Impact of Shipping Distance on Online Retailers' Sales: A Case Study of Maiyang on Tmall

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Abstract: Many studies have qualitatively explained that information and communication technology (ICT) has loosened the restrictions of distance and space on retailers' sales. Few empirical studies, however, have explored the impact of shipping distance on online retailers' sales. This study examined the Maiyang (M-Y) store on Tmall in China as a case study to investigate the relationship between shipping distance and sales. The results showed that sales volume in 2014 at the county level did not strictly obey the distance decay law. The shipped distance of high-priced commodities may not be much longer than that of low-priced commodities. Within the scope of investigation, the relationships between income, cost, and net profit curves do not follow central place theory. Goods have neither thresholds nor ranges. The key factor in the spatial discrepancy of sales is the size of market. The impact of shipping distance on sales is not as strong as that of traditional retailers in Information Era.

Keywords: online retailers; shipping distance; central place theory

1 Introduction

The information and communication technology (ICT) revolution has created a virtual environment with favorable conditions for the birth of new economic activities, namely, e-commerce (Rayport and Sviokla, 1994; Pyle, 1996; Liu et al., 2004). It has profoundly changed the means of production, consumption, communication, and marketing patterns while simultaneously promoting organizational efficiency and business competitiveness (Anderson et al., 2003; Aoyama, 2003; Ettlinger, 2008; Cao et al., 2010; Zhen et al., 2014). In contrast to the exchanges characteristic of the traditional retail environment, commodity transactions between online retailers and consumers are implemented in a virtual geographic space. Commodities reach consumers quickly from logistics distribution centers. Commercial organizations and the entire socioeconomic space have been reshaped by these new means of exchange and delivery (Park, 2004; Schwanen et al., 2006; Martin, 2008; Zhen and Wei, 2008; Yu et al., 2013; Xi et al., 2017).

Central place theory suggests that sellers seek to maximize profit and capture as large a market as possible and that the shipping distance between them becomes as large as possible (Xu and Zhu, 1988). In addition, consumers consciously go to the nearest central place or store to buy goods or obtain services to minimize travel expenses. Due to the shipping distance, tra-

ditional retailers' sales volumes obey the distance decay law. Furthermore, the survival and development of retailers require goods to have thresholds, and their markets should not exceed the range of their goods. As few customers purchase high-priced goods, these goods have higher market-share thresholds (Kolars and Nystuen, 1974; Kaplan et al., 2009; Anderson, 2012). One of the important assumptions of central place theory is that the study area is considered homogeneous. Although there is no such area in the real world, this theory is important for studying the locations, sizes, and spatial models of the retail and service industries.

The ICT revolution has an important influence on central place theory, which originated in industrial society. Most researchers have concluded that ICT has loosened the restrictions of distance or space on retailers' sales and spatial organization in an information society (Park, 2004; Park and Taylor, 2004; Yu et al., 2013). Due to their use of Internet platforms and modern logistics systems, online retailers do not need to establish sales sites near their customers to provide them with goods and services, which has greatly expanded their sales scopes (Park, 2004; Schwanen et al., 2006; Ghezzi et al.,2012; Morganti et al., 2014; Yeung and Ang, 2016). Consumers do not have to bear enormous costs to travel to a central place or shop to purchase goods. Such retailers can carry out economic activities on a global scale and arrange their spatial organization rationally in accordance with development needs. For instance, Javalgi and Ramsey (2001) found that modern enterprises could provide people from different social and cultural backgrounds with goods and services through the Internet and global logistics networks. Nemoto et al. (2001) and Rotem-Mindali et al. (2014) argued that the Internet has provided consumers with the opportunity to purchase goods from anywhere in the world. Furthermore, Crewe (2013) argued that the emergence of the Internet has created a new space for fashion consumption. Compared with the traditional sales space, this new space is characterized by unprecedented openness, fluidity, and interactivity. These studies indicated that the geographical space is still binding on human activities and that distance death is exaggerated (Morgan, 2001; 2004; Krizek et al., 2005; Farag et al., 2006).

In addition, some researchers have inferred the spatial disparity of online retail sales by exploring the impacts of urbanization level, socioeconomic environment, and individual characteristics on online shopping behavior. Farag et al. (2006) observed that compared with residents of rural areas in the Netherlands, those living in highly urbanized areas are more likely to accept Internet technology. Consequently, they engage in online shopping more frequently. Cao et al. (2013) found that this phenomenon also exists in the Twin Cities of Minnesota. Ren and Kwan (2009) reported that residents of the Columbus metropolitan area in Ohio, U.S. who live in largely white neighborhoods with high levels of income and Internet development engage in more Internet consumption. In comparing the online retail markets of the U.S. and Japan, Aoyama (2003) could not clearly explain spatial differences in sales, although her research indicated that social space-related factors such as the residential distribution and accessibility of brick-and-mortar shops indirectly affect the spatial discrepancy in the sales of online retailers. Farag et al. (2006) argued that the education, income, and age of residents, the development of brick-and-mortar businesses, and traffic accessibility could affect online retailers' sales. In addition, the fast-paced life of modern society may stimulate online retail sales because consumers can save on time costs by browsing commodity information on the Internet and enjoy the quick delivery service provided by modern logistics networks (Farag et al., 2007; Hsiao, 2009; Yu et al., 2013).

