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Retail of Fresh Vegetables in China: Why Wet Markets Are Not Replaceable by Supermarkets?

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Supermarkets have existed in China for more than 20 years. Although they have many advantages, supermarkets have not replaced wet markets as the leading retail outlets for fresh food. Currently, the two types of market compete but coexist. The study uses survey data gathered from December 2015 to January 2016 in Nanjing, which is an important central city of China, to create a Hedonic model that tests the causal relationships of quality and price among wet markets and supermarkets. The main conclusions are as follows: i) Supermarkets have a quality advantage, while wet markets have a price advantage; ii) For sales of fresh vegetables, supermarkets concentrate on high quality and high prices; and iii) In addition to the quality differences, supermarkets have other distinguishing advantages, such as variety, convenience, environment, and service characteristics.

Key words: fresh vegetables, market competition, supermarkets, wet markets

INTRODUCTION

Since the 1980s, small food stores, along with nationally managed and collectively owned vegetable markets, have gradually faded from agricultural product retailing. In their place, wet markets, which mainly consist of individual vendors, began to lead. Since the mid-1990s, supermarkets, an entirely new product circulation mode, have developed rapidly in China. Supermarkets have increasingly set aside areas for fresh agricultural products, and the diversity and amount of these products have continually expanded. Thus, supermarkets have appropriated a higher proportion of the daily circulation of fresh agricultural products. The increased number of supermarkets provide more sites for customers to buy fresh agricultural products, which has greatly affected the traditional retail channels with wet markets as their base. Currently, in China's large and medium-sized cities, fresh vegetable retail channels usually cover four categories: wet markets, community stores, standardized vegetable markets and supermarkets. Based on the layout scale of the city and the purchase habits of the local preferences, this paper chooses supermarkets and wet markets for comparative analysis. In developed countries and districts, supermarkets, as a modern product circulation method, have become established as the main business form of fresh food retailing. In terms of market shares judged by sales, 50% to 70% of fresh food in Japan is sold by supermarkets. In the United States, 90% of food, along with 56% of fruits and vegetables, is

sold by supermarkets. In France, 55.7% of fresh vegetables and 59.3% of fresh fruit are sold by supermarkets. In England, the sale of fresh food in supermarkets accounted for 8% of fresh food retailing in 1969. However, after 20 years' development, the proportion had increased to 72% by 1995 and reached over 90% by 2005. In China, Kantar Worldpanel China continually monitored the purchasing power of urban families nationwide. Until the date when this monitoring ended, wet markets were still the main channels for Chinese customers to purchase fresh food, accounting for 60.3%. However, modern channels are becoming increasingly prominent. At that time, hypermarkets and supermarkets accounted for 28% of the retail channels of fresh food, and their growth trends have become much more evident in recent years.

Supermarkets have more advantages than wet markets; for example, the shopping environment is more comfortable, and they provide diversified, normalised and convenient service. As per capita income levels have continued to rise, supermarkets have successfully catered to consumers' need to cope with the rapid pace of life by upgrading the consumption structure. After more than 20 years of development, can supermarkets, which have so many advantages, replace wet markets as the major retail sites for fresh food rather than competing and co-existing with wet markets? This study is based on the supply of fresh agricultural products and uses vegetables as an example. Through a field survey of Nanjing City, the purpose of this study is to investigate the current market dynamics and competition strategies of supermarkets and wet markets. The study also provides a supply-side explanation as to why Chinese supermarkets have not followed international trends and why they have not.

The remainder of the article is organized as follows: The first section is the literature review. The second

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section outlines the data resources and builds the empirical models. The third section makes the descriptive analysis and analyzes the empirical results. The last section presents the conclusions and policy implications.

LITERATURE REVIEW

After years of development, supermarkets in developed countries and districts have long occupied the major market share of urban agricultural products retailing; however, in China, traditional wet markets remain the main retail channel. Whether supermarkets can weaken the status of wet markets depends on the demand of urban consumers for agricultural products (Liu *et al.*, 2007). Most Chinese scholars believe that the purchase channels that consumers choose will directly influence the respective market share of supermarkets and wet markets.

