Does e-shopping for intangible services attenuate the effect of spatial attributes on travel distance and duration?

Abstract: E-shopping for intangible services (e.g., eating out services, hairdressing, and visits to movie theatres) refers to searching and paying for services online, but it requires e-shoppers to travel to use these services. In theory, e-shoppers' search space via the internet is less constrained by spatial attributes. As a result, spatial attributes may barely affect the distance and duration of trips resulting from e-shopping for intangible services. The present study used data from 714 valid face-to-face interviews in Beijing, China, to verify this hypothesis. The results showed that e-shoppers were likely to travel farther after purchasing intangible services online. The effect of spatial attributes on the distance of a single trip was largely attenuated due to online purchases of these services, and the effect on the duration was correspondingly weaker to a limited extent. Therefore, spatial interventions aiming to moderate travel distances and durations may not be as effective in the age of online shopping.

Key words: spatial attributes, online shopping, intangible services, travel distance, travel duration, China

1. Introduction

Traffic congestion is a major problem in many large cities. Spatial attributes influence travel distance and duration (Maat & Timmermans, 2009; Cao et al., 2010; Ewing & Cervero, 2010; Ding et al., 2017). Therefore, land-use policies (e.g., spatial or built environment interventions) are conventionally considered a potential strategy to reduce travel demand and moderate urban congestion. However, this policy may not be effective when people make trips to consume intangible services (e.g., eating out services, hairdressing, and visits to movie theaters) which they previously ordered online. Shi et al. (2020) pointed out that consumers' search spaces are rarely constrained by spatial attributes when buying intangible services online. As a result, they are expected to travel longer distances to consume these services. Additionally, geographers often indicate that the use of information and communication technologies (ICTs) attenuates the role of spatial attributes in human travel activities (Schwanen & Kwan, 2008; Alexander et al., 2010, 2011; Xi et al., 2017; Elldér, 2015; Hubers et al., 2018). Therefore, the following question may be asked: does e-shopping for intangible services attenuate the effect of spatial attributes on travel distance and duration?

Due to the substantially increasing use of e-shopping, China exhibits the largest e-retailing sales worldwide. McKinsey and company (2017) indicated that China accounted for 42.4% of worldwide e-retail transactions in 2017, and this value was only 24.1% in the United States. Chinese people frequently purchase intangible services online. Online sales of intangible services in China reached ¥ 612.4 billion (≈US $91.3 billion, and ≈EUR 80.9 billion) in 2016 (IResearch, 2017). Therefore, China is a well-suited country to address this question. The present study used data from 714 structured interviews in Beijing, China, in 2015 to investigate whether e-shopping for intangible services attenuated the impact of spatial attributes on travel distance and duration. The remainder of this paper is structured as follows. Section 2 presents a literature review and conceptual framework. Methodologies are introduced in Section 3, followed by the results in Section 4. Finally, conclusions and implications are presented in Section 5.

2. Literature review and conceptual framework

2.1 Related literature

Generally, geographers categorize spatial attributes into two dimensions: types of geographic areas (e.g., urban areas, suburban areas, and exurban/rural areas) and built environments (e.g., residential density, workplace density, and transportation accessibility) (Cao, 2009; Zhen et al., 2018). The relationship between spatial attributes and travel distance and duration received much scholarly attention, which indicates significant effects of spatial attributes on travel distances and durations (e.g., Fan & Khattak, 2008; Rotem-Mindali, 2008; Maat & Timmermans, 2009; Cao et al., 2010; Ewing & Cervero, 2010; Feng et al., 2013; Akar et al., 2016; Jiao et al., 2016; Ding et al., 2017; Chen & Akar, 2017).

Existing studies primarily defined travel distances and durations in two ways. The first group of studies referred to total distances and durations of all trips during a given period of time, which resulted in conflicting outcomes. For example, Rotem-Mindali (2008) found that people in strongly urbanized areas tended to travel longer distances for shopping purposes during a given day compared to people in weakly urbanized areas. Some studies indicated that people in strongly urbanized areas were likely to spend more time on total trips (e.g., Feng et al., 2013). In contrast, Cao et al. (2010) revealed that people were likely to drive longer distances for daily activities in exurban areas. Many empirical studies indicated that elements of an urban-built environment, such as high street connectivity, residential (population) density, workplace (employment) density, transportation accessibility, mixed land use, and job-population balance level, were negatively associated with total travel distances (Fan & Khattak, 2008; Maat & Timmermans, 2009; Akar et al., 2016). However, a Dutch study by Maat and Timmermans (2009) indicated that workplace density had a positive effect on daily travel distances.

The second group of studies referred to the distance traveled and the time spent per single trip (i.e., from origin to destination). De Vos and Witlox (2016) found that people living in suburban areas tended to travel longer distances per trip for leisure activities. The duration per trip was also longer for people outside urban areas to a certain extent. Focusing on travel in general, Ding et al. (2017) indicated that employment density, street connectivity, and transit accessibility of the residential environment had negative effects on the travel distance from home to destination. In contrast, accessibility to employment at residential locations was positively associated with the travel distance to a limited extent. Akar et al. (2016) revealed that transportation accessibility, the density of population and employment, street connectivity, and job-population levels were negatively related to longer average distance per trip in Ohio. Chen and Akar (2017) indicated that residential density and job-population balance at trip origin and destination and intersection density at trip origin negatively correlated with the distance traveled per trip in the Cleveland metropolitan area. However, a higher density of bus stations at the trip destination likely resulted in longer distances per trip.

However, we are only aware of two empirical studies focusing on the association between spatial attributes and the distance per trip with respect to shopping purposes. Using data from Seattle, Washington, Jiao et al. (2016) found that people in urban areas were more likely to make shorter average-distances per trip to grocery stores compared to people in suburban areas. Chen (2017) revealed that, in Beijing, people in traditional neighborhoods (where the land use is mixed with housing, temples, and schools) and enclave neighborhoods (dominated by residential, educational, and working places) were inclined to travel longer distances from home to the food market compared to people living in superblock neighborhoods (dominated by residential land use).

Additionally, some researchers investigated the relationship between spatial attributes and general activity-travel space during a given period. For example, Buliung and Kanaroglou (2006) suggested that people in suburban areas had larger activity spaces compared to people in urban areas during two consecutive days in Portland, Oregon. Similarly, Fan and Khattak (2008) found that North Carolina residents in downtown areas had smaller activities spaces compared to people in suburban areas for a given 24 hours. These results loosely suggest that people who have a larger activity-travel space tend to travel farther to perform activities. Therefore, the outcomes of these studies are largely consistent with findings of previous studies on travel distances (e.g., De Vos & Witlox, 2016; Jiao et al., 2016).