In sum, although some studies have qualitatively explored the impact of shipping distance on online retailers' sales in the Information Era, few empirical studies have investigated the following questions. 1) Does online retailers' sales volume obey the distance decay law? 2) Is the shipped distance of high-priced commodities longer than that of low-priced commodities? 3) In the online retail context, do goods have thresholds and ranges? 4) What is different about the influence of shipping distance and other regional factors (such as the size of the market, level of Internet development, and number of logistics distribution networks) on online retailers' sales? This study explored these questions based on the trading records and financial data of M-Y (Maiyang store), a shoe store operating on the Chinese online commerce platform Tmall[①].

[①]Tmall, which has more than 100 000 brands, is a comprehensive shopping site in China and the largest comprehensive online shopping platform in Asia.

2 Data and Methodology

2.1 Case study: M-Y

M-Y, which is near the Hangzhou bus terminal in the Jianggan district of Zhejiang Province, is an online retailer of women's shoes made by small- and medium-sized enterprises in the county-level city of Tongxiang in the same province. It formally launched operations in early January 2011 with three shareholder employees in an approximately 80 m² office that also housed a warehouse and a photographic studio. The company has developed considerably since its establishment. At the end of 2015, M-Y had 23 employees, a 100 m² office (including a photographic studio), and an 800 m² warehouse. From 2011 to 2014, the company's annual sales rate grew by 188.80% on average, with its sales volume reaching 3.3×10^7 yuan (RMB) in 2014. Its products are sold in about 2800 counties across China (excluding Hong Kong, Macao, and Taiwan). To transport goods, the company relies on the network distribution centers of such Chinese express delivery companies as YTO (Yuantong), ZTO (Zhongtong), STO (Shentong), YDO (Yunda), SF (Shunfeng), and CNRAM (Chinese postal parcel post)[①]. M-Y is a typical medium and small B2C (business to costomer) commerce enterprise with well-divided functional departments and a sales range of merchandise that covers the vast majority of counties in China. We mainly considered its 2014 sales figures.

2.2 Data

M-Y provided the research team with records of 124 609 successful transactions and its financial statements for 2014 (Table 1). The transaction records included such important information as actual payment,

order status, sales quantity data, commodity names, and the logistics companies used. The financial statements revealed data on staff salaries, rent, electricity charges, delivery costs, Internet and advertising fees, payments for goods, and commissions.

M-Y's sales volume in a particular unit of analysis (province, county, or municipality) is equal to the total actual payment received from that unit. Sales costs consist of freight and non-freight fees, and net profit is equal to sales volume minus sales costs. M-Y's sales costs and net profit are calculated for each unit of analysis. However, as the freight and non-freight fees for each commodity are difficult to compute, we codetermine freight based on the standard charge of express companies, merchandise weight (calculated in accordance with a uniform standard), and a deflator index. The deflator index is the annual total freight fees paid by M-Y divided by the annual freight fees calculated in accordance with the standard express charges. The non-freight fee of each commodity is its annual non-freight fee divided by sales quantity. Finally, we measure sales scope based on the shipping distance between the sales site and geometric center of analysis unit.

The spatial distribution of online retailers' sales is influenced by socioeconomic factors (i.e., regional factors). In accordance with prior research (e.g., Aoyama, 2003; Farag et al., 2006; Weltevreden and van Rietbergen, 2007; Ren and Kwan, 2009; Galliano et al., 2011; Song et al., 2014), the independent variables considered in this study are the size of female population, the per-capita disposable income of urban households, the number of post offices, the number of Internet domain names, shipping distance, average shipping time, and urbanization rate (Table 2 and Table 3). In China, the

Table 1 Information in M-Y transaction records and financial statements

Transaction records	Financial statements
Order number, Customer name, Alipay account, Payables, Payment points, Rebate points, Actual payment, Order status, Recipient name, Delivery address, Cell phone number, Creation time of order, Payment time of order, Sales quantity, Commodity name, Commodity type, Logistics number, Logistics company, *etc.*	Staff salary, Bonuses, Rent, Electricity charges, Delivery costs, Internet fees, Advertising fees, Payments for goods, Commission, *etc.*

Note: Alipay account means Alipay user names

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①The transportation of goods for most online retailers in China mainly depends on the distribution networks of these six express companies.

D_{SP_i} represents the shipping distance of Price i in spring; $D_{SP_i} = dP_{i1}w_1 + dP_a w_2 + ... + dP_{tx}w_n$. dP_{tx} denotes the straight line between the county geometric center of the nth transaction record in price i and M-Y; and w_n indicates the weight of the nth transaction record determined by the commodity quantity.

size of female population must be measured in terms of both the population with local *hukou* (household registration records) and permanent population. The permanent population comprises both members of the population with local *hukou* and the floating population, and it thus more accurate for assessing regional consumption volumes. The urbanization rate is measured by the permanent population. STO is mainly responsible for goods delivery. The expected time for goods transported by STO (from Jianggan district to each county) was obtained by a python program on http://www.kuaidihelp.com/ and was used to reflect accessibility. As the number of post offices and number of Internet domain names were obtained from the National Bureau of Statistics of China (2015) alone, the unit of analysis for the factors affecting the spatial features of sales is the province or municipality. The average shipping time of goods is equal to the mean of the expected time of goods transported to each county in a province or municipality.