When city consumers buy agricultural products, factors such as shopping environment, convenience and service level have some influence on their choices. However, a substantial number of empirical studies have shown that price and quality are the most significant factors that influence consumers' choices (Hu, 2005; Gu *et al.*, 2015). The supermarket and the farmer's market are not only irreplaceable in terms of benefits but also comparable in terms of disadvantages. The two distribution outlets will therefore coexist in a short time (Zhou *et al.*, 2004; Zhang *et al.*, 2013; Pu *et al.*, 2015). In recent years, the 'Agriculture-Supermarket Jointing' strategy has enabled supermarkets to improve the quality of fresh agricultural products in order to make profits (Zhou, 2016; Zheng *et al.*, 2018). Supermarket and community direct store dual-channel mode is higher than single-mode (Pu *et al.*, 2017). With the use of new technologies such as the Internet, supermarkets need to evolve in the selling mode in order to realize the value of the new supply chain under the new business situation (Wang *et al.*, 2017; Tian, 2018).

In developing countries, the modern retailing system is represented by supermarkets, which target mainly or only high-income consumers because these consumers can afford large expenditures and can drive to the supermarket (Goldman *et al.*, 1974). However, these are the results of an early study that did not conduct a practical investigation and depended on an empirical hypothesis. In recent years, scholars have begun to study supermarket consumer groups based on investigative data. Neven *et al.* (2006) and Figue *et al.* (2009) discovered that in Kenya and Vietnam, respectively, when supermarkets were in the initial stage of development, the people who shopped there were mainly high- and middle-income consumers. When investigating the expansion strategies of supermarkets in fresh food retailing, Schipman *et al.* (2011) found that modern retailers pursued two strategies in terms of fresh fruit and vegetable (FFV) sales. One option was to exploit economies of scale and compete with wet markets based on costs and prices to gain a share of the existing market. Another option was to build up new market segments for higher-quality prod-

ucts, catering especially to the growing share of 'better-off' consumers. The latter strategy was likely to have a lower impact on sales volumes in traditional wet markets, at least in the short term (Balsevich *et al.*, 2003; Henson *et al.*, 2005).

In summary, among the scholars in China and abroad who have studied the retail channels of fresh agricultural products, most have relied on the consumers' point of view to analyse purchasing behaviour regarding the choice of agricultural products channels as well as the factors influencing the behaviour. They have also investigated the influences of the characteristics, attitudes and behaviours of different consumer groups on the selection of fresh agricultural products purchase sites (supermarkets or wet markets). All of these factors indirectly reflect the competition between supermarkets and wet markets.

The possible contributions of this study are as follows: i) In previous studies, researchers mostly discussed consumers' choice behaviours and influencing factors and rarely analysed the competitive forms and management strategies of the retail subjects; thus, the direct studies on the behaviours of retail subjects are lacking. This study finds a new perspective. ii) Recent studies have concluded that the dominant position of retail in wet markets may be replaced by supermarkets or that wet markets may be converted into supermarkets. After more than 20 years of development, although the share of supermarkets in the field of fresh agricultural products is steadily increasing, it still lags behind wet markets. This study attempts to provide related explanations from the point of view of quality and price disparities through field research.

RESOURCES AND MODEL BUILDING

Nanjing City, the research area of this study, is an important central city in the Yangtze River Delta of China, with a population of 8.430,000 as of 31 November 2018. Nanjing is a large-scale agricultural products consumption market that has enormous logistics centres and is the headquarters of SG supermarkets and other large-scale markets. Currently, there are many supermarkets selling fresh agricultural products in Nanjing, such as Wal-Mart, Carrefour, Jin Run, Metro AG, Auchan, SG, Hualian and Trust-Mart. Different types of supermarkets have apparent distinctions in the capital background, operational philosophy, introduction criteria, procurement systems and modes of operation, all of which are important factors that influence food quality and safety. Some supermarkets wholly outsource their fresh food counters and must perform regular quality inspections. Other supermarkets operate their own fresh food departments, including vegetable procurement, logistics, sales, etc. Among them, the local SG supermarket in Nanjing has completed the construction of its own vegetable base to ensure the high quality of fresh vegetables.