In summary, most previous studies focused on the total distances and durations of all trips during a given period (e.g., Rotem-Mindali, 2008; Maat & Timmermans, 2009; Cao et al., 2010; Akar et al., 2016), but less scholarly attention was paid to the distance and duration of a single trip (e.g., Akar et al., 2016; Ding et al., 2017). Research on the distance and duration of a single trip can create valuable insights because it may be strongly affected by spatial attributes and strongly associated with travel mode choices (Ding et al., 2017). Against this background, we focus on the distance and duration of a single trip for intangible services in the present study.

2.2 Conceptual framework

In this section, we discuss how spatial attributes affect the distance and duration of single trips when people adopt offline and online channels.

When consumers purchase intangible services offline (i.e., buying without searching and paying online), spatial attributes largely determine the ease of obtaining information and knowledge about consumption opportunities (i.e., cognitive limitations). In theory, people mostly have more cognitive limitations in weakly urbanized areas compared to strongly urbanized areas since commercial facilities are sparsely distributed. For example, people in weakly urbanized areas are only aware of a limited number of restaurants within a certain space. To gain maximum utility (e.g., to find a desirable place to consume services), consumers tend to extend their search spaces for traveling (Fan & Khattak, 2008). As a result, people generally travel a longer distance and duration per single trip and have larger activity spaces in weakly urbanized areas. In contrast, commercial facilities are densely distributed in strongly urbanized areas. In principle, people have lower cognitive limitations of information and knowledge about consumption opportunities. To maximize the utility (e.g., to reduce the costs of searching and traveling), they only need smaller search spaces and make shorter distance and duration trips, which results in smaller activity spaces. Previous studies confirmed this assumption (e.g., Jiao et al., 2016).

When consumers purchase online (i.e., buying with searching and paying online), two circumstances may exist. (1) E-shoppers search and pay for an intangible service online beforehand, then make a trip to a specific place to consume the service. Consequently, the cognitive limitations imposed by the physical characteristics of one’s environment are theoretically reduced to a certain extent (Schwanen & Kwan, 2008). Consumers are easily aware of information on the consumption opportunities of the whole city via the internet wherever they are. That is, e-shoppers in different parts of a city have the same search spaces on the internet. Therefore, the link between spatial attributes and cognitive limitations becomes weak. In this context, two possible assumptions may be proposed. (a) The distance and duration of a single trip via the online channel becomes longer compared to a single trip via the offline channel. (b) More importantly, the distance and duration of a single trip due to e-shopping for intangible services are expected to vary less between different parts of a city. (2) E-shoppers already know which space they want to visit before getting online to pay for a service. The link between spatial attributes and cognitive limitations does not substantially change with e-shoppers in the second case. However, we assume that most e-shoppers are the former case because of the unique advantages of the internet (e.g., enabling larger search spaces and cognitive spaces to e-shoppers (Kamis & Stohr, 2006)).

In addition to the type of geographic areas, other factors such as individuals' socio-demographics, internet experience, and e-shopping behaviors, play key roles in (shopping) travel distances and durations. (1) It is rather evident that socio-demographics such as gender, income and age significantly determine general travel distances and durations and activity spaces (Schwanen et al., 2002; Buliung & Kanaroglou, 2006; Fan & Khattak, 2008; Ding et al., 2017). For shopping purposes, Gould and Golob (1997) found that women were likely to travel longer durations per week than men. In contrast, Chen (2017) revealed that women tended to travel a shorter distance from home to the food market compared to men. (2) As to internet experience, Jamal et al. (2017, 2019) indicated that the use of smart-phones reduced travel distances in Halifax, Canada. Srinivasan and Reddy Athuru (2004) found that travel durations decreased due to the use of ICTs. (3) With respect to e-shopping behavior, Weltevreden and Rotem-Mindali (2009) revealed that the use of e-shopping for second-hand items increased personal trip frequency and travel distances. However, the adoption of e-shopping for daily products, tickets, financial products, and other items led to a reduction in travel distances. Shi et al. (2020) found that e-shopping for intangible services stimulated e-shoppers to travel longer distances and durations per single trip. Therefore, socio-demographics, internet experience, and e-shopping behavior are expected to affect the distance and duration of a single trip. These factors will be considered control variables in the following regression models.

3. Methodologies

3.1 Data sources

The present study used data derived from face-to-face structured interviews in Beijing, China, (21.7 million inhabitants in 2016) in October and November 2015. Before the survey was started, the sampled units were selected using the cluster sampling method in the following 4 steps (Daniel, 2012). (1) Define the target population. The present study focused on online shopping behavior for intangible services. Therefore, residents who had purchased intangible services online were defined as the target population in this survey. (2) Determine the sample size. According to Krejcie and Morgan (1970), 384 participants or more were theoretically needed to ensure the quality of data in a Beijing sample. After the budget was considered, the desired sample size was determined as 600-1000. (3) Define the sampled area. The urban area within the 5th ring road was selected as the sampled area since most Beijing residents lived in this area. (4) Determine the sample units. Residential neighborhoods were primarily tightly blocked to protect residents' privacy in China (Sun et al., 2017). Interviewers found it quite difficult to recruit respondents in residential neighborhoods. According to the principle of cluster sampling and following previous studies (Daniel, 2012; Sun et al., 2017; Shi et al., 2019), shopping centers where e-shoppers (i.e., target population) mostly visited after they ordered intangible services online were finally defined as potential sampled units.

Our hypothesis that spatial attributes influence travel distance and duration ideally requires that respondents from each area of the city be approached. Therefore, seven city-level shopping centers that serve residents across the whole city were randomly geographically selected as sampled units in the survey: Xinzhongguan shopping center, Xidan shopping center, Zhuozhan shopping center, Xin'ao shopping center, Wangfujing shopping center, Guomao shopping center, and Kaide-Mall shopping center in Wangjing (see Figure 1). Using the convenience sample method, consumers visiting these shopping centers were randomly recruited to participate in the survey. Face-to-face interviews were performed at these shopping centers. A paper-based questionnaire designed by the Urban and Regional Planning (URP) research group of Lanzhou University was used to record the information provided by participants. A total of 800 residents participated in the survey. Eighty-six respondents were excluded because of a lack of key information. A total of 714 valid samples were used in the present study.