2.3　Methodology

To compare the impact of shipping distance and other regional factors on the spatial discrepancy in sales and to avoid the multicollinearity problem among independent variables, we adopted the principal component regression method. This method first transforms several indexes into comprehensive indexes and then conducts a regression analysis on the principal component sequence and the normalized dependent variable. Its results may eliminate the multicollinearity and autocorrelation between multiple variables without changing the index system to explain the dependent variable (Huang and Huang, 2007; Zhang and Zhou, 2013).

The analysis procedure is detailed as follows. First, we standardized the raw data and conducted principal component analysis. Second, we selected the independent variables of the regression. The eigenvector corresponding to the largest eigenvalue is the coefficient of the first principal component, the eigenvector corresponding to the second largest eigenvalue is the coefficient of the second principal component, and so on. The number of selected principal components depends on the interpretation of dependent variable. Third, to obtain the new independent variables, we multiplied the score coefficient matrix of principal component by the normalized value matrix of independent variable. Finally, based on the standardized dependent variable and new independent variables, we executed the linear regression and converted the coefficients of principal component regression into the coefficients of original variables.

3　Results

3.1　Spatial distribution of M-Y's sales

In this section, the spatial distribution of M-Y's sales

Table 2　Descriptions of dependent and independent variables

Variables	Name	Descriptions	Source
Dependent variables	y	Sales volume (10^4 yuan)	M-Y
Independent variables	x_1	Female population size (10^4 persons), which reflects the regional market volume	Statistics Bulletins of National Economic and Social Development in provinces or municipalities
	x_2	Per-capita disposable income of urban households (10^4 yuan), which reflects women's purchasing power	CSY
	x_3	Number of post offices, which reflects the sophistication of logistics facilities	CSY
	x_4	Number of Internet domain names (10^4 units), which reflects the level of Internet development	CSY
	x_5	Shipping distance (km), which reflects the degree of spatial resistance or freight costs	Calculated by ArcGis
	x_6	Average shipping time (day), which reflects the degree of spatial resistance or freight costs and accessibility	http://www.kuaidihelp.com/
	x_7	Urbanization rate (%), which reflects the fashion-related sophistication of female shoe customers	CSY

Note: The number of post offices includes postal enterprises and express delivery companies with operating licenses

Table 3 Descriptive statistics of variables

Variable	Minimum	Maximum	Mean	SD
y	8.67	344.56	105.49	68.49
x_1	154	5048	2150	1345
x_2	2.18	4.88	2.75	0.69
x_3	284	14476	4310.77	3053.47
x_4	0.90	390.5	61.12	91.12
x_5	126.13	3716.80	1250.77	802.73
x_6	0.90	6.36	2.76	1.13
x_7	25.75	89.6	55.84	13.61

quantity and volume is described for 2014. Fig.1 and Table 4 show that its sales quantity and volume at the county level were highly concentrated in some urban agglomerations, such as YD and PRD, which indicated that M-Y's sales were concentrated in economically developed areas. possible reason is that the economically developed areas have perfect modern logistics network facilities and Internet facilities are densely populated, and their residents have strong purchasing power. According to statistics, the sales quantity and volume in the 21 urban agglomerations were 84 128 pairs of shoes and 2.06×10^7 yuan, respectively, accounting for 63.08% and 62.91% of its sales quantity and volume, respectively, for the country as a whole. The top eight urban agglomerations in terms of sales quantity/volume in 2014 were YD, CY, BTH, PRD, LDP, HN, SDP, and WH, as shown in Table 4. The per-capita consumption quantity and volume per10000 people in these 8 urban agglomerations were 1 pair and 273.42 yuan, respectively, both higher than the respective average national figures (less than 1 pair and 33.1 yuan). In terms of per-capita consumption quantity/volume, the top eight urban agglomerations in 2014 were IM, NX, CZX, YD, SX, PRD, GZ, and YN. This spatial pattern of sales quantity/volume was closely associated with the size of the female population, level of economic development, and shipping distance. It is important to note that although the sales volumes in IM and NX were not very large, the per-capita consumption quantity and volume in these two regions placed them at the top of the list of the 21 urban agglomerations considered. Climate provides a possible explanation. IM and NX are very cold in winter and spring, and the women living there thus have a greater need for warm (and more expensive) shoes.
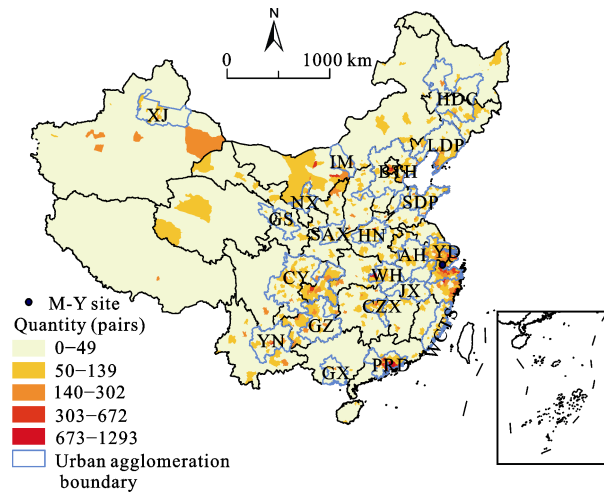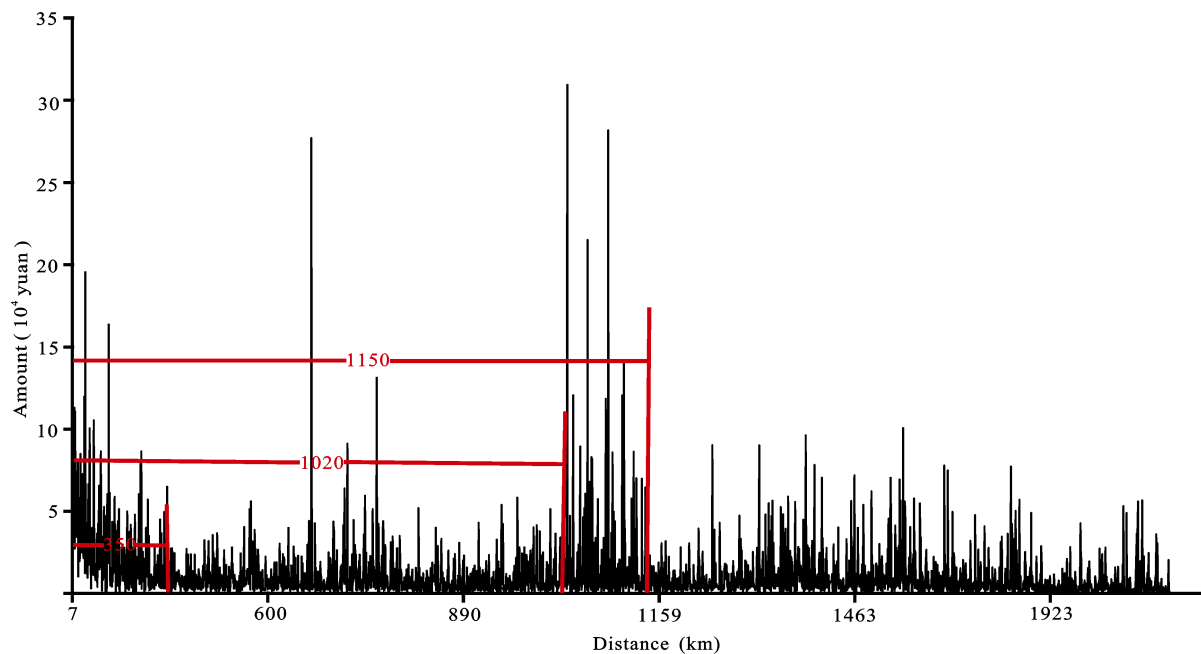