This study mainly targets Wal-Mart, Carrefour, Jin Run, SG, Auchan and Metro AG in Nanjing; these super-

markets are all active fresh vegetable retailers with a large trading volume and high market acceptance. The selected supermarkets cover the Nanjing supermarkets that have established a fresh vegetable department. To investigate these supermarkets, this study analyses their modes of operation. We selected 34 sample supermarkets in six main neighbourhoods: 18 SGs, 2 Auchans, 2 Metro AGs, 3 Jin Runs, 4 Carrefours and 5 Wal-Mart. In Nanjing, a range of wet markets are found throughout the main streets. To avoid the repetition of samples, our study referred to a list from the Nanjing Wet Markets Association and randomly targeted two wet markets near sample supermarkets in each of the six main urban areas. We then chose as our respondents two or three retailers from each of the wet markets which mainly sell vegetables. These are relatively stable vegetables in the four seasons that people consume the most in their daily lives.

The core content of our research questionnaire is price and quality information about fresh vegetables. As there is a wide range of vegetable types, this study cannot cover all of them. Therefore, according to horticultural vegetable classifications and the accessibility of in-season vegetables during our investigation, our study selected seven typical vegetables. Greens represent leafy vegetables, cucumbers represent cucurbit vegetables, turnips represent root vegetables, tomatoes represent solanaceous vegetables, scallions represent scallion vegetables, French beans represent bean vegetables and potatoes represent tuber vegetables.

The observation of vegetable prices and quality information occurred from December 5, 2015, to January 1, 2016. Each supermarket and wet market was visited once a week, usually in the morning to ensure the consistency of the data. The observation lasted for a total of five weeks. While one group of researchers investigated supermarkets, another group simultaneously investigated adjacent wet markets, a method that can avoid mistakes in price and quality information caused by time differences. The group researching supermarkets collected data in the whole vegetable selling area. The group researching wet markets randomly sampled 20% of the vegetable stalls; after the first visit, we visited the same stalls over the next four weeks. Each pair of price and quality data was collected as one sample. The sample distribution over the 5-week observations is displayed in Table 1.

The design and assessment criteria for the perfor-

mance characteristics of the questionnaire. First, different varieties of vegetables have similar attributes of quality and unique characteristics. For example, freshness of leaves, stems, roots, colors, pests and diseases of vegetables and radishes, weight, smoothness of skin, firmness, mechanical damage, colour, etc. Second, prior to the formal investigation, the author conducted a pre-investigation into the quality assessment of fresh vegetables, picked some samples of seven kinds of vegetables in supermarkets and agricultural markets, and evaluated their quality through actual observation and comparison.

This study uses hedonic models, which concentrate on each characteristic of the products rather than the utility value of the products themselves to customers. The hedonic model is commonly used to calculate the impact of product attributes on prices, namely, the implicit prices of each characteristic in the market. The signs and degrees of those implicit prices reflect the price premium of certain characteristics, which are compared with overall product prices against the same market background and conditions.

When estimating the implicit prices of characteristics, it is crucial to select the appropriate pattern function forms, of which the most common are the linear form, the double logarithmic form and the semi-log form by certain transformation. In addition, Box-Cox transformations were proposed by Goodman in 1977. Considering that the independent variables in this study are mainly dummy variables, and referring to the study of Shipman (2012), this study adopts the linear function. The concrete function is as follows:

$$P_h = \sum_{k=0}^N \beta_{kh} X_h^k + v$$

In this function, 'P_h' is the price of fresh product 'h' (in *yuan per kilogram*), X_h^k is the value of attribute k of product 'h', ' β_{kh} ' is the implicit price of attribute k, and 'v' is a random disturbance.

