in their Netherlands sample.

In most studies, an individual person is usually taken as the primary unit in the analysis of activity participation and travel behavior. However, when making the decisions, one member in a multi-member household may coordinate with other members. As the wife in a nuclear family is cooking, the husband may have to take care of kids. On the other hand, if the husband spends more time on work or works overtime, the wife will shoulder more maintenance activities such as cleaning and grocery shopping. These interactions require collective decisions of household members regarding activity engagement and trip-making behavior. Therefore, the models based on individuals' behavior are inadequate to capture these trade-offs of household members, and hence it becomes important to incorporate interpersonal interactions (as well as intrapersonal interactions) in activity-based microsimulation of travel demand. As discussed in the next section, a number of studies have shed light on understanding intrahousehold interactions of activity participation and time allocation. However, "much remains to be explored and learnt" (Bhat and Pendyala, 2005, p.447).

The purpose of this paper is to explore gender-role based differences of Chinese residents in time allocation between household heads, and between weekday and weekend. As far as we know, this study is the first application of structural equations models to the data from China. The next section reviews literature regarding intrahousehold interactions. Section 3 describes the survey method, data, and variables. Section 4 investigates gender differences in activity participation and time allocation using bivariate tests. Section 5 presents a conceptual model and discusses model results. The final section recapitulates the key findings.

Literature Review

During the past decade, a number of studies have pointed to understanding intrahousehold interactions of activity engagement. Generally, the methodology used in these studies can be grouped into four categories (Kato and Matsumoto, 2006). The first approach is based on structural equations models (SEMs) (e.g., van Wissen, 1989; Pendyala, 2003); the second approach is based on discrete choice models (e.g., Srinivasan and Athuru, 2005; Wen and Koppelman, 1999); the third approach is based on time allocation models (e.g., Kato and Matsumoto, 2006; Zhang et al., 2005); the last approach is based on microscopic simulations (e.g., Meister et al., 2005). SEMs are used in this study.

Previous research found interesting intrahousehold interactions. Using the Dutch Panel data, van Wissen (1989) employed SEMs to estimate substitution, companion, and complementary effects for three types of activities: shopping, recreation, and visits. He found that complementary effects tend to be pervasive for all activities; companionship relations are important; but substitutable relations lack empirical support. Overall, the working duration of the male greatly determines the activity patterns of both partners; the employment status of the female is important in determining household activity roles but her working duration influences mainly her own nonwork activity duration; and all nonwork activities by the male are influenced by the female's behavior. He also found that recreational activities carry a larger variation than shopping and visits.

Using the data from the 1994 Portland Activity and Travel Survey, Golob and McNally (1997) developed an SEM to capture connections between activity participation and associated derived travel, links between activities pursued by both household heads, relationships between types of travel, and time-budget feedbacks from travel time to activity durations. They classified activities into three broad types: work, maintenance, and discretionary. Activity duration and travel time for these three types of activities, and for men and women were chosen as endogenous variables. With respect to intrapersonal activity interactions, they found negative associations between maintenance activity participation and discretionary activity participation, and between work activity participation and participation of each of the former two types of activities. Their results also showed intrapersonal interactions between activity duration and travel duration. Further, they found that men's work activity participation had a positive effect on women's participation in maintenance activity, an interpersonal and inter-activity interaction. In fact, this interaction is the only one that the authors assumed in their model specification.

Using the data from a household travel survey in southeast Florida, Pendyala (2003) developed an SEM to investigate the relationships among work activity duration, work travel time, nonwork activity duration, nonwork travel time, and nonwork trip frequency between household members. He identified household members based on work duration and age instead of gender, with person 1 working longer and/or being older. He found complementary effects of nonwork activity duration between household members and complementary relations of nonwork travel duration. Further, person 1's work activity duration had a positive direct effect on person 2's nonwork duration, but the total effect was negative.

Using the Puget Sound Transportation Panel data, 1989-1990, Gliebe and Koppelman (2002) developed a proportional shares model of joint activity participation between two adult household members, based on the theory of random utility maximization. This model simultaneously represents each decision maker's independent activity participation, allocation of time to joint activities, and the interaction between individual and joint activities. They found that employment commitments and childcare responsibility had significant effects on trade-offs between joint and independent activities. It was also evident for sex-role differences in childcare and employment participation. For instance, the female spend more time on out-of-home maintenance activities when children are present; the female tend to work fewer hours than the male when pre-school children are present.