Fig. 1 Spatial distribution of M-Y's sales quantity (2014), these urban agglomeration boundaries were confirmed with reference to Huang and Chen (2015). The meaning of abbreviation are shown in Table 4

3.2 Relationship between sales volume and shipped distance

Connecting lines between M-Y site and the geometric centers of counties were first drawn, and their shipped distances were then calculated using ArcGis. Next, the sales curve was drawn with reference to the county-level sales volumes and corresponding spatial distances. Fig. 2 shows that those volumes changed with distance. For example, the largest sales volume (309 300 yuan) was recorded in Dongguan in Guangdong province, which was 1044.31 km from the M-Y site. The corresponding sales quantity in Dongguan was 1.30×10^5 pairs. The smallest sales volume (99 yuan) was recorded in the more distant Mashan district of Jixi prefecture in Heilongjiang Province, which was 1837.72 km from M-Y. The corresponding sales quantity was one pair. According to the relationship between sales volume and distance for M-Y in 2014, the consumptions of buffer zones in the radius of 0-350 km and 1030-1050 km were the largest, 5.87 and 4.66×10^6, respectively (Fig. 2), accounting for 17.97% and 14.25% of the volume for the whole country, respectively. The corresponding figures for sales quantities and their percentages of the national total were 24 100 and 19 100 pairs and 18.10% and 14.31%, respectively. Within the former buffer area, the average sales volume and quantity in the 1 km buffer zone were 16 800 yuan and 69 pairs, respectively. Within the latter buffer area, they were 35 800 yuan

Table 4 M-Y's sales in urban agglomerations (2014)

Urban agglomeration	Quantity (pairs)	Proportion (%)	Volume (10⁴ yuan)	Proportion (%)	Per-capita consumption quantity (pair/10⁴ persons)	Per-capita consumption volume (yuan/10⁴ persons)
Yangtze River Delta (YD)	17716	13.28	430.30	13.16	1.64	397.82
Chengdu-Chongqing (CY)	9694	7.27	238.73	7.30	1.01	249.02
Beijing-Tianjin-Hebei (BTH)	9013	6.76	222.39	6.80	1.01	248.59
Pearl River Delta (PRD)	8084	6.06	192.61	5.89	1.40	334.19
Liaodong Peninsula (LDP)	4220	3.16	104.89	3.21	0.98	244.55
Henan (HN)	3702	2.78	89.84	2.75	0.87	210.57
Shandong Peninsula (SDP)	3590	2.69	88.72	2.71	0.74	182.56
Wuhan (WH)	3312	2.48	82.00	2.51	1.07	265.61
West Coast in Taiwan Straits (WCTS)	2810	2.11	66.06	2.02	1.02	240.48
Harbin-Dalian-Changchun (HDC)	2794	2.09	68.19	2.09	0.85	206.96
Guizhou (GZ)	2459	1.84	62.19	1.90	1.27	322.09
Changsha-Zhuzhou-Xiangtan (CZX)	2365	1.77	58.05	1.78	1.68	412.15
Yunnan (YN)	2235	1.68	51.75	1.58	1.26	292.19
Anhui (AH)	2180	1.63	53.22	1.63	0.67	163.12
Shaanxi (SAX)	1723	1.29	43.63	1.33	0.87	220.66
Inner Mongolia (IM)	1563	1.17	39.05	1.19	2.68	669.81
Jiangxi (JX)	1436	1.08	35.03	1.07	0.80	195.87
Gansu (GS)	1357	1.02	33.87	1.04	1.11	278.16
Xinjiang (XJ)	1193	0.89	30.53	0.93	0.96	246.61
Ningxia (NX)	1140	0.85	28.12	0.86	2.12	521.89
Shanxi (SX)	891	0.67	22.32	0.68	1.57	392.21
Guangxi (GX)	651	0.49	15.78	0.48	0.50	121.48
Sum	84128	63.08	2057.25	62.91	-	-

