Using Huff Model for Predicting the Potential Chiness Retail Market

Shuai Su*, Myoung-Kil Youn**

Absract

This study aimed to predict retail sales of local markets in Jinan city of China with the Huff model. Using the Huff Model, we examined whether the predicted retail sales of local markets may be different in Jinan, China, from the department stores, supermarkets, shopping centers/shopping malls, and home appliance stores. The probability that a customer shops at location depends upon the store size and the travel time factors calculated by the Huff Model. We found that the predictedretail sales of shopping malls have a greater value than others. People who live in a mid-sized city may have easier access to any stores within the city boundary than people in metropolitan areas. Therefore, people in a mid-sized city are more sensitive to store size, because a bigger store size means greater opportunities, incentivizing consumers to travel further to competing stores after passing by nearer, smaller stores. This study has some limitations. First, the data is somewhat restricted in that the subject stores do not represent all of the stores in Jinan. Second, we cannot compare the estimated market share of the stores and the actual sales data. It is further suggested in this study that more databases be developed throughout such East Asian countries as Korea and Japan and that a different parameter λ value in the Huff Model be utilized for mid-sized cities.

Keywords: the Huff Model, predict retail sales, potential sales volume

Ⅰ. Introduction

Because of its ease of use, the spatial interaction Huff Model is widely used to investigate market areas (Park et al., 2006; Lv et al., 2008 Kim & Youn, 2010); and (Kim et al., 2011). The Huff Model is a gravity model that is widely used in the retailing practice (Hernandez, 2000) the recent Huff Model was designed in retail sales forecasting of agricultural products in Korea (Youn et al., 2007). The usefulness of the Huff Model, however, lies in its ability to predict the market share of shopping centers (Craig, et al.,1984).

Employing the Huff Model, this study examines sales of department stores, supermarkets, shopping centers/shopping malls, and home appliance stores in Jinan, a large local city situated in the middle of China. The study that emanates from the comparison and analysis of 2010 data establishes a research model by setting up such variables as outlay (i.e., store size and travel time). A Microsoft Excel 2003 spreadsheet is used to examine the correlation between changes of sales volumes and the respective variables.

Ⅱ. Revisiting the existing models

One of the most important decisions retailers have to make is the choice of a store's location (Craig et al., 1984). For selecting the best location, return on investment is the most important decision criterion (Krause-Traudes, et al., 2008). Therefore, retailers need to evaluate what the potential sales of a new store will be. Three approaches to estimate the potential sales for a store at a location are (1) the Huff gravity model, (2) regression analysis, and (3) the analog model (Levy & Weitz, 2007).

Utilizing the model, the probability that customer i shops at location j depends upon two factors: the size of the store and the time it takes to travel to the store (Levy & Weitz, 2007)—the larger the store, the greater the probability of shopping, while the greater the travel time or distance, the lower the probability. The mathematical formula is as follows (Huff, 1964):

$$P_{ij} = (S_j / T_{ij}^{\lambda}) / (\sum S_j / T_{ij}^{\lambda})$$

where *Pij* denotes the probability that customer i shops at location *j*, *Sj* is the size of the store at location *j*, *Tij* is the travel time for customer *i* to get to loation *j*, and λ is a parameter that is to be estimated empirically to reflect the effect of traveltime on various kinds of shopping trips.

The conditions for the experiments are set as follows: The test area (*i*) is optionally selected, and consumers understand that all the stores sell both goods and services and that travel time and distance

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to each store are the only differentiating factors.

Ⅲ. Estimation the huff model

The exponent λ reflects the relative effect of store size and travel time. In Korea and Japan,have using the Huff Model for the λ(λ=2) in the formula (Youn.M.,1997), and estimating the average absolute error rate has been lower 1.6% (error rate: 0.1% ~ 5.4%) in a market share of Korean department stores (Yim, S. and Lee, J., 2000).

Our study is designed to estimate the λ(λ = 2) in a mid-sized China city and examine whether the value of predictedretail sales may be different between department stores, supermarkets, shopping center/shopping malls, and/or home appliance stores. With the results, we may be able to help establish the ideal locations, markets, and estimated potential sales volumes in other cities of China, as well as other eastern Asia countries.

We selected the city of Jinan in China, compared to Beijing, Shanghai, which is the capital and the biggest business city in China. In 2010, Jinan was a typical, mid-sized city of approximately 946,300 households and 31 shopping centers (12 department stores, 4 supermarkets, 5 shopping centers/shopping malls, 10 home appliance stores). The city of Jinan is divided into five communities. Table 1 - 3 supplies specific information about store sizes, distance,and travel times.