Thanks to the partnership between Transportation Research Board and *Transportation*, several papers regarding "Intra-Household Interactions and Group Decision-Making" have been published in a special issue of *Transportation* (32:5). Bhat and Pendyala (2005) provided a complete review of these cutting-edge studies. Some of these studies also found gender-role differences in activity participation. For example, Srinivasan and Athuru (2005) found that women are more likely to take short trips and participate in maintenance activities; Srinivasan and Bhat (2005) found that unemployed women tend to carry a larger share of household maintenance activities.

Overall, the results reviewed here show some similarities in terms of intrapersonal interactions, but also demonstrate diverse variation in the relationship between interpersonal activity participations, which is largely due to limited research in this area. Although the modeling approaches have recently been diversified, the SEM is a powerful approach to reveal complex intrahousehold interactions. Further, the data used in these studies exclusively came from the United States and Europe. Since China and India account for about 40% of world population and have different cultures from western countries, previous findings explain only half of the story. Therefore, time-use research using the data from those developing countries will further shed light on our understanding of activity participation and time allocation.

Data Description

This study uses an existing data coming from a two-day activity diary survey conducted in Shenzhen on November 1 (Sunday) - 2 (Monday), 1998. Shenzhen, located in southeast China and adjacent to Hong Kong, has experienced explosive growth after China's Open Door Policy in 1978. As the first Special Economic Zone (SEZ), Shenzhen has transformed from an agriculture-based Bao'an county into a modern metropolis – a center of industry, commerce, finance, tourism, and transportation. In 2005, Shenzhen housed 8.27 million people, compared to 0.31 million native residents in 1979 (http://www.sz.gov.cn/zwgk/tjsj/200609/t20060911_12 1609.htm, accessed on Oct. 16, 2006; SSB, 2002). It is worth noting that Shenzhen is the fastest growing city in China, that its residents have been substantially influenced by western culture, and that their incomes are much higher than the national average. Thus, Shenzhen cannot be viewed as a traditional Chinese city. A city profile of Shenzhen can be found in Ng (2003).

Using the data from National Census and other statistics such as the location and age of neighborhoods and design of housing, and through site surveys, we screened potential residential neighborhoods to ensure that they represent different geographical districts. We selected four neighborhoods inside the SEZ and one neighborhood outside the SEZ, as shown in Figure 1. Table 1 presents some characteristics of these neighborhoods. With supports from subdistricts (Ju Wei Hui), we randomly surveyed 100 households for each neighborhood. Both male household head and female household head were asked to complete the questionnaire. The number of responses totaled 386, yielding a 77.2% response rate. However, since some households provided information of one adult member and not all respondents reported activity records, the sample used in this study reduces to 261 households. Table 2 presents sample characteristics of these neighborhoods. Most households living in AiRongYuan are young nuclear families and work in the SheKou Industry Park; most households living in LianHuaBei are young nuclear families, are highly educated, and are white collar workers; ShuiWei-HuangGang neighborhood housed native residents, who live in large households and have high income from rent; most residents living in Xin'An are government employees; most households living in XinXiu are old nuclear families. Refer to Chai et al. (2002) for a detailed description of resident characteristics.

The variables used in this study can be classified into three categories: household attributes, individual attributes, and time allocation. Household attributes contain household information such as household structure, income, number of workers, presence of children, and the availability of motorized vehicles. Individual attributes include age, education, occupation, commute means, commute distance, and commute time of both household heads. Time allocation data came from 24-hour activity records of both household heads on Sunday and Monday. These activities were further grouped into seven categories, as shown in Table 3. Activity duration was computed by summing the time spent on each category of activities.

Figure 1 Geographical Location of Neighborhoods

Table 1 Characteristics of Neighborhoods

	AiRongYuan	LainHuaBei	ShuiWei-HuangGang	Xin'An	XinXiu
Location	Inner-ring suburbs	Fringe of CBD	Fringe of CBD	Suburbs	Old downtown
Neighborhood age	Late 1980s	Mid 1990s	Early 1990s	Mid 1980s	Mid or late1980s
Housing type	Multiple-story apartments	Mid- and high-rise apartments	Single family houses	Multiple-story apartments	Multiple-story apartments
Traits of neighborhood	Residential neighborhood attached to an Industry Park	Young-generation and high-educated neighborhoods	Urban village*	Mid- and low-income neighborhoods	Old city center

* The explosion of urban development makes some villages enclosed by urban communities, and these villages share attributes common to both rural areas and urban areas.
Source: Chai et al., (2002).