Fig. 2 Relationship between sales volume and distance for M-Y (2014)
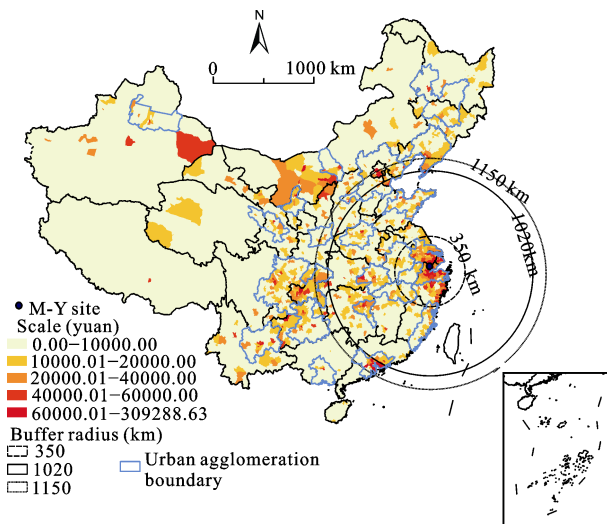
Fig. 3 Classification of M-Y's sales volume and buffer zones by agglomeration area (2014)

and 147 pairs, respectively. The 0–350 km buffer zone passed through YD, Wenzhou, and Taizhou, which have high levels of economic development, whereas the 1020–1150 km zone passed through the core areas of PRD, SAX, SX, LDP, BTH, and the eastern region of CY, where the level of economic development is also high (Fig. 3). The female residents of these areas had a strong consumption capacity. These results showed that the scale of online retailers' sales did not obey strictly the distance decay rule, but showed obvious economic agglomeration. This seems to indicate that the impact of market size on the sales of online retailers exceeds the shipping distance within the scope of the study. Accordingly, in today's information society, the influence of distance on online retailers is not as strong as it was in the agricultural and industrial societies. Depending on the availability of ICT and highly efficient logistics systems, consumers could overcome geographic obstacles such as mountains and rivers to obtain goods and services. Population size and purchasing power may exert stronger effects on online retailers' sales than distance.

3.3 Price-based comparison of commodities' shipped distances

Central place theory holds that the upper and lower limits of shipping distance of goods with high prices are longer, while the upper and lower limits of the shipping distances of goods with low prices are shorter (Kolars and Nystuen, 1974; Kaplan et al., 2009; Anderson,

2012). In today's information society, where the delivery of goods in online retailing mainly depends on third-party logistics companies, is the shipping distance of high-price goods longer? Due to the obvious seasonal differences in the prices of commodity, there was a significant difference in the shipping distance between high- and low-price goods in different seasons. Hence, the shipping distance of differently priced goods in different seasons was compared.