As attributes of experience and credence are challenging to observe, our study used a series of observable characteristics to represent the quality of vegetables. In addition to inherent quality attributes, such as shape, size, gloss and freshness, our study included sales attributes, such as packaging, labelling and brand. The included attributes are not only internal quality attributes and sales attributes of agricultural products because scholars have improved the basic hedonic models to include more attributes, such as purchase site vari-

Table 1. Sample Distribution of the Seven Vegetables

Type of Vegetable	Supermarkets	Wet Markets	Sample Numbers
Greens	309	266	575
Cucumbers	276	232	508
Turnips	202	226	428
Tomatoes	347	270	617
Scallions	181	111	292
French beans	176	198	374
Potatoes	260	250	510

ables, regional average income (which can control the potential demand) and other attributes (Shipman *et al.*, 2011; Gorton *et al.*, 2011; Minton *et al.*, 2008). Referring to the existing literature regarding the choice of variables, this study selected the linear form of hedonic pricing models. $P_h = f$ (Search for quality attributes, sales attributes, purchase site variables, and regional average income)

When judging the quality of vegetables, people usually observe their gloss, shape, size, freshness and other physical characteristics, which are called search goods attributes. Normally, when the same vegetables exhibit a similar appearance, their inherent quality is almost the same. As some information about agricultural products is severely asymmetric and not visible to the consumer, such as highly concentrated pesticide residue on vegetables, there is another category called credence goods attributes. If we want to identify this attribute, vegetables must be tested by expert personnel using specialised instruments and equipment. In most circumstances, it is impossible for customers to judge whether the level of pesticide residue on vegetables exceeds the standards because of the high expense and knowledge required to obtain that information. Therefore, in our study, we define product quality as a collection of observable search characteristics. The final evaluation criteria are those regular appearance elements that are already recognized by consumers as closely related to the inherent quality and are also treated as important product characteristics. After referring to the relevant research and discussion among our team, we constructed a quality evaluation system for each category of vegetables. Through a pre-investigation in supermarkets and wet markets, we optimized the index system of the different vegetables. The next section describes the whole quality evaluation system.

DESCRIPTIVE ANALYSIS AND EMPIRICAL RESULTS

Wet markets are unique places for agricultural products. They start a business early in order to ensure freshness. The average business hours of Nanjing's wet markets are 6 a.m. To 7 p.m. On average, each stall handles 32 kinds of vegetables. 89.7% of the purchase channels are wholesale markets and a small amount was self-produced and self-sold. 35% of supermarket operators in wet markets have taken fresh steps. The usual way is to add quilts and ice at room temperature, while 64.3% did not take fresh-water measures.

As a broad business location for regular department stores, fresh vegetables are one of its many selling goods. Throughout recent years, retailers have paid more and more attention to the market share of fresh agricultural products. The Fresh Department is almost independent of other large product distribution divisions and enjoys improved organizational support and departmental authority. The average business hours of the large and medium-sized supermarket chains in the main urban area of Nanjing are 7:30 a.m. To 10:00 p.m., each

of which handles an average of 81 kinds of vegetables. The average business hours of the large and medium-sized supermarket chains in the main urban area of Nanjing are 7:30 a.m. to 10:00 p.m., each of which handles a total of 81 kinds of vegetables.

The style of "farmer-supermarket docking" with a high-quality agricultural product base is dominant, followed by the supply of self-built production bases and wholesale market procurement. According to survey data, even if it is the same brand of supermarket chains, there are still variations in the network of each purchase. For example, on average, 70% of the vegetables in Nanjing local brand Suguo Supermarket are supplied on a self-made basis, while the remaining 30% are complemented by agricultural orders and wholesale markets. Nonetheless, there are also several Suguo Supermarkets, almost 100% of which are supplied by self-built bases or bought from wholesale markets; Carrefour, Metro and Wal-Mart both buy fresh vegetables from wholesale markets or qualified retailers; Ochang and Darun Distribution. There are self-built production bases and strategic cooperation bases and, at the same time, there are differences in each procurement channel.