Table 2 Sample Characteristics

	AiRongYuan	LianHuaBei	ShuiWei-HuangGang	Xin'An	XinXiu	Total
Number of generations						238 households
1	11 (20.8)	8 (19.0)	7 (12.7)	0 (0.0)	0 (0.0)	26 (10.9)
2	24 (45.3)	21 (50.0)	26 (47.3)	28 (52.8)	29 (82.9)	128 (53.8)
3+	18 (34.0)	13 (31.0)	22 (40.0)	25 (47.2)	6 (17.1)	84 (35.3)
Household size						238 households
2	6 (11.3)	1 (2.3)	6 (11.1)	0 (0.0)	0 (0.0)	13 (5.5)
3	26 (49.1)	19 (44.2)	8 (14.8)	13 (24.1)	13 (38.2)	79 (33.2)
4	14 (26.4)	13 (30.2)	10 (18.5)	12 (22.2)	13 (38.2)	62 (26.1)
5	6 (11.3)	6 (14.0)	15 (27.8)	15 (27.8)	4 (11.8)	46 (19.3)
6+	1 (1.9)	4 (9.3)	15 (27.8)	14 (25.9)	4 (11.8)	38 (16.0)
Monthly income (RMB)						240 households
10k +	2 (3.4)	0 (0.0)	1 (1.9)	2 (3.9)	4 (11.8)	9 (3.8)
3k~10k	32 (55.2)	31 (72.1)	36 (66.7)	23 (45.1)	11 (32.3)	133 (55.4)
1k~3k	22 (37.9)	12 (27.9)	15 (27.8)	24 (47.1)	17 (50.0)	90 (37.5)
0~1k	2 (3.4)	0 (0.0)	2 (3.7)	2 (3.9)	2 (5.9)	8 (3.3)
Age						443 individuals
21~30	16 (16.3)	2 (2.5)	24 (24.2)	19 (19.2)	10 (15.2)	71 (16.2)
31~40	67 (68.4)	74 (91.4)	22 (22.2)	31 (31.3)	16 (24.2)	210 (47.4)
41~50	10 (10.2)	5 (6.2)	36 (36.4)	35 (35.4)	23 (34.8)	109 (24.6)
51~60	3 (3.1)	0 (0.0)	13 (13.1)	9 (9.1)	15 (22.7)	40 (9.0)
61+	2 (2.0)	0 (0.0)	4 (4.0)	5 (5.1)	2 (3.0)	13 (2.9)
Occupation						444 individuals
White collar	59 (56.2)	67 (88.2)	39 (41.9)	76 (73.1)	52 (78.8)	293 (66.0)
Blue collar	22 (21.0)	5 (6.6)	13 (14.0)	7 (6.7)	6 (9.1)	53 (11.9)
Unemployed	24 (22.9)	4 (5.3)	41 (44.1)	21 (20.2)	8 (12.1)	98 (22.1)
Education						418 individuals
College degree and above	34 (34.7)	39 (47.0)	10 (13.5)	26 (26.3)	19 (29.7)	128 (30.6)
Senior high school	62 (63.3)	33 (39.8)	29 (39.2)	59 (60.0)	39 (60.9)	222 (53.1)
Elementary or junior high school	2 (2.0)	11 (13.3)	35 (47.3)	14 (14.1)	6 (9.4)	68 (16.3)

Note: The numbers in parentheses are percentages.
Source: Chai et al., (2002)

Table 3 Activity Type Classification

Category	Specific Activities
Sleep	Sleep and nap
Personal care	Meals, bath, hair-cutting, etc
	Visiting post office and bank, chauffeuring
Work	Work and work-related activities
Maintenance	Home-based maintenance work such as cooking, cleaning, and yard wok
	Taking care of the older and babysitting
Shopping	Grocery, market, superstore, book store, pharmacy etc
Travel	Commute and travel for nonwork activities
Leisure	Reading, TV/movie, music, chatting, games, physical exercise, scenery watching, social and club activities

Source: Chai et al., (2002).

Descriptive Analysis

Paired-sample t-tests were used to identify sex-role differences in activity participation and time allocation. As shown in the sixth column of Table 4, on Monday, there are no significant differences in time allocation of personal care and sleep between household heads. On average, however, male household heads allocated longer time on travel, work activities, and leisure activities than female household heads, but female household heads tend to carry more responsibilities of maintenance and shopping. Further, work activity duration and maintenance activity duration had the largest absolute gender-role differences (about 2 hours) between household heads. The seventh column shows that time allocation of all types of activity between household heads significantly differs on the weekend (personal care is significant at the 0.1 level). In particular, male household heads slept longer and participated in more personal care activities than female household heads. Gender-role differences in other activities on Sunday are the same as those on Monday. Unlike weekday, durations of maintenance activity and leisure activity had the largest absolute gender-role differences (about 2.5 and 1.5 hours, respectively) on the weekend. The gender differences in time allocation on Monday and on Sunday clearly depict household activity roles of Shenzhen residents: males dominate out-of-home activities, but females dominate in-home activities. Therefore, although the residents of Shenzhen are less conservative than residents of inland cities, their household roles are consistent with Chinese traditional culture.