The shoes offered for sale by M-Y in 2014 were divided into eight categories: spring, summer, autumn, winter, autumn-winter, spring-summer, spring-autumn, and unknown season in accordance with the seasonal information contained within the commodity names. These eight categories accounted for 4.1%, 12.72%, 13.04%, 20.02%, 21.43%, 7.1%, 8.53%, and 7.1% of the company's total shoe sales in the focal year, respectively. A sit was difficult to compare shoe sales in the autumn-winter, spring-summer, and spring-autumn categories with those in the four single-season categories, the shipped distances of shoes (by commodity price) in the four seasons alone were counted and compared, with the results presented in Fig. 4 showing fluctuations with price increases in all four seasons. In spring, the shipping distances of shoes priced at 293 and 263 yuan fluctuated the most widely and most narrowly—by 1616 and 604 km, respectively. The corresponding figures for summer were 268 and 148 yuan and 1463 and 879.81 km, respectively; those for autumn were 269 and 218 yuan and 1423 and 843.45 km, respectively; and those for winter were 488 and 418 yuan and 2197 and 518 km, respectively. Although the purchase rate of high-priced shoes is low and commodity suppliers need a higher demand threshold for survival, the shipped distance of those shoes is not necessarily longer than that of their low-priced counterparts in an information society. The main reason for this phenomenon is that online retailers take on the commodity freight fee, which is lower for them than for traditional retailers. Consequently, the freight fee is not a key influencing factor in the commodity sales and purchases of online retailers and consumers. Low-priced goods could be sold to customers in distant locales, which indicates that the restriction of shipping distance on the sale of online retailers is obviously weakened. In this case, there were significant seasonal differences in the average shipped distances. The average shipped
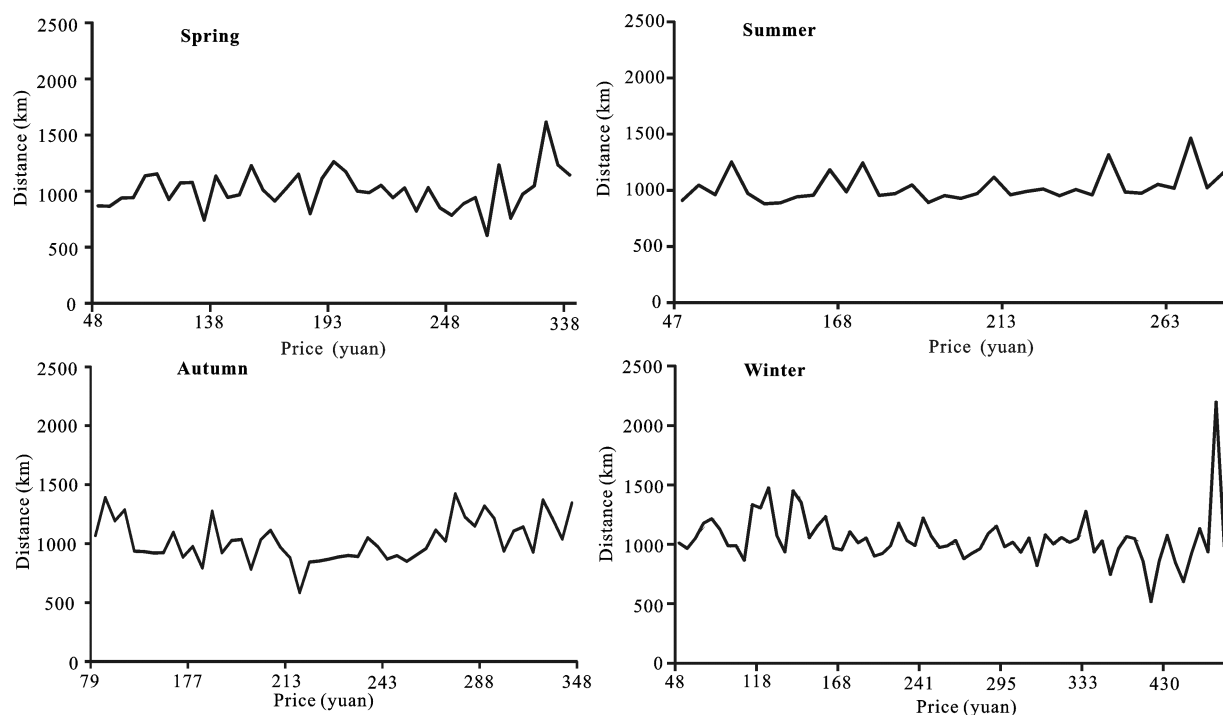
Fig. 4   Shipped distances of the differently priced shoes in the four seasons (2014)

distances in the spring (1063.66 km) and winter (1003.89 km) were much longer than those in the summer (980.17 km) and autumn (951.3 km). A possible reason for the discrepancy is that in the north and west areas of China, it is very cold in spring and winter, and the inhabitants of those areas require more warm shoes.

3.4   Relationships between income, cost, and net profit curves

Central place theory holds that when the sales or shipping distance is equal to OA, which is the threshold of demand, income equals costs, and enterprises only obtain normal benefits (Fig. 5). When the sales or shipping distance exceeds A, the income is more than the cost and the net profit increases gradually, and when B is reached, the net profit is the largest. When the sales or shipping distance exceeds B, the net profit gradually drops to C with zero, and OC is the longest shipping distance (Xu and Zhu, 1988).

The income, cost, and net profit curves of M-Y in 2014 were drawn in accordance with the sales volume, cost, and net profit in each county and the distance between sales site and the geometric centers of counties. Fig. 6 shows that the income and cost curves rose slowly with the increase in distance. In particular, when the distance exceeded 2560 km, the freight costs
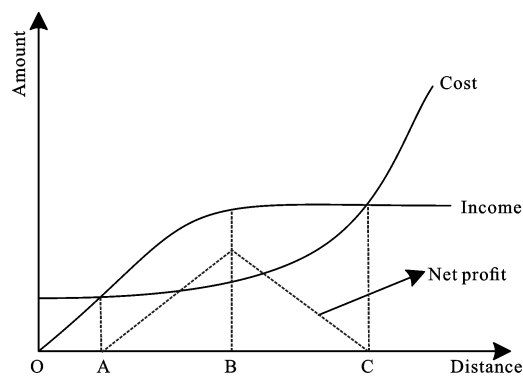

Fig. 5   Relationship between the demand threshold and the shipping distance. Source: Xu and Zhu, 1988

increased significantly, leading to a rapid rise in the cost curve. The main reason for this result is that when the distance reached that point, the main markets in question were the relatively remote northeast, northwest, and southwest provinces of China, where the logistics systems and economic development levels remained underdeveloped and which had lower population densities. As a result, the cost of shipping goods to these regions was much higher than that for the more accessible eastern regions. With an increase in distance, the net profit curve volatility initially rose and then declined quickly due to the rapid increase in freight fees. The maximum profit (9.32 million yuan) point was located in Qianwei county of Sichuan Province, which

county of Sichuan Province, which was 1588.16 km from M-Y. The income curve is above the cost curve in Fig. 6, indicating that the goods of M-Y did not have the thresholds or ranges. The net profit was always higher than the sales cost within the range radius of 7–415.01 km, in which the main market for M-Y comprised the economically developed eastern coastal regions such as the YD urban agglomeration.