Supermarkets take a variety of steps in the area of vegetable conservation, such as the delivery of cold chains, automatic humidification, preservation of snow, and so on. Just three supermarkets have not taken fresh measures on potatoes and tomatoes, but similar measures have been taken on other vegetable varieties. Ultimately, Da Runfa attaches great importance to fresh vegetables. There are many ways stores in the three main urban areas, such as cold chains, ice, humidification, and so on. Just three supermarkets have not taken fresh measures on potatoes and tomatoes, but similar measures have been taken on other vegetable types. Ultimately, Da Runfa attaches great importance to fresh vegetables. Supermarkets do reasonably well in the sale of fresh vegetables, about half of which are approved. Among them, the certification for non-polluting agricultural products is the most followed by green food certification, a very small number of green vegetables, cucumbers, tomatoes, radishes have organic food certification.

Table 2 compares the quality attributes of fresh vegetables in supermarkets and wet markets. Among the seven vegetables, the turnips and tomatoes in supermarkets are evidently better than those in wet markets when all the product attributes are considered.

For the gloss attribute, supermarkets offer significantly better cucumbers and scallions than wet markets, while the quality of greens, French beans and potatoes on offer in supermarkets and wet markets are similar. For the size attribute, the average size of potatoes in supermarkets is almost the same as that of potatoes in wet markets. For the surface attribute, no significant difference in the smoothness of potatoes is observed. The carpodium attribute and cucurbit body attribute are suitable only for cucumbers. The carpodium length of cucumbers is approximately the same in supermarkets and wet markets, while the cucumbers in supermarkets tend to have a straighter body. Roots, the fresh-

Table 2. Quality Differences of Fresh Vegetables between Supermarkets and Wet Markets

Quality attributes	Greens	Cucumbers	Turnips	Tomatoes	Scallions	French beans	Potatoes
Gloss	0	+	+	+	+	0	0
Size			+	+			0
Surface			+	+			0
Carp podium		0					
Cucurbit body		+					
Roots	+				+		
Maturity				+			
Degree of hardness		0	+	+		+	0
Mechanical injury		+	+	+	0	0	0
Skin spots						+	
Cleanliness					0		+
Germination degree							0
Degree of plant diseases and insect pests	+						
Freshness of leaves	0				0		
Freshness of stems	0				0		
Labelling	+	+	+	+	+	+	+
Packaging	+	+	+	+	+	+	+
Brand certification	+	+	+	+	+	+	+
Overall sensory quality	0	0	+	+	0	+	0

Notes: +, -, and 0 denote whether fresh vegetables in supermarkets are superior to, inferior to or similar to those in wet markets, respectively; a blank means this kind of vegetable is not suitable for the specific quality attribute. All the data are from The investigation.

ness of leaves and freshness of stems apply only to greens and scallions. Supermarkets have a higher proportion of greens and scallions without roots than wet markets, but the freshness of the leaves and stems is not distinctive. For the degree of hardness attribute, supermarkets offer better French beans than wet markets, but there are no clear differences between cucumbers and potatoes. For the mechanical injury attribute, cucumbers in supermarkets endure less mechanical injury, while the differences between scallions, French beans and potatoes are not clear. The skin spots attribute applies only to French beans: supermarkets offer significantly better French beans than wet markets. For the cleanliness attribute, potatoes in supermarkets are cleaner than those in wet markets, while the scallions are similar in cleanliness. The attribute of germination degree applies only to potatoes, and the differences in this attribute are minuscule. The attribute of plant diseases and insect pests applies only to greens. Supermarkets offer significantly better greens than wet markets because they offer greens with fewer plant diseases and insect pests.