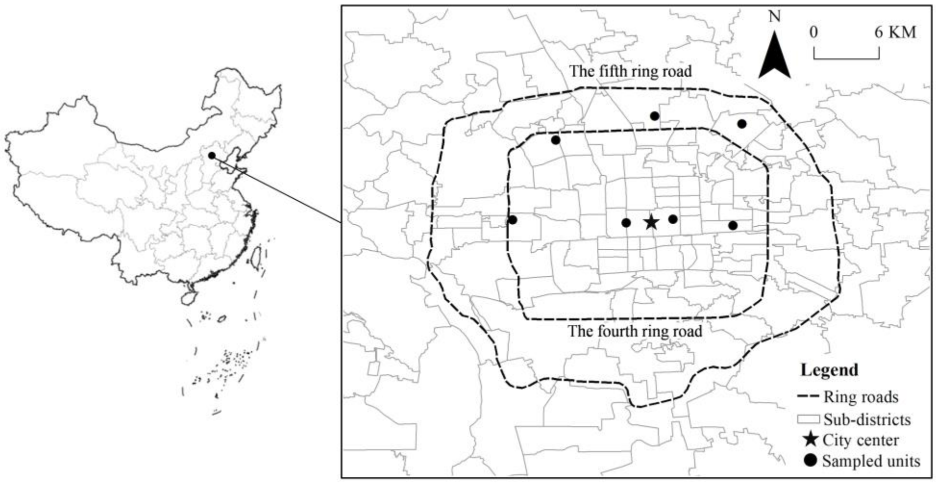

Figure 1 Sampled area

Basic information about the valid respondents is shown in Table 1. According to the report from the China Electronic Commerce Research Center (2016) on the e-shopping population in China, 47.4% were men in 2016, and 48.8% older than 26. Correspondingly, 39.1% of the valid respondents were men, and 48.4% older than 26 (see Table 1). The respondents were roughly representative of the e-shopping population with respect to age. However, they were somewhat biased toward women, which could be mostly attributed to the fact that women visit shopping centers more frequently in China (Feng et al., 2015). Additionally, the survey performed at the seven shopping centers likely resulted in respondents who were somewhat biased toward more mobile e-shoppers and e-shoppers who frequently visited these shopping centers. The respondents were of unknown representativeness with respect to all other attributes.

Table 1 Respondents' socio-demographics and internet experience

Characteristics	Distributions	N	%
Gender	Male	279	39.1
	Female	435	60.9
Age (Years)	20 or less (Value=1)	75	10.5
	21-25 (Value=2)	293	41.0
	26-30 (Value=3)	203	28.4
	More than 30 (Value=4)	143	20.0
Income (¥/month)	2000 or less (Value=1)	136	19.0
	2001-6000 (Value=2)	233	32.6
	6001-10000 (Value=3)	211	29.6
	More than 10000 (Value=4)	134	18.8
Living expense (¥/month)	1000 or less (Value=1)	62	8.7
	1001-3000 (Value=2)	321	45.0

	3001-5000 (Value=3)	196	27.5
	More than 5000 (Value=4)	135	18.9
Years of using the internet on PCs	5 or less (Value=1)	72	10.1
	6-9 (Value=2)	260	36.4
	More than 9 (Value=3)	382	53.5
Total		714	100.0

3.2 Variable description

Distance and duration of a single trip. In China, people engaging in e-shopping for intangible services normally use offline channels to consume intangible services (i.e., they also make trips to consume services without searching or paying online). In this survey, only respondents who purchased intangible services via both channels were asked the following: 1) How far away is your most visited place for consuming intangible services when the online channel is used?; and 2) How far away is your most visited place for consuming intangible services when the offline channel is used? Single trip distances and durations may differ by the type of services. Therefore, intangible services were divided into four categories in this survey: daily life services (e.g., hairdressing visits, personal care, photography services), local tour services (e.g., visits to zoos, local theme parks, museums, resorts), leisure services (e.g., visits to movie theatres, (karaoke) bars, fitness services), and eating out services (e.g., going out to eat at restaurants, or snack & dessert stores). For each category of services, participants were asked to respond to the two questions. The number of e-shoppers who completed reporting the distance and duration through both channels separately is presented in Table 2.

Table 2 Number of e-shoppers reporting the distance and duration for both channels

Type of services	E-shoppers		E-shoppers reporting the distance for both channels		E-shoppers reporting the duration for both channels	
	N	%	N	%	N	%
Daily life services	295	41.3	285	39.9	282	39.5
Local tour services	271	38.0	244	34.2	243	34.0
Leisure services	598	83.8	493	69.0	495	69.3
Eating out services	654	91.6	632	88.5	628	88.0
Total	714	100.0	714	100.0	714	100.0

Spatial attributes. As stated previously, spatial attributes are generally grouped into two dimensions of the type of geographic areas and built environments. According to our assumption, the type of geographic areas is more applicable to the study. Previous studies regularly treated residential location as a spatial attribute determining travel behavior (e.g., Maat & Timmermans, 2009; Cao et al., 2010; Ewing & Cervero, 2010) and online shopping behavior (e.g., Cao et al., 2013; Zhen et al., 2018). However, considering that shopping travel is often linked with other travel purposes (particularly with commuting travel) (Ferrell, 2005; Rotem-Mindali & Weltevreden, 2013), some researchers argue that other places (e.g., workplace) also play relevant roles in shopping travel or online shopping behavior (Zhen et al., 2018; Shi et al., 2019, 2020). To address this issue, some geographers regard both residential location and workplace as explanatory factors of store shopping and e-shopping behaviors (Zhen et al., 2018). Other studies use the location where people primarily depart for trips as an indicator of spatial attributes (Shi et al., 2019, 2020). Following the work of Shi et al. (2019, 2020), respondents were asked to indicate the places where they primarily departed for trips to consume intangible services. Departure location was used as a spatial attribute in the present study.

As the level of urbanization continuously decreases from the city center to the city periphery in Beijing, three types of geographic areas were determined: areas within the fourth ring road, areas between the fourth ring road and the fifth ring road, and areas outside the fifth ring road, which were defined as urban areas, suburban areas, and exurban areas, respectively (see Figure 1). Accordingly, the type of geographic areas where respondents primarily departed from was captured. Of the 714 valid samples, 374 primarily departed from urban areas, 185 primarily departed from suburban areas, and 155 primarily departed from exurban areas (see Table 3).

Table 3 Number of respondents by departure location

Departure location	N	%
Urban area	374	52.4
Suburban area	185	25.9
Exurban area	155	21.7
Total	714	100.0

Socio-demographics, internet experience, and e-shopping frequency. Respondents' socio-demographics, including gender, age, personal income, and living expense (i.e., the sum of all daily expenses, such as rent, shopping expenses and transport expenses) were captured in the present survey. Following previous studies (Ren & Kwan, 2009; Shi et al., 2019), the number of years of internet use on PCs was used as an indicator of internet experience in this study (see Table 1). Notably, some control variables, including age, income, living expense, and years of using the internet, were measured using ordinal scales in the following regression models. The values assigned are shown in Table 1.