A comparison of intrapersonal time allocation on Monday and on Sunday demonstrates some interesting patterns. As shown in the last two columns of Table 4, all differences are significant at the 0.05 level. For both household heads, as a result of reduced working time on Sunday, durations of most types of activity increased but only travel time decreased. Specifically, men averaged 28-minute travel time and women traveled 18 minutes on Sunday, compared to 64 minutes of Netherlanders and 90 minutes of Americans on the weekend (Kitamura et al., 1997, cited in Pendyala, 2003). This finding suggests that most households conducted nonwork activities at home or within a short distance of home on the weekend, a result partially confirmed by Liu and Chai (2001). There are a few reasons for this discrepancy between residents of China and western countries. First, in 1998, many Chinese were not affluent enough to afford automobiles, and alternative modes were the only choice for most households; second, the built environment in China is quite different from that of western countries: most destinations are within walking distance of residences; third, in China, out-of-home nonwork activities such as grocery shopping are spread throughout the whole week instead of being concentrated on the weekend (Chai et al., 2002).

Table 4 Paired Sample T-tests for Time Allocation (hour)

Activities	Monday		Sunday		P-value for Men vs women (Monday)	P-value for Men vs women (Sunday)	P-value for Monday vs Sunday (Men)	P-value for Monday vs Sunday (Women)
	Men	Women	Men	Women				
Work	6.95	4.97	1.89	1.01	0.000	0.000	0.000	0.000
Maintenance	0.53	2.58	0.82	3.31	0.000	0.000	0.002	0.000
Shopping	0.12	0.57	0.55	1.09	0.000	0.000	0.000	0.000
Personal care	3.12	3.04	3.44	3.26	0.298	0.078	0.005	0.021
Sleep*	8.90	9.01	10.08	9.81	0.328	0.030	0.000	0.000
Travel	0.85	0.65	0.46	0.29	0.002	0.010	0.000	0.000
Leisure	3.53	3.11	6.69	5.16	0.019	0.000	0.000	0.000
Missing	0.01	0.07	0.06	0.08				

*The longer sleep duration may result from two facts: (1) sleep includes nap; (2) daytime is shorter than nighttime in November.

Multivariate Analysis

In this section, we explored the relationships among work activity duration, maintenance activity duration, and leisure activity duration for both male household heads and female household heads. We can include more activity categories in the model. However, accurate estimates of model parameters will require a larger sample size. More importantly, our selection of these three activities is consistent with the classic Reichmann's (1976) classification: subsistence activity, maintenance activity, and discretionary activity. Figure 2 illustrates a conceptual model in the form of flow diagram. The variables in the dashed rectangle represent endogenous variables and other variables are exogenous variables. Work activity duration and commute time were treated as exogenous variables since they tend to be mandatory and inflexible (Pendyala, 2003). With respect to intrapersonal time allocation, we assumed that work activity duration and commute time influences both maintenance activity duration and leisure activity duration, and maintenance activity duration in turn affects leisure activity duration (as leisure activities are the most discretionary and elastic), as observed by Golob and McNally (1997).

To capture interpersonal interactions, men's and women's durations of the same type of activity were allowed to influence each other, as illustrated by double arrows. In particular, the interactions between men's and women's maintenance activities can fall into at least two categories: substitution and complementary (or companion). Given a fixed amount of maintenance work in a two-adult household, a longer duration of one adult means a shorter duration of the other adult. By contrast, both adults may conduct maintenance work together, either for a short time (such as cooking) or for a long time (such as painting the house). Interpersonal interactions of leisure activities can be complementary (or companion). On the other hand, we may empirically find negative interactions between leisure activity durations. However, due to discretionary nature of leisure activities, this "substitution" effect is likely to be a proxy for other activities such as maintenance.

Moreover, interpersonal interactions of maintenance activities for some households may be substitution, but the interactions for other households may be complementary. That is, for the whole sample, the relationship of maintenance activity participation between household heads may be empirically independent. Therefore, although women's maintenance activity duration may influence men's leisure activity duration *indirectly* through men's maintenance activity duration, we further hypothesized that women's maintenance activity duration has a *direct* influence men's leisure activity duration. Similarly, we assumed a direct influence from men's maintenance activity duration to women's leisure activity duration, and direct interpersonal influences from work activity duration to maintenance activity duration, and to leisure activity duration. In practice, van Wissen (1989), Golob and McNally (1997), and Pendyala (2003) observed some interpersonal interactions between participations in different activities.