3.5 Comparison of the impact of shipping distance and other regional factors on sales volume

The degrees of correlation and multicollinearity between independent and dependent variables had to be tested before the principal component regression analysis was performed. The tests indicated significant correlations between dependent variable (sales volume) and independent variables (female population size, per-capita disposable income of urban households, number of post offices, number of Internet domain names, shipping distance, and average shipping time). The respective Pearson coefficients were 0.685[**], 0.348[*], 0.787[**], 0.403[*], –0.472[**], and –0.48[**] (Table 5). However, no significant relationship was found between the dependent variable sales volume and the independent variable urbanization rate, and the Pearson coefficient was only 0.169. After eliminating the urbanization rate and executing the linear regression analysis, the value of variance inflation

factor ranged from 2 to 12.97, indicating a collinearity problem in the linear regression model. It was thus necessary to standardize the dependent variables for principal component analysis and then calculate the post-rotation scores of the principal component factors. Subsequently, linear regression analysis was carried out between those scores and the standardized dependent variables. The results were as follows. The adjusted R^2 and sig. were 0.51 and 0.000, respectively, and DW was close to 2 (Table 6). The coefficients of principal component regression all passed the significance test, demonstrating that the regression model was optimum overall. To ascertain the discrepancies of influencing factors, the principal component regression equation with standardized regression coefficients (Beta) had to be transformed into the following multivariate linear regression equation.

$$y = 0.0053x_1 + 36.06x_2 + 0.0038x_3 + 0.1322x_4 - 0.035x_5 - 21.96x_6 + 83.5823 \tag{1}$$

According to the absolute value of independent variable coefficient in this regression equation, the factors influencing the spatial disparities in sales volume in 2014 were the per-capita disposable income of urban households (36.06), average shipping time (21.96), number of Internet domain names (0.1322), shipping distance (0.035), female population size (0.0053), and number of post offices (0.0038), in that order. The
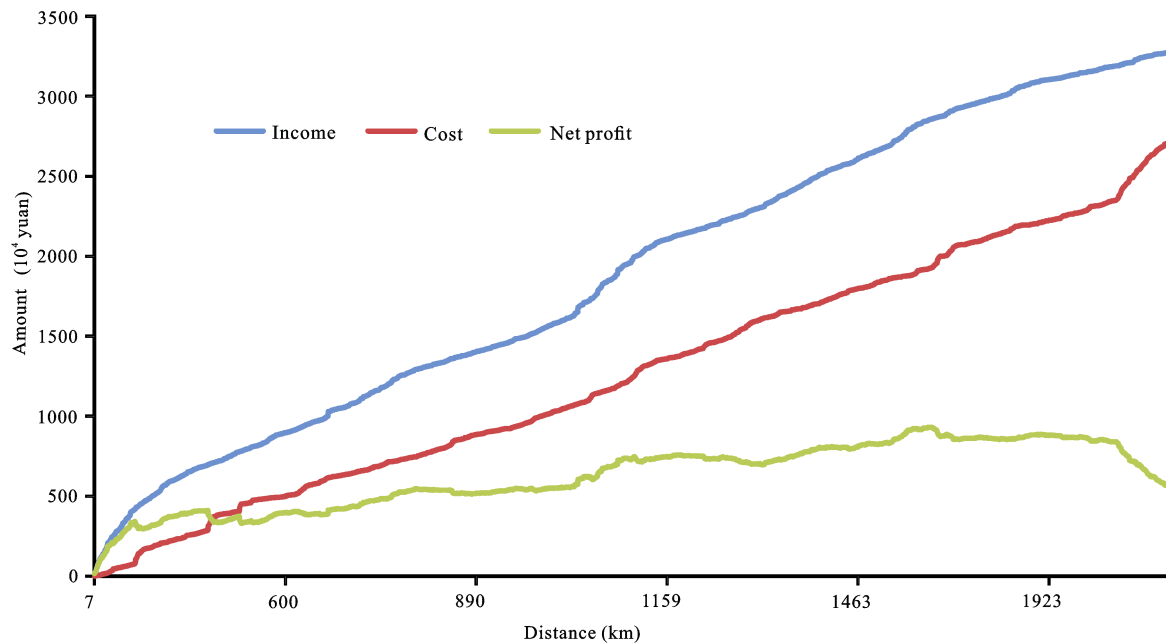

Fig. 6 Income, cost, and net profit curves of M-Y (2014)

per-capita disposable income of urban households was the most important factor. These regression results may well explain why M-Y's sales volume was concentrated in developed areas and populous provinces. This also confirmed that the consumption scales of online shoppers in Beijing, Shanghai, Guangzhou, and Shenzhen had been at the forefront on November 11 in recent years. The average shipping time had far more of an impact on M-Y's sales than shipping distance. This indicated that the decisions of consumers' online shopping were more sensitive to the shipping time. Because most shoppers usually adopt online shopping mainly in order to save travel time and shopping time. This phenomenon is consistent with the efficiency hypothesis (Anderson et al., 2003; Farag et al., 2006). As the Internet provides the platform for online shopping, its development state is very important. Some researchers have considered the differences in the level of Internet development as the main reasons for regional differences in the development of online retail industry in Canada (Michalak and Calder, 2003). Therefore, the improvement of communication network facilities in underdeveloped areas contributes to the development of e-commerce and economy. The influence of the size of female population on the spatial pattern of M-Y's sales was not as important as that of the level of Internet development and purchasing power. The size of the market determined by income levels and population size were the key factors. Shipping distance and the sophistication level of logistics facilities were not primary factors. Thus, online retailers may sell commodities at low prices to the inhabitants of remote areas to meet their consumption demand, thereby earning both profits and favorable appraisals,

which indicate that the improvement in traffic conditions compresses the space- time distance, and the shipping costs per unit distance are significantly reduced. This indicated that the impact of shipping distance on online retailers' sales is not as strong as that of traditional retailers in the Information Era. This view is consistent with previous research (e.g., Park, 2004; Park and Taylor, 2004; Yu et al., 2013).