Based on the respondents' feedback from a prior survey, interviewers from the URP research group of Lanzhou University found that e-shopping frequency largely varied by service type. Therefore, two scales were used to measure the frequency of e-shopping. For eating out services and leisure services, e-shoppers were asked to report monthly frequency of online purchases. For daily life services and local tour services, they were asked to report yearly frequency of online shopping. E-shopping frequencies are shown in Table 4. The measurement scales differed by type of services. Therefore, e-shopping frequency for each type was normalized using the min-max normalization approach. The normalized frequencies were used as independent variables in the subsequent regression models.

Table 4 E-shopping frequencies for four types of intangible services

Type of services	Frequency/times per regular year	
	Mean	S.D.
Daily life services (n=295)	11.4	13.6
Local tour services (n=271)	8.3	12.3
Type of services	Frequency/times per regular month	
	Mean	S.D.
Leisure services (n=598)	3.5	3.5
Eating out services (n=654)	6.1	5.7

3.3 Modeling approach

As assumed previously, consumers may tend to travel longer when using the online channel. To examine this hypothesis, the paired samples t-test was used to compare distances and durations between the online and offline channels. However, prior tests show that the distances and durations of single trips do not follow a normal distribution, which indicates that the requirement of paired samples t-tests for our data is not satisfied. Therefore, the nonparametric statistical method Wilcoxon signed-rank test was used.

We further investigated whether/how the distance and duration of a single trip for offline and online purchases differed by spatial attributes. Given the non-normality of data for distances and durations, nonparametric statistical methods were applicable to the present study, and the Kruskal-Wallis test was used. Respondents were initially categorized into three groups by geographic area (i.e., urban group, suburban group, and exurban group). According to the type of services, the Kruskal-Wallis test was used to indicate the extent to which the distance and duration of travel using online and offline channels differed between the three groups of respondents, separately.

To control for other factors, such as socio-demographics, internet experience, and e-shopping frequency, regression models were also developed. Because travel distance and duration are continuous variables, the linear regression model was selected as a potential approach. Using departure location, socio-demographics, internet experience, and e-shopping frequency as independent variables and the distance and duration of a single trip as dependent variables, initial regression models were developed. However, the standardized residuals of initial regression models did not follow a normal distribution, which suggests that the data failed to meet the assumption of the linear regression model. Therefore, the natural logarithm of one plus the distance and one plus the duration were used as the dependent variables in the regression models. One kilometer or one minute was added to return the log transformation to positive values, which avoids violating the fact that the distances and durations were non-negative values (Choo & Mokhtarian, 2004; Collantes & Mokhtarian, 2007). As a result, the distribution of standardized residuals of modified models largely followed the normal distribution, which roughly supports the assumption of the linear regression model. This suggests that the outcomes of modified models were acceptable.

Notably, the distance and duration of a single trip for different types of intangible services were integrated as observations in these models. It is consequently possible that multiple trips of a single respondent were used in the models. A total of 1654 observations were included in the regression models about distances, and 1648 observations in the regression models concerning durations. The type of intangible services was controlled for in these models. To take the heterogeneity of respondents into account, the cluster-robust method was used for regression estimations.

The linear regression models for the online and offline channels were separately developed. Therefore, direct comparisons of the coefficient values (i.e., effect sizes) of spatial attributes were not allowed between independent models. Consequently, the weakening effect of e-shopping on the association between spatial attributes and travel distances/durations cannot be identified accurately. To overcome this problem, the Fisher's permutation test was applied based on linear regression models, and the bootstrap approach was used for resampling (Good, 2013; Ahlstrom et al., 2016). For each test, the number of permutations was set to 5000. The regression models and Fisher's permutation tests were performed using the software Stata 15.1.

4. Results

4.1 Preliminary results

Using the Wilcoxon signed-rank test, we compared distances and durations of single trips via the online and offline channels, and the outcomes are shown in Figures 2 and 3. For all categories of services, distances and durations of online channel trips were averagely longer than the offline channel trips. The results of Wilcoxon signed-rank tests suggest that the differences were statistically significant (p<0.01), which suggests that online shopping for intangible services likely made consumers travel longer distances and durations. This result was mostly attributed to the fact that search spaces and cognitive spaces were extended via the internet. Apparently, this finding confirms our expectation that most e-shoppers are in the situation where they search and pay for services online beforehand, and then they make a trip to a specific place to use the service.