Table 1. department store size and travel time

	Size (m²)	travel time						Size (m²)	travel time				
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ			Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	22,000	32	20	26	29	56	H	35,000	65	17	17	61	24
B	30,000	31	22	27	26	58	I	40,000	63	16	16	59	26
C	40,000	35	18	26	31	54	J	20,000	57	4	25	57	37
D	60,000	35	18	26	31	54	K	13,000	44	11	30	44	47
E	26,000	50	7	15	47	38	L	80,000	42	15	34	41	51
F	40,000	45	10	16	41	43	M	25,000	11	52	61	23	89

Table 2. home appliance size and travel time

	Size (m²)	travel time						Size (m²)	travel time				
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ			Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	250,000	31	21	28	27	58	F	10,000	15	51	50	4	85
B	40,000	36	18	24	31	53	G	8,000	16	45	44	5	79
C	22,000	35	18	24	31	54	H	4,000	62	14	14	57	28
D	15,000	38	17	21	33	51	I	4,000	65	19	19	62	23
E	15,000	31	21	28	27	58	J	8,000	54	7	27	54	38

Table 3. supermarkets, shopping centers size and travel time

	Size (m²)	travel time						Size (m²)	travel time				
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ			Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	43,000	37	17	22	33	52	A	23,000	15	50	49	3	85
B	150,000	35	19	23	31	53	B	12,000	62	15	15	58	27
C	110,000	34	19	25	30	55	C	20,000	45	12	31	45	48
D	50,000	31	23	27	26	58	D	75,000	11	51	60	23	89
E	570,000	47	10	16	43	41							

Table 4. Department store probability of a consumer at a given point of origin I traveling to store j

	Probability (%) Communities						Probability (%) Communities				
	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	4.8	1.7	3.6	8.0	2.7	H	1.9	3.8	13.1	2.8	22.6
B	7.1	1.9	4.5	12.8	3.4	I	2.3	5.2	18.3	3.4	22.5
C	7.4	3.9	6.7	12.3	5.2	J	1.4	33.6	3.5	1.8	5.6
D	11.1	5.9	10.0	18.4	7.8	K	1.5	3.5	1.6	2.0	2.2
E	2.3	17.1	13.2	3.6	7.1	L	10.5	10.9	7.6	13.8	11.6
F	4.5	12.2	17.1	7.2	8.1	M	45.2	0.3	0.8	13.9	1.2

The estimation of the probability of a consumer at a given point of origin I traveling to store A j probability estimation when λ = 2: Table 4 - 6 shows the probability that customer I shops at store j. For example, the probability of community Ⅰ residents store A is 4.8%.

Using the probabilities, we calculated how many households would shop at each store. Table 8 shows the number of households that shop at it. For example, the number of households that reside in community Ⅰ is 164,700, of which 7,906 households would shop at store A. In Table 7, the total number of households shopping at store A is 43,823, making the market share of the store 4.63%.

Table 5. Home appliance probability of a consumer at a given point of origin I traveling to store j

	Probability (%) Communities						Probability (%) Communities				
	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	7.4	11.8	13.1	3.0	11.2	F	7.5	0.4	0.8	23.0	1.0
B	4.3	6.5	7.2	1.6	5.9	G	0.3	2.0	3.9	0.1	4.0
C	2.5	5.0	6.4	1.0	4.5	H	0.2	1.1	2.1	0.1	5.9
D	3.8	3.3	3.6	1.5	3.5	I	0.7	15.6	2.1	0.2	4.4
E	10.7	0.4	0.8	44.9	1.1	J	7.5	0.4	0.8	23.0	1.0

Table 6. Supermarkets, shopping malls probability of a consumer at a given point of origin I traveling to store j

Super market	Probability (%) Communities					shop mall	Probability (%) Communities				
	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	13.1	4.0	9.1	93.2	8.4	A	5.6	2.3	3.1	5.7	3.6
B	0.4	23.5	51.4	0.2	44.1	B	21.3	6.8	9.4	22.4	11.7
C	1.3	59.9	19.7	0.4	22.4	C	17.1	4.6	5.9	17.6	8.1
D	85.2	12.6	19.8	6.3	25.0	D	9.5	1.4	2.3	10.6	3.2
						E	46.5	84.9	79.3	43.7	73.4