Methodology

Given the complex relationships illustrated in Figure 2, an SEM approach was employed in this study. Using the matrix notation in Mueller (1996), an SEM for observed variables can be defined as having the following form:

$\mathbf{Y} = \mathbf{B}\mathbf{Y} + \Gamma\mathbf{X} + \zeta$,

where

$\mathbf{Y}$ = $(N_Y \times 1)$ column vector of endogenous variables (N_Y = number of endogenous variables),

$\mathbf{X}$ = $(N_X \times 1)$ column vector of exogenous variables (N_X = number of exogenous variables),

$\mathbf{B}$ = $(N_Y \times N_Y)$ matrix of coefficients representing the direct effects of endogenous variables on other endogenous variables,

$\boldsymbol{\Gamma}$ = ($N_Y \times N_X$) matrix of coefficients representing the direct effects of exogenous variables on endogenous variables, and,
$\boldsymbol{\zeta}$ = ($N_Y \times 1$) column vector of errors.

The two coefficient matrices **B** and $\boldsymbol{\Gamma}$ determine the structure of an SEM. In addition, a covariance matrix $\boldsymbol{\Phi}$ ($N_X \times N_X$) for exogenous variables X and a covariance matrix $\boldsymbol{\Psi}$ ($N_Y \times N_Y$) for error terms $\boldsymbol{\zeta}$ can be specified. The **B**, $\boldsymbol{\Gamma}$, $\boldsymbol{\Phi}$, and $\boldsymbol{\Psi}$ matrices together establish an SEM for observed variables. To estimate an SEM, $\boldsymbol{\Sigma}$, the model-implied covariance matrix of observed variables **X** and **Y**, will be reproduced in terms of specific functions of unknown model parameters (namely, the **B**, $\boldsymbol{\Gamma}$, $\boldsymbol{\Phi}$, and $\boldsymbol{\Psi}$ matrices). If specific values for the unknown parameters are inserted in these functions, a model-implied (reproduced) covariance matrix is obtained, and then the difference between this matrix and the observed (sample) covariance matrix **S** is calculated based on some criterion. A structural equations modeling program fits the specified model to the data by repeatedly inserting better and better estimates of these parameters until the difference between the reproduced and observed covariance matrices is optimally minimized in terms of some criterion. In view of the nature of the estimation process, the SEM is commonly referred to as covariance structure analysis. The goodness-of-fit of an SEM relies on how well its model-implied covariance matrix $\boldsymbol{\Sigma}$ conforms to its observed covariance matrix **S** (Raykov and Marcoulides, 2000).