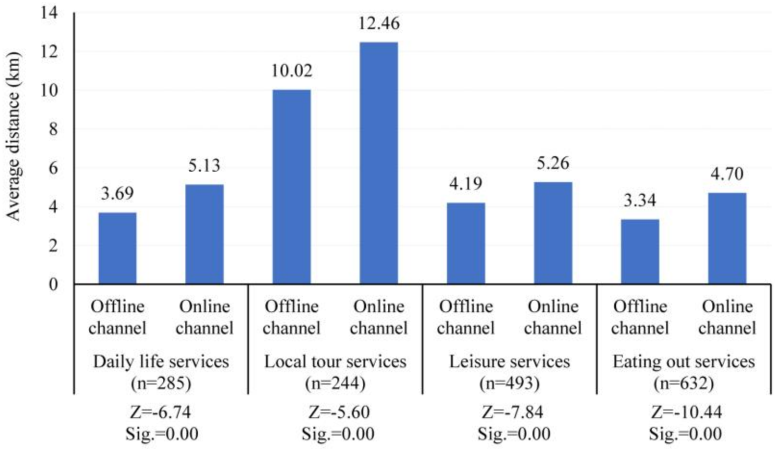

Figure 2 Wilcoxon signed-rank tests of distances

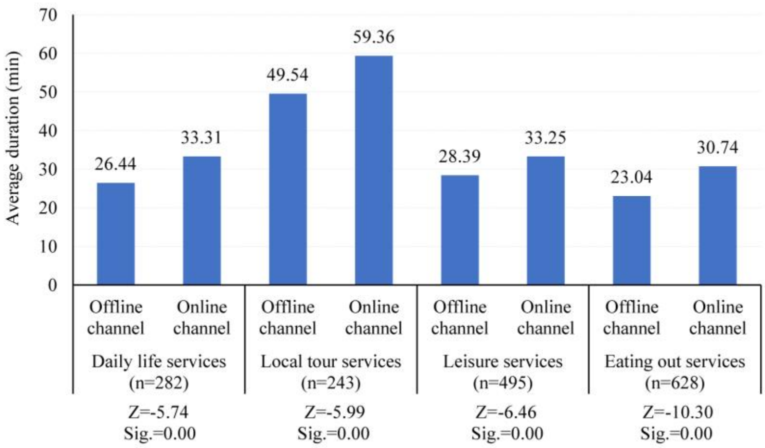

Figure 3 Wilcoxon signed-rank tests of durations

The Kruskal-Wallis test was subsequently used to examine the differences in travel distances and durations between three groups categorized by geographic areas. The results for distances are presented in Table 5. Apparently, for both offline and online purchases, people who mostly departed for trips from weakly urbanized areas tended to make longer distance trips compared to those from strongly urbanized areas. This finding is roughly consistent with previous studies (e.g., De Vos & Witlox, 2016; Jiao et al., 2016). The Kruskal-Wallis tests revealed that the distances of offline channel trips varied more by departure locations compared to the online channel trips. Particularly for daily life services and local tour services, differences in distances of offline channel trips between the three groups of respondents were statistically significant (p<0.10). In contrast, differences in distances of online channel trips were not. Therefore, we preliminarily assume that, all else being equal, the role of spatial attributes in the distance of a single trip is likely attenuated when e-shopping is used.

Table 5　Kruskal-Wallis tests of the distance by departure locations/km

Type of services	Purchase channel	Urban area		Suburban area		Exurban area		Kruskal-Wallis test	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	χ^2	Sig.
Daily life services (n=285)	Offline	3.17	3.25	3.66	3.11	4.93	5.42	5.20	0.074
	Online	4.84	4.07	4.71	3.84	6.32	5.87	1.46	0.483
Local tour services (n=244)	Offline	8.07	7.78	9.47	10.43	15.63	14.91	9.52	0.009
	Online	11.10	9.35	12.36	11.96	16.06	14.88	2.83	0.243
Leisure services (n=493)	Offline	3.71	3.34	4.29	3.91	5.24	4.61	8.61	0.014
	Online	4.85	4.15	5.32	4.20	6.16	4.94	6.60	0.037
Eating out services (n=632)	Offline	3.18	3.54	2.81	2.82	4.42	4.49	10.36	0.006
	Online	4.45	3.92	4.39	4.01	5.70	4.85	6.74	0.034

Durations per single trip are presented in Table 6. Roughly speaking, people primarily departed for trips from weakly urbanized areas were likely to make longer duration trips compared to those from strongly urbanized areas via both channels. This result is consistent with a study on leisure travel distances by De Vos and Witlox (2016). The results of Kruskal-Wallis tests showed that differences in the durations of single trips using both channels for daily life services and leisure services between the three groups of respondents were not statistically significant (p>0.10). This result indicates that departure locations did not significantly affect the duration of a single trip through both channels. Additionally, differences in the durations of offline channel trips for local tour services and eating out services between the three groups of respondents were statistically significant at a higher level. This result suggests that online shopping for these two categories of services likely attenuates the association between spatial attributes and the duration of a single trip when other factors are not considered.

Table 6　Kruskal-Wallis tests of the duration by departure locations/min

Type of services	Purchase channel	Urban area		Suburban area		Exurban area		Kruskal-Wallis test	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	χ^2	Sig.
Daily life services (n=282)	Offline	25.75	16.39	25.49	15.13	29.23	16.69	2.67	0.263
	Online	33.17	16.95	30.71	17.85	36.86	20.72	3.16	0.206
Local tour services (n=243)	Offline	45.38	28.47	47.38	29.48	62.85	36.49	9.40	0.009
	Online	56.99	31.19	57.29	29.65	67.95	36.49	4.67	0.097
Leisure services (n=495)	Offline	27.45	16.41	28.48	16.61	30.59	22.35	0.52	0.772
	Online	32.14	18.11	34.69	19.40	34.38	23.10	1.37	0.504
Eating out services (n=628)	Offline	23.32	15.93	20.30	13.81	25.80	17.21	7.14	0.028
	Online	30.68	18.05	29.55	18.69	32.43	20.45	1.30	0.523

4.2 Regression outcomes

In addition to spatial attributes, other elements, such as individuals' socio-demographics, internet experience, and e-shopping frequency, are expected to influence travel distance and duration. In this section, linear regression models controlling for these factors were developed for the two channels separately, and permutation tests were further applied to confirm the preliminary findings.

Table 7 shows the regression outcomes for offline channel distances (Model 1) and online channel distances (Models 2 and 3) separately. The results indicate that the departure locations of "urban area" and "suburban area" ("exurban area" = ref.) were significantly and negatively associated with distances in the three models. This result means that, as expected, compared to e-shoppers mostly departing from weakly urbanized areas, e-shoppers from highly urbanized areas likely traveled shorter distances when purchasing through both channels.

The same control variables were included in Models 1 and 2, which makes these models highly comparable. Therefore, using these models as base models, a permutation test was further applied to accurately identify the difference in the effect sizes of spatial attributes. As shown in Table 8, the differences in the coefficients of "urban area" and "suburban area" from Model 2 to Model 1 were 0.09 and 0.06, respectively. Both coefficients are larger than 0, and the former value is statistically significant (p<0.10). This result suggests that, when e-shoppers purchase services online, the negative association between the spatial attributes and travel distances becomes weaker. Therefore, we conclude that e-shopping does attenuate the role of spatial attributes in the distance of a single trip, even when controlling for some influential factors. This finding confirms the preliminary results of travel distances in Section 4.1.

The results also suggest that individuals' socio-demographics, internet experiences, e-shopping frequencies, and the type of services significantly affect the distance. Compared to women, men tended to make longer-distance trips when they purchased online. This result may be partially attributed to their higher likelihood of driving a car in China (Yang et al., 2013), which results in longer-distance trips. Older respondents tended to travel longer distances with both channels. However, age had an insignificant effect on the distance after internet experience and e-shopping frequency were controlled. Our respondents were relatively young, and we could loosely assume that middle-aged people tend to travel longer distances compared to young people, which may be attributed to their high shopping responsibilities for families (Shi et al., 2019). People with lower incomes were inclined to travel longer distances when they used the online channel. There are two possible reasons for this result. First, they are more likely to extend their searching and consumption spaces to consume services at lower prices and reduce shopping expenses. Second, they tend to live in neighborhoods with lower shopping accessibility, which are primarily areas with lower rent. Therefore, they must travel longer distances to consume intangible services. People who had higher living expenses also tended to travel longer distances with the offline channel. People with higher living expenses are likely to shop more. To satisfy their higher shopping demands, they tend to travel longer distances to extend activity spaces for the consumption of intangible services.