Table 7. Number of households shopping at each department store

	Number of household	Communities						Number of household	Communities				
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ			Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	43,823(4.6%)	7,906	3,242	6,314	22,856	3,505	H	70,688(7.5%)	3,129	7,247	22,977	8,000	29,335
B	64,193(6.8%)	11,694	3,623	7,893	36,570	4,413	I	84,722(8.9%)	3,788	9,916	32,098	9,714	29,205
C	73,268(7.4%)	12,188	7,437	11,752	35,141	6,750	J	84,931(8.9%)	2,306	64,075	6,139	5,143	7,269
D	109,766(11.6%)	18,282	11,251	17,540	52,569	10,124	K	20,521(2.2%)	2,471	6,675	2,806	5,714	2,856
E	79,052(8.4%)	3,788	32,610	23,153	10,285	9,216	L	105,894(11.2%)	17,294	20,786	13,330	39,427	15,057
F	91,755(9.7%)	7,412	23,265	29,993	20,570	10,514	M	117,690(12.4%)	74,444	572	1,403	39,712	1,558

Table 8. Number of households shopping at each Home appliance

	Number of household	Communities						Number of household	Communities				
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ			Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	457,962(48.4%)	103,102	103,359	105,415	70,282	75,803	F	149,496(15.8%)	17,623	763	1,403	128,279	1,428
B	80,776(8.5%)	12,188	22,503	22,977	8,571	14,538	H	81,528(8.6%)	12,353	763	1,403	65,711	1,298
C	44,336(4.7%)	7,082	12,396	12,629	4,571	7,658	I	16,260(1.7%)	494	3,623	6,665	286	5,192
D	33,576(3.5%)	4,118	9,535	11,226	2,857	5,841	J	14,054(1.5%)	329	2,098	3,683	286	7,658
E	27,504(2.9%)	6,259	6,102	6,314	4,286	4,543	K	40,868(4.3%)	1,153	29,749	3,683	571	5,711
F	91,755(9.7%)	7,412	23,265	29,993	20,570	10,514	M	117,690(12.4%)	74,444	572	1,403	39,712	1,558

Table 9. Number of households shopping ateach Super markets, shopping malls

	Number of household	Communities						Number of household	Communities				
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ			Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
A	39,920(4.2%)	9,223	4,469	5,423	16,151	4,654	A	322,239(34.1%)	21,576	7,673	15,948	266,152	10,891
B	143,772(15.2%)	35,081	12,893	16,557	64,119	15,123	B	193,399(20.4%)	659	44,765	90,239	431	57,304
C	108,056(11.4%)	28,164	8,761	10,313	50,326	10,492	C	181,150(19.1%)	2,141	114,279	34,485	1,118	29,127
D	56,862(6.0%)	15,647	2,712	4,067	30,228	4,209	D	249,509(26.4%)	140,324	23,976	34,759	17,996	32,453
E	597,696(63.2%)	76,586	161,866	139,041	124,872	95,331							

We compared the estimated market share of the mart with the t department store, supermarket, shopping center/shopping mall, home appliance stores data. Table 10 shows the comparison between the department store, supermarket, shopping center/shopping mall, home appliance stores, as well as values.

Table 10. Sales estimates of local markets

		Max Expected %	Mix Expected %	Absolute value %
1	Department store	12.44	2.71	9.73
2	Home appliance stores	48.39	1.49	46.9
3	Shopping mall	63.16	4.22	58.94
4	Super market	34.05	19.14	14.91

IV. Discussion and conclusions

Using the Huff Model, we examined whether the predicted retail sales of local markets may be different in Jinan, China, from the department stores, supermarkets, shopping centers/shopping malls, and home appliance stores. The probability that a customer shops at location depends upon the store size and the travel time factors calculated by the Huff Model. We found that the predictedretail sales of shopping malls have a greater value than others. People who live in a mid-sized city may have easier access to any stores within the city boundary than people in metropolitan areas. Therefore, people in a mid-sized city are more sensitive to store size, because a bigger store size means greater opportunities, incentivizing consumers to travel further to competing stores after passing by nearer, smaller stores.

This study has some limitations. First, the data is somewhat restricted in that the subject stores do not represent all of the stores in Jinan. Second, we cannot compare the estimated market share of the stores and the actual sales data. It is further suggested in this study that more databases be developed throughout such East Asian countries as Korea and Japan and that a different parameter λ value in the Huff Model be utilized for mid-sized cities.

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