4   Discussion and Conclusions

Advances in ICT and modern logistics networks have provided favorable conditions for the establishment and development of online retailers. Shopping in the virtual space provided by the Internet allows consumers to save on shopping time and shipping costs. These developments and the concomitant transformation of sales and shopping models have tremendous implications for central place theory. Most relevant studies have explained the impact of shipping distance on online retailers' sales using qualitative rather than experimental methods. According to the transaction records and financial statements for 2014 provided by M-Y, an online shoe retailer on the Tmall platform, we investigated the relationship between shipping distance and its sales and then compared the effects of shipping distance and other regional factors on its sales.

M-Y's sales quantity and volume for 2014 were concentrated in YD, CY, PRD, BTH, and other developed areas, with relatively few sales in the underdeveloped counties of the central and western regions. For M-Y, the key factor in the spatial discrepancy of sales was the size of the market determined by income levels and

Table 5   Correlations between dependent variable (sales volume) and independent variables

Dependent variables	Female population size	Per-capita disposable income of urban households	Number of post offices	Number of Internet domain names	Shipping distance	Average shipping time
Sales volume	0.685**	0.348*	0.787**	0.403*	–0.472**	–0.48**

Note: *$P<0.01$, **$P<0.05$, ***$P<0.001$

Table 6   Regression results on influence factors (2014)

Principal component factors	Beta	T	Sig.	VIF
F_1	0.666	5.206	0.000***	1.000
F_2	–0.315	–2.463	0.020**	1.000
R Square	Adjusted R Square	F	SIG	DW
0.736	0.510	16.581	0.000	1.677

Note: *$P<0.01$, **$P<0.05$, ***$P<0.001$

population size. The impact of shipping distance on its sales was not as strong as that of traditional retailers. Hence, M-Y's sales could not strictly obey the distance decay law. In addition, no obvious law was seen to govern the relationship between shoe prices and shipping distance—that is, the shipped distance of high-priced shoes was not much longer than that of low-priced shoes. Furthermore, within the scope of this study, the variations in the income, net profit, and cost curves could not obey the law of traditional commercial geography, leading to the conclusion that online retailers' goods have neither thresholds nor ranges. Thus, under the influence of ICT, geospatial hindrances are weakened for online retailers, and their costs of engaging in economic activities on a broad geospatial scale are greatly reduced. The negative effect of average shipping time on M-Y's sales is much higher than the shipping distance. These factors encourage online retailers to participate in economic globalization. Under the guarantees of modern logistics systems, when selling and buying commodities, online retailers and consumers do not need to take distance into account, as it no longer significantly increases freight costs and times. Shipping distance is still a factor, but its impact on the sales of online retail enterprises is relatively weak. Furthermore, the cost of goods delivery may affect the shopping decisions of online shoppers. However, the price of M-Y's merchandise usually includes delivery costs. If consumers live in the non-preferential areas (remote areas such as Xinjiang and Tibet) identified jointly by M-Y and Express, additional delivery costs may be added.

Research drawing on central place theory, which regards the market as homogeneous, has used a large quantity of data on different commodities to investigate the relationship between sales volume and shipped distance, compare the shipped distances of differently priced merchandise, and probe the relationships between income, cost, and net profit curves, producing highly scientific and reasonable results. However, modern improvements in transportation and advances in ICT mean that some of the rules of central place theory are ill-equipped to explain geographical phenomena in the online retail context. It is thus necessary to break with the strict hypotheses of central place theory and to innovate and develop it (Wang et al., 2012). In this study, M-Y had a heterogeneous market for its single type of goods. Although the study's results did not overturn all

of the laws of central place theory and have difficulty in accurately explaining whether the online retailing sales follows the law of distance decay, it might have revealed the impact of shipping distance on online retailers' sales in the Information Era. This study found that online retail sales are concentrated in economically developed regions, which is similar to that of various types of website information flow distance decay with significant economic agglomeration (Zhang, 2010). In other words, online retail sales and information flows of websites do not strictly follow the distance decay rule. Looking at the limitations of this study, the statistics for shipping distance were not calibrated to each consumer, and the weight of goods was homogenized. As a result, the relationship between sales volume and shipping distance, the comparison of the shipped distances of differently priced commodities: and the relationships between income, cost, and net profit curves require further study. In particular, the thresholds and ranges of online retailers' goods should be explored in greater depth. In addition, in the case in which the province is the influencing factor analysis unit, the spatial autocorrelation of the sales may be hidden. The factors of M-Y's sales in prefecture-level cities or counties could be well explored with the spatial regression model. Finally, attributes of goods, such as goods designed for a certain cultural group, and the locations of delivery warehouses may affect the conclusions of this study. Therefore, the relationship between the sales of different types of goods and shipping distance should be further explored.

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