With respect to internet experience, people who were experienced in using the internet on PCs tended to travel longer distances when they purchased online. Their higher propensity of searching for information online may result in larger activity spaces for the consuming of intangible services. People who purchased online frequently were also more likely to travel shorter distances, which may be explained by time budgets. Previous studies showed that time budget was a constraint factor determining shopping behavior (Lundevaller, 2009; Suel & Polak, 2018). When people performed e-shopping for intangible services frequently, they frequently had to travel to consume the services. Therefore, they may be more likely to travel a shorter distance per trip to reduce the total time costs.

Furthermore, the distance of a single trip varied significantly by the type of services. Compared to daily life services, people tended to travel longer distances to consume local tour services with both channels and consume leisure services using the offline channel. People were likely to travel shorter distances to consume eating out services compared to daily life services using the offline channel. These outcomes were explained by the difference in spatial distribution between types of services. Compared to urban facilities for daily life services, local tour services and leisure services were sparsely distributed in Beijing, and eating out services were densely distributed.

Table 7 Linear regression outcomes concerning distances

Independent variables	Offline channel		Online channel			
	Model 1		Model 2		Model 3	
	B	Cluster-robust S.E.	B	Cluster-robust S.E.	B	Cluster-robust S.E.
Gender (Female=ref.)	0.03	0.05	0.11**	0.05	0.11**	0.05
Age	0.06*	0.03	0.08**	0.03	0.04	0.03
Income	-0.02	0.03	-0.08**	0.03	-0.08**	0.03
Living expense	0.08**	0.03	0.06	0.04	0.04	0.04
Departure location (Exurban area=ref.)						
Urban area	**-0.25*** **	**0.06**	**-0.16** **	**0.07**	**-0.16** **	**0.07**
Suburban area	**-0.18*** **	**0.07**	**-0.12* **	**0.07**	**-0.13* **	**0.07**
Years of using internet on PCs					0.13***	0.04
E-shopping frequency					-0.50***	0.13
Type of services (Daily life service=ref.)						
Local tour services	0.77***	0.06	0.71***	0.06	0.68***	0.06
Leisure services	0.14***	0.04	0.04	0.04	0.04	0.04
Eating out services	-0.07*	0.04	-0.06	0.04	-0.04	0.04
Constant	1.15***	0.10	1.48***	0.11	1.38***	0.12
R^2	0.176		0.147		0.168	
F	33.11		26.05		24.23	
Sig.	0.00		0.00		0.00	
Number of observations	1654		1654		1654	

Note: *p<0.1; **p<0.05; ***p<0.01.

Table 8 Permutation test of distances

Independent variables	Difference in Coef. (Model 2 - Model 1)	*p*-values
Gender (Female=ref.)	0.08	0.081
Age	0.02	0.241
Income	-0.06	0.042
Living expense	-0.02	0.287
Departure location (Exurban area=ref.)		
Urban area	**0.09**	**0.094**
Suburban area	**0.06**	**0.215**
Type of services (Daily life service=ref.)		
Local tour services	-0.05	0.287
Leisure services	-0.11	0.066
Eating out services	0.00	0.497
Constant	0.33	0.003
Observed difference	0.077	
Empirical *p*-value	0.081	

The regression outcomes for offline channel durations (Model 4) and online channel durations (Models 5 and 6) are reported separately in Table 9. Similarly, the departure locations of “urban area” and “suburban area” (“exurban area” = ref.) were negatively associated with duration in the three models. However, the associations were at a low confidence level, which suggests that people who primarily departed from highly urbanized areas (compared to weakly urbanized areas) were, to a limited extent, likely to travel shorter durations using both channels.

Similarly, the permutation test based on Models 4 and 5 indicates that the differences in the coefficients of “urban area” and “suburban area” from Model 5 to Model 4 were 0.06 and 0.05, respectively (see Table 10). Both values were more than 0 but were not significant ($p>0.10$). This result suggests that the negative association between the spatial attributes and travel durations becomes somewhat weaker when e-shoppers purchase services online, which roughly supports the preliminary findings of the travel durations discussed in Section 4.1.

People who also used the internet on PCs for multiple years tended to spend more time on a single trip when buying online (Model 6). Their longer travel durations were primarily regarded as the consequence of their longer travel distances, although longer distances may be compensated for with the use of faster travel modes (De Vos & Witlox, 2016). With respect to the role of the types of services in Table 9, similar outcomes to distances were found.

Table 9 Linear regression outcomes concerning durations

Independent variables	Offline channel		Online channel			
	Model 4		Model 5		Model 6	
	B	Cluster-robust S.E.	B	Cluster-robust S.E.	B	Cluster-robust S.E.
Gender (Female=ref.)	-0.03	0.05	-0.00	0.05	-0.00	0.05
Age	0.02	0.03	0.03	0.02	0.01	0.03
Income	0.03	0.03	-0.03	0.03	-0.03	0.03
Living expense	0.04	0.03	0.03	0.03	0.02	0.03
Departure location (Exurban area=ref.)						
Urban area	**-0.10**	**0.06**	**-0.04**	**0.06**	**-0.04**	**0.06**
Suburban area	**-0.11***	**0.07**	**-0.06**	**0.07**	**-0.06**	**0.07**
Years of using internet on PCs					0.07**	0.04
E-shopping frequency					-0.06	0.08
Type of services (Daily life service=ref.)						
Local tour services	0.60***	0.05	0.56***	0.05	0.55***	0.05
Leisure services	0.08**	0.04	-0.02	0.04	-0.02	0.04
Eating out services	-0.16***	0.04	-0.10***	0.04	-0.09**	0.04
Constant	2.99***	0.10	3.32***	0.10	3.23***	0.10
R^2	0.145		0.120		0.125	
F	34.89		30.14		25.17	
Sig.	0.00		0.00		0.00	
Number of observations	1648		1648		1648	

Note: **p*<0.1; ***p*<0.05; ****p*<0.01.

Table 10 Permutation test of durations

Independent variables	Difference in Coef. (Model 5 - Model 4)	*p*-values
Gender (Female=ref.)	0.03	0.314
Age	0.01	0.333
Income	-0.05	0.039
Living expense	-0.01	0.385
Departure location (Exurban area=ref.)		
Urban area	**0.06**	**0.166**
Suburban area	**0.05**	**0.222**
Type of services (Daily life service=ref.)		
Local tour services	-0.04	0.308
Leisure services	-0.09	0.074
Eating out services	0.05	0.204
Constant	0.33	0.003
Observed difference	0.025	
Empirical *p*-value	0.314	

5. Conclusions and implications

Using data from Beijing, China, the present study empirically examined whether e-shopping for intangible services attenuated the effect of spatial attributes on the distance and duration of single trips. The results indicated that people tended to travel farther when buying intangible services online. The distance of a single trip differed less by spatial attributes (i.e., urban areas, suburban areas, and exurban areas) due to e-shopping for services. Correspondingly, the association of spatial attributes with the duration of a single trip became weaker to a limited extent. Additionally, individuals' socio-demographics, internet experience, e-shopping frequency, and the type of services significantly affected the distance and duration of single trips.