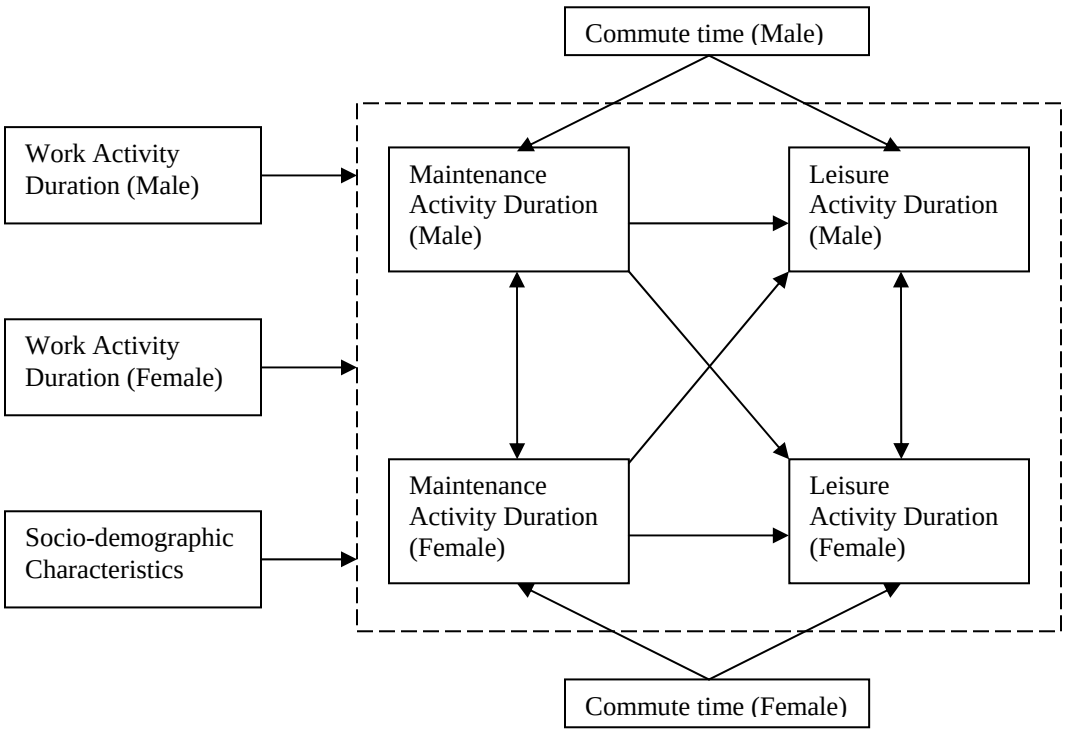

Figure 2 Flow Diagram of Postulated Direct Effects for Two Household Heads

Because some exogenous variables in this data contain missing vales (as shown in Table 5), the full information maximum likelihood (FIML) estimation approach (specifically, the FIML approach with "ModelMeansAndIntercepts" method in AMOS 5.0) was chosen to develop SEMs. In most studies, pairwise deletion and listwise deletion were used to deal with missing data (Roth, 1994). However, in presence of incomplete data, the FIML approach has a few advantages relative to listwise deletion and pairwise deletion. If the data are missing complete at random (MCAR), pairwise deletion and listwise deletion approaches produce consistent but inefficient estimates, while FIML estimates are both

consistent and efficient. If the data are missing at random (MAR), pairwise deletion and listwise deletion estimates are biased, but FIML estimates are asymptotically unbiased (Arbuckle, 1996). Although the FIML approach requires at least MAR data to produce consistent estimates, it is shown that the approach can reduce bias even if the data somewhat deviate from MAR (e.g., Little and Rubin, 1989). The FIML method assumes multivariate normality, and maximizes the likelihood of the model with all information of the observed data (Computational details for the FIML estimation can be found in Arbuckle, 1996, p. 246-248). In AMOS, the application of the FIML approach has a limitation. Specifically, AMOS does not fit the saturated model (due to time-consuming computation resulting from incomplete data), which is required to calculate the chi-square statistic and other goodness-of-fit measures depending on this statistic. That is, when incomplete data are present, AMOS does not report most of usual fit indices (SmallWaters, undated). However, we finally adopted the FIML approach given its advantages over listwise deletion and pairwise deletion. As shown later in the last rows of Tables 6 and 7, the squared multiple correlations (SMCs) of final models are fairly good. A comparison of these SMCs across models suggests that the variation of activity patterns on Sunday appears to be larger than that on Monday.

Table 5 Variables with Missing Values (N=261)

Variables	Valid Cases	Variables	Valid Cases
Presence of children (<18)	245 (93.9%)	Availability of vehicles	213 (81.6%)
# students in the household	234 (89.7%)	Age (female)	258 (98.9%)
Household size	249 (95.4%)	Age (male)	258 (98.9%)
# generations in the household	247 (94.6%)	Education (female)	213 (81.6%)
Income	239 (91.6%)	Commute time (male)	230 (88.1%)

Weekday Time Allocation

Table 6 presents an SEM for intrahousehold time allocation on a typical weekday (Monday). The results offer some logical and consistent findings. With respect to intrapersonal time allocation, men's and women's work activity duration negatively influences their respective maintenance activity duration and leisure activity duration; as their maintenance activity duration increases, their respective leisure activity duration also goes down. These findings are consistent with Golob and McNally (1997). On the other hand, there are some gender-role differences in the magnitude of the influences. First, all else equal, a one-hour reduction in maintenance activity tends to increase men's leisure activity duration by 47 minutes, but women's gain in leisure activity duration is only 35 minutes. By contrast, the influence of work activity duration on maintenance activity duration is larger for women than for men. In other words, all else equal, women are more likely to increase maintenance activities than men when they reduce their working time. Although the direct effect of work activity duration on leisure activity duration is similar for men and women, the total effect appears to differ. In particular, if work activity duration reduces by one hour, men tend to have 11 more minutes ((0.492-0.316) × 60) allocated to leisure activities. Further, a longer commute time tends to negatively influence men's leisure activity duration but women's duration is not affected.

The results also provide some insightful interactions between a male household head and a female household head. First, men's leisure activity duration is positively correlated to women's leisure activity duration. However, when determining the directions of influence, we found that the influence is from women to men but the other direction is statistically insignificant. This finding suggests that interpersonal interactions of leisure activities are not just complementary but have a clear direction. In other words, when a female household head conducts leisure activities, the male head is likely to participate in such activities, or they may plan and do some leisure activities jointly; on the contrary, the

female head does not always participate when a male head initiates some leisure activities. The underlying reasons of this phenomenon may be (1) women tend to carry more household maintenance responsibilities than men and hence have more time constraints; (2) men are generally more social than women in China.