This study contributes to the body of existing literature. First, different from most previous studies that focused on the total distances and durations of all trips during a given period (e.g., Cao et al., 2010; Ewing & Cervero, 2010), we concentrated on the distance and duration of a single trip for the consumption of intangible services and identified their determinants. Particularly, some factors (e.g., spatial attributes, socio-demographics, internet experience, e-shopping frequency, and the type of services) significantly affected the distance or duration of single trips caused by e-shopping. Second, similar to some existing studies indicating that the use of ICTs weakens the spatial constraint on human activities (e.g., Schwanen & Kwan, 2008; Xi et al., 2017; Hubers et al., 2018), the present paper confirmed that the effect of spatial attributes on travel distance and duration was mediated by e-shopping for intangible services. Geographers must rethink the role of spatial attributes in the information era in future research.

Our findings have important implications for the management of the urban transportation system. On the one hand, e-shopping for intangible services stimulates e-shoppers to make longer trips, which may result in higher levels of car use and urban sprawl. Therefore, e-shopping for intangible services may be regarded as a new challenge for the urban transportation system. On the other hand, quite a number of previous studies indicate a significant association between spatial attributes and travel behavior (e.g., Cao, 2015; Ding et al., 2017), which suggests that land-use policies (e.g., spatial interventions such as densification and land-use mixing) may be regarded as a cost-effective tool that leads to a sustainable transportation system. However, the role of ICTs in travel behavior is not highlighted in previous studies. The present study found that spatial attributes played a weaker role in travel distances and durations due to e-shopping for intangible services. Therefore, land-use policies aiming to reduce travel distances and durations may not be as effective as before. Importantly, travel mode choice is strongly determined by the distance of a single trip (Ding et al., 2017), which suggests that it may not be as valid as before to implement land-use policies to adjust travel mode choice when people purchase intangible services online.

The present study has some limitations that may be taken into account in future studies. First, the selection bias resulting from the recruited respondents at the seven shopping centers in Beijing may limit the generalizability of our findings. The possible selection bias toward more-mobile e-shoppers may interfere with the assessment of the weakening effect of e-shopping on the association between spatial attributes and travel distances and durations. Future research should collect data in more shopping centers and other types of spaces to minimize selection bias. Second, the constants were statistically significant ($p<0.01$) in regression models for distances and durations. This result suggests that some potential factors affecting travel distance and duration were not included in these models. Future research should consider these factors (e.g., household income, car ownership) as additional control variables in regression models so that the weakening effect of e-shopping on the influence of spatial attributes on travel distance and duration may be more precisely measured. Third, travel behavior may be characterized using several dimensions, such as the distance or duration of a single trip, the total travel distances or durations during a given period, travel frequency, and travel mode choices. Focusing on the dimension of the distance and duration of a single trip, the present study examined whether e-shopping behavior attenuated the effects of spatial attributes. Future scholars may examine whether e-shopping behavior attenuates the associations between spatial attributes and other dimensions of travel behavior. Finally, in addition to travel behavior for consuming services, the use of ICTs may also affect travel behavior for other purposes (e.g., commuting travel, business travel, and social travel). Future studies may also analyze the relationships between spatial attributes and the characteristics of trips for other purposes in the context of ICTs.

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References

Ahlstrom, C., Kircher, K., Thorslund, B., & Adell, E. (2016). Bicyclists' visual strategies when conducting self-paced vs. system-paced smartphone tasks in traffic. Transportation Research Part F: Traffic Psychology and Behaviour, 41, 204-216.

Akar, G., Chen, N., & Gordon, S. I. (2016). Influence of neighborhood types on trip distances: Spatial error models for Central Ohio. International Journal of Sustainable Transportation, 10(3), 284-293.

Alexander, B., Ettema, D., & Dijst, M. (2010). Fragmentation of work activity as a multi-dimensional construct and its association with ICT, employment and sociodemographic characteristics. Journal of Transport Geography, 18(1), 55-64.

Alexander, B., Hubers, C., Schwanen, T., Dijst, M., & Ettema, D. (2011). Anything, anywhere, anytime? Developing indicators to assess the spatial and temporal fragmentation of activities. Environment and Planning B: Planning and Design, 38(4), 678-705.

Buliung, R. N., & Kanaroglou, P. S. (2006). Urban form and household activity-travel behavior. Growth and Change, 37(2), 172-199.

Cao X., Chen, Q., & Choo, S. (2013). Geographic distribution of e-shopping: Application of structural equation models in the Twin Cities of Minnesota. Transportation Research Record: Journal of the Transportation Research Board, (2383), 18-26.

Cao, X. (2009). E-shopping, spatial attributes, and personal travel: A review of empirical studies. Transportation Research Record: Journal of the Transportation Research Board, (2135), 160-169.

Cao, X. (2015). Examining the impacts of neighborhood design and residential self-selection on active travel: A methodological assessment. Urban Geography, 36(2), 236-255.

Cao, X. J., Xu, Z., & Fan, Y. (2010). Exploring the connections among residential location, self-selection, and driving: Propensity score matching with multiple treatments. Transportation Research Part A: Policy and Practice, 44(10), 797-805.

Chen, Y. (2017). Neighborhood form and residents' walking and biking distance to food markets: Evidence from Beijing, China. Transport Policy. https://doi.org/10.1016/j.tranpol.2017.09.015.

Chen, Y. J., & Akar, G. (2017). Using trip chaining and joint travel as mediating variables to explore the relationships among travel behavior, socio-demographics, and urban form. Journal of Transport and Land Use, 10(1), 573-588

China Electronic Commerce Research Center. (2016). Report of Insight into Online Consumption of Consumers and Guidance on E-shopping in 2016 in China. Available at: http://www.100ec.cn/zt/16zgxfz/ (accessed 4 April 2019).

Choo, S., & Mokhtarian, P. L. (2004). What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice. Transportation Research Part A: Policy and Practice, 38(3), 201-222.

Collantes, G. O., & Mokhtarian, P. L. (2007). Subjective assessments of personal mobility: What makes the difference between a little and a lot? Transport Policy, 14(3), 181-192.

Daniel, J. (2012). Chapter 5. Choosing the Type of Probability Sampling. In Sampling Essentials: Practical Guidelines for Making Sampling Choices. Thousand Oaks, CA: SAGE.

De Vos, J., & Witlox, F. (2016). Do people live in urban neighbourhoods because they do not like to travel? Analysing an alternative residential self-selection hypothesis. Travel Behaviour and Society, 4, 29-39.

Ding, C., Wang, D., Liu, C., Zhang, Y., & Yang, J. (2017). Exploring the influence of built environment on travel mode choice considering the mediating effects of car ownership and travel distance. Transportation Research Part A: Policy and Practice, 100, 65-80.

Elldér, E. (2015). Does telework weaken urban structure-travel relationships? Journal of Transport and Land Use, 10(2), 187-210.

Ewing, R., & Cervero, R. (2010). Travel and the built environment: A meta-analysis. Journal of the American Planning Association, 76(3), 265-294.

Fan, Y., & Khattak, A. J. (2008). Urban form, individual spatial footprints, and travel: Examination of space-use behavior. Transportation Research Record: Journal of the Transportation Research Board, (2082), 98-106.

Feng, J., Dijst, M., Prillwitz, J., & Wissink, B. (2013). Travel time and distance in international perspective: A comparison between Nanjing (China) and the Randstad (the Netherlands). Urban Studies, 50(14), 2993-3010.

Feng, J., Dijst, M., Wissink, B., & Prillwitz, J. (2015). Elderly co-residence and the household responsibilities hypothesis: Evidence from Nanjing, China. Urban Geography, 36(5), 757-776.

Ferrell, C. E. (2005). Home-based teleshopping and shopping travel: Where do people find the time? Transportation Research Record: Journal of the Transportation Research Board, (1926), 212-223.

Good, P. (2013). Permutation tests: a practical guide to resampling methods for testing hypotheses. Springer Science & Business Media.

Gould, J., & Golob, T. F. (1997). Shopping without travel or travel without shopping? An investigation of electronic home shopping. Transport Reviews, 17(4), 355-376.

Hubers, C., Dijst, M., & Schwanen, T. (2018). The fragmented worker? ICTs, coping strategies and gender differences in the temporal and spatial fragmentation of paid labour. Time & Society, 27(1), 92-130.

IResearch. (2017). Report of O2O E-commerce Serving Local Life in 2017 in China. Available at: http://report.iresearch.cn/report/201707/3024.shtml (accessed 20 January 2019).

Jamal, S., & Habib, M. A. (2019). Investigation of the use of smartphone applications for trip planning and travel outcomes. Transportation Planning and Technology, 42(3), 227-243.

Jamal, S., Habib, M. A., & Khan, N. A. (2017). Does the use of smartphone influence travel outcome? An investigation on the determinants of the impact of smartphone use on vehicle kilometres travelled. Transportation Research Procedia, 25, 2690-2704.

Jiao, J., Moudon, A. V., & Drewnowski, A. (2016). Does urban form influence grocery shopping frequency? A study from Seattle, Washington, USA. International Journal of Retail & Distribution Management, 44(9), 903-922.

Kamis, A. A., & Stohr, E. A. (2006). Parametric search engines: What makes them effective when shopping online for differentiated products? Information & Management, 43(7), 904-918.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30(3), 607-610.

Lundevaller, E. H. (2009). The effect of travel cost on frequencies of shopping and recreational trips in Sweden. Journal of Transport Geography, 17(3), 208-215

Maat, K., & Timmermans, H. J. (2009). A causal model relating urban form with daily travel distance through activity-travel decisions. Transportation Planning and Technology, 32(2), 115-134.

McKinsey and Company. (2017). Digital China: Powering the economy to global competitiveness. Available at: https://www.mckinsey.com/featured-insights/china/digital-china-powering-the-economy-to-global-competitiveness (accessed 4 April 2019).

Ren, F., & Kwan, M. P. (2009). The impact of geographic context on e-shopping behavior. Environment and Planning B: Planning and Design, 36(2), 262-278.

Rotem-Mindali, O. (2008). Urban form and trends in shopping journeys: Empirical evidence from the Netherlands. Paper presented at the RSA Annual International Conference “Regions: The Dilemmas of Integration and Competition”, University of Economics Prague, Czech Republic, 27th-29th May 2008.

Rotem-Mindali, O., & Weltevreden, J. W. (2013). Transport effects of e-commerce: What can be learned after years of research? Transportation, 40(5), 867-885.

Schwanen, T., & Kwan, M. P. (2008). The internet, mobile phone and space-time constraints. Geoforum, 39(3), 1362-1377.

Schwanen, T., Dijst, M., & Dieleman, F. M. (2002). A microlevel analysis of residential context and travel time. Environment and Planning A, 34(8), 1487-1507

Shi, K., Cheng, L., De Vos, J., Yang, Y., & Witlox, F. (2020). The modification effects of e-shopping on shopping travel: A focus on intangible services in a Chinese context. Under review.

Shi, K., De Vos, J., Yang, Y., & Witlox, F. (2019). Does e-shopping replace shopping trips? Empirical evidence from Chengdu, China. Transportation Research Part A: Policy and Practice, 122, 21-33.

Srinivasan, K. K., & Reddy Athuru, S. (2004). Modeling interaction between internet communication and travel activities: Evidence from Bay Area, California, Travel Survey 2000. Transportation Research Record: Journal of the Transportation Research Board, (1894), 230-240.

Suel, E., & Polak, J. W. (2018). Incorporating online shopping into travel demand modelling: Challenges, progress, and opportunities. Transport Reviews, 38(5), 576-601.

Sun, B., Ermagun, A., & Dan, B. (2017). Built environmental impacts on commuting mode choice and distance: Evidence from Shanghai. Transportation Research Part D: Transport and Environment, 52, 441-453.

Weltevreden, J. W., & Rotem-Mindali, O. (2009). Mobility effects of B2C and C2C e-commerce in the Netherlands: A quantitative assessment. Journal of Transport Geography, 17(2), 83-92.

Xi, G., Zhen, F., Gilles, P., & Valerie, F. (2017). Spatio-temporal fragmentation of leisure activities in information era: Empirical evidence from Nanjing, China. Chinese Geographical Science, 27(1), 137-150.

Yang, M., Li, D., Wang, W., Zhao, J., & Chen, X. (2013). Modeling gender-based differences in mode choice considering time-use pattern: Analysis of bicycle, public transit, and car use in Suzhou, China. Advances in Mechanical Engineering, http://dx.doi.org/10.1155/2013/706918.

Zhen, F., Du, X., Cao, J., & Mokhtarian, P. L. (2018). The association between spatial attributes and e-shopping in the shopping process for search goods and experience goods: Evidence from Nanjing. Journal of Transport Geography, 66, 291-299.