Interestingly, although the direct effect of women's maintenance activity duration on men's leisure activity duration is positive, the total effect is negative. When a female head takes more maintenance responsibility, it is reasonable that the other head gains some leisure time. However, for women, the increased maintenance activities leave little time for their leisure activities, which in turn reduce men's leisure activities due to the complementary manner of leisure activity participation just discussed. Women's work activity duration has a positive influence on men's leisure activity duration, counter to our expectation. Given a fixed amount of maintenance responsibilities, we assumed that women's work activity duration negatively influences men's leisure activity duration through the connections among work activity, maintenance activity, and leisure activity. However, in this data, we did not find any significant relationship between men's and women's maintenance activity durations. That is, a reduction in women's maintenance activities may not necessarily increase men's maintenance work. On the other hand, the absence of the female makes the male more independent. However, the total effect of this variable is not large due to the complementary effect of reduced women's leisure activities.

Table 6 Structural Equations Model for Time Allocation on Monday (N=258)

Variables	Effect	Maintenance Activity Duration		Leisure Activity Duration	
		Female (F)	Male (M)	Female (F)	Male (M)
Constant		3.062	2.125	6.290	7.734
Maintenance activity duration (F)	Direct	--		-0.578	0.091*
	Indirect	--			-0.109
	Total	--		-0.578	-0.017
Maintenance activity duration (M)	Direct		--		-0.782
	Indirect		--		
	Total		--		-0.782
Leisure activity duration (F)	Direct			--	0.188
	Indirect			--	
	Total			--	0.188
Work activity duration (F)	Direct	-0.418		-0.557	0.136
	Indirect			0.241	-0.098
	Total	-0.418		-0.316	0.039
Work activity duration (M)	Direct		-0.126		-0.591
	Indirect				0.099
	Total		-0.126		-0.492
Commute time (M)	Direct				-0.017
	Indirect				
	Total				-0.017
Age (F)	Direct	0.028		0.038	
	Indirect			-0.016	0.007
	Total	0.028		0.021	0.007
Worker	Direct				-1.442
	Indirect				
	Total				-1.442
Education (F)	Direct	-0.217			
	Indirect			0.125	0.004
	Total	-0.217		0.125	0.004
# students	Direct			-0.414	
	Indirect				-0.078
	Total			-0.414	-0.078
# generations in the household	Direct		-0.180		0.214
	Indirect				0.141
	Total		-0.180		0.354
Presence of children (<18)	Direct	1.549	0.306*		
	Indirect			-0.895	-0.266
	Total	1.549	0.306	-0.895	-0.266
Income	Direct		-0.116		
	Indirect				0.091
	Total		-0.116		0.091
Availability of vehicles	Direct			0.390*	
	Indirect				0.073
	Total			0.390	0.073
Squared multiple correlations		0.551	0.729	0.674	0.916

* Significant at the 0.10 level. All other variables significant at the 0.05 level.

The direct effect of socio-demographic characteristics also shows some gender differences in time allocation. Women are more likely to increase their maintenance and leisure activities as they are getting older; the availability of vehicles (including motorcycles) in the household has a positive influence on women's leisure activity duration, but the number of students in the household has a negative influence on women's leisure activity participation; women with a higher educational background and men living in an affluent household tend to spend less time on maintenance activities; working has a negative influence on men's leisure activity duration. Further, the number of generations living in the household negatively influences men's maintenance activity duration but positively affects their leisure activity duration. In China, grandparents are more willing (sometimes feel obligated) to shoulder household maintenance responsibilities such as babysitting. As a result, the male household head is somewhat relieved from maintenance work and is able to spend more time on leisure activities. However, we did not find any influence of this variable on the female household head. The presence of children under 18 years old increases both men's and women's maintenance activities, but its influence on women is much larger than that on men. These findings suggest that women carry more household maintenance responsibilities than men.

Weekend Time Allocation

As shown in Table 7, the relationships of intrapersonal time allocations on a typical weekend (Sunday) are similar to those on Monday. So are gender differences in the magnitude of those influences. However, commute time became insignificant, which is plausible since not many respondents worked on the weekend. With respect to interpersonal interactions, we found that the association of leisure activity durations between household heads is positive, and the influence is also from women to men; women's work activity duration on the weekend tends to increase men's leisure activities, a scenario of being independent. The results also showed some patterns, which are unique to weekend. When one household head works, the other tends to spend more time on maintenance activities.

Similar to the results in the weekday model, older women tend to spend more time on maintenance and leisure activities on the weekend. In addition, men are more likely to increase their maintenance activities when they are older. Household income is negatively associated with women's maintenance activity duration and men's leisure activity duration. The negative association between income and men's leisure activity duration seems to be counterintuitive. In this data, however, household income is positively correlated with shopping activity duration (correlation: 0.134). That is, affluent residents may spend more time on shopping but less time on leisure. It is interesting that the availability of vehicles reduces men's leisure activities. A study of leisure time utilization in three Chinese cities showed that most Chinese residents conducted leisure activities at home, and about 70% of weekend leisure time of Shenzhen residents was spent at home (Chai et al., 2002). The availability of vehicles increases the probability of conducting outdoor activities (as well as the corresponding travel time), and hence reduces time for leisure activities. Household structure also has some influence on individuals' weekend time allocation. The number of generations positively affect men's leisure activity duration, but household size is negatively associated with men's maintenance and leisure activity durations. The presence of children increases men's maintenance activities, but reduces leisure activity duration of both household heads, especially the male.

Table 7 Structural Equations Model for Time Allocation on Sunday (N=261)

Variables	Effect	Maintenance Activity Duration		Leisure Activity Duration	
		Female (F)	Male (M)	Female (F)	Male (M)
Constant		3.255	0.632	7.191	9.034
Maintenance activity duration (F)	Direct	--		-0.601	
	Indirect	--			-0.131
	Total	--		-0.601	-0.131
Maintenance activity duration (M)	Direct		--		-0.822
	Indirect		--		
	Total		--		-0.822
Leisure activity duration (F)	Direct			--	0.218
	Indirect			--	
	Total			--	0.218
Work activity duration (F)	Direct	-0.323	0.055*	-0.541	0.142
	Indirect			0.194	-0.121
	Total	-0.323	0.055	-0.347	0.021
Work activity duration (M)	Direct	0.128	-0.074		-0.658
	Indirect			-0.077	0.044
	Total	0.128	-0.074	-0.077	-0.614
Age (F)	Direct	0.026		0.025	
	Indirect			-0.015	0.002
	Total	0.026		0.010	0.002
Age (M)	Direct		0.011*		
	Indirect				-0.009
	Total		0.011		-0.009
# generations in the household	Direct				0.453
	Indirect				
	Total				0.453
Household size	Direct		-0.114		-0.149
	Indirect				0.094
	Total		-0.114		-0.055
Presence of children (<18)	Direct		0.445	-0.584	-0.955
	Indirect				-0.493
	Total		0.445	-0.584	-1.448
Income	Direct	-0.179*			-0.222
	Indirect			0.108	0.023
	Total	-0.179		0.108	-0.199
Availability of vehicles	Direct				-0.776
	Indirect				
	Total				-0.776
Squared multiple correlations		0.158	0.078	0.398	0.799

* Significant at the 0.10 level. All other variables significant at the 0.05 level.

Conclusions

Bivariate analysis and structure equations models have been employed to study activity time allocation of the male household head and the female household head between weekday and weekend. Based on observations on Shenzhen residents, we found clear individuals' role in the household: men are dominant in out-of-home activities, but women dominate in-home activities. On average, women carry more maintenance responsibilities than men, but men spend more time on work and leisure activities than women, especially on the weekend. On the weekend, Shenzhen's residents are not as mobile as individuals of western countries because most people spend their time at home and around their neighborhoods, especially the female. Further, the influences of household structure on time allocation of both household heads demonstrated substantial gender-role differences.

The results also showed some interesting interpersonal interactions of time allocation. Specifically, the more women participate in leisure activities, the more men spend time on leisure activities, but not vice versa. Although not substantial, women's work activity duration tends to increase men's leisure activities. During the weekday, as women spend more time on maintenance activities, overall, men as well as women participate in fewer leisure activities. On the weekend, as one household head works, the other tends to carry more maintenance activities. These findings provide some evidence for intrahousehold coordination of activities and joint activity engagement.

This study represents a preliminary investigation of time allocation behavior of Chinese urban residents. In this study, we mainly considered activity participation and time allocation of permanent residents of Shenzhen, but paid less attention to floating residents, who account for one third of Shenzhen population (Ng, 2003). Future study should identify permanent residents and floating residents, and explore whether their activity patterns and time allocations are different. Further, as the recently remarkable growth of disposable income and auto ownership in China, we believe that urban residents have changed their activity patterns and time allocation to some extent since 1998. Another round of survey and research becomes necessary to explore how activity patterns are influenced by dramatic changes in socio-economic characteristics, and to better understand interpersonal interactions within household (and/or with a broader social network) of Chinese residents. In future research, more sophisticated method such as mixed logit models should be employed to capture joint activity engagement and the influence of the social network.

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