Regarding selling attributes, the seven kinds of fresh vegetables sold in wet markets have no labelling, packaging or brand. Retailers sell either home-grown vegetables or vegetables bought from wholesale markets, thus most of the vegetables sold are common vegetables. In contrast, supermarkets offer a larger proportion of packaged and labelled vegetables as well as a few vegetables under brand names. Therefore, in terms of sales attributes, supermarkets rank higher than wet markets. In

regard to overall sensory quality, different vegetables in supermarkets and wet markets do not perform exactly the same. Table 2 shows that turnips, tomatoes and French beans in supermarkets have higher overall sensory quality than those in wet markets, but greens, cucumbers, scallions and potatoes are almost the same.

To compare the price differences of fresh vegetables between supermarkets and wet markets, we first compared the minimum, maximum, average value and degree of difference (Table 3). As shown in the table, the average prices of the seven vegetables in supermarkets are significantly higher than those in wet markets under a 1% significance level, and the price premium of greens, cucumbers, turnips, tomatoes, scallions, French beans and potatoes is 64.23%, 70.69%, 25.83%, 52.01%, 52.96%, 38.26%, and 48.94%, respectively. The high price premiums suggest that supermarkets are not competitive with wet markets in prices for fresh vegetables. However, notably, the minimum prices of turnips and potatoes in supermarkets are lower than those in wet markets.

On one hand, the overall price level of supermarkets is higher than that of wet markets. Vegetable prices in supermarkets and wet markets are all formed by the 'cost + expenses + profit' principle. However, supermarkets have a much higher operational expenditure on spoilage, material consumption, equipment, labour cost, etc.; therefore, the overall price level is higher. On the other hand, certain vegetables are cheaper in supermarkets than in wet markets during certain periods, such as holidays, weekends and anniversaries. Normally, super-

Table 3. Price Differences of Fresh Vegetables between Supermarkets and Wet Markets

Type of vegetable	Supermarkets		Wet markets		Differences (%)
	Price	Samples	Price	Samples	
Greens					
Minimum	2.10		1.50		
Maximum	24.80		7.00		
Average	6.29	309	3.83	266	64.23***
Cucumbers					
Minimum	3.00		2.10		
Maximum	25.96		6.50		
Average	7.63	276	4.47	232	70.69***
Turnips					
Minimum	0.49		0.80		
Maximum	15.00		2.20		
Average	1.90	202	1.51	226	25.83***
Tomatoes					
Minimum	2.38		2.00		
Maximum	15.96		5.00		
Average	5.67	347	3.73	270	52.01***
Scallions					
Minimum	2.99		1.50		
Maximum	12.80		10.00		
Average	5.95	181	3.89	111	52.96***
French beans					
Minimum	1.98		1.50		
Maximum	16.80		8.00		
Average	8.24	176	5.96	196	38.26***
Potatoes					
Minimum	0.79		0.80		
Maximum	5.61		5.00		
Average	4.20	260	2.82	250	48.94***

Notes: *, **, and *** denote a 10%, 5% and 1% significance level, respectively. Price here is a continuous variable, so the difference tests use a T test, and the price unit is *yuan/kg*. Price differences between supermarkets and wet markets are indicated by a price premium, which is calculated by $[(P_s - P_w) / P_w] * 100\%$, where P_s refers to the vegetable prices in supermarkets, and P_w refers to the prices in wet markets. All the data are from our investigation.

markets choose several types of seasonal vegetables that are faster-moving and for which consumers have a high price sensitivity. They sell these vegetables more cheaper than the wet markets and even below their own cost. These items act as a guest collection to attract consumers and to promote the sale of other items. Additionally, the low costs of the supermarkets' bulk purchasing make it possible for some vegetables with little spoilage (such as turnips and potatoes) to sell more cheaper than those in wet markets.

Table 4 shows the regression results for greens. In supermarkets, only roots, brand certification and packaging pass the significance test—that is, these three attributes have a significant effect on the price of greens. There is a negative correlation between greens with roots and their prices. Greens without primary processing (cut roots) have a lower price by 2.76 *yuan*, while brand certification and packaging have a positive effect on prices, increasing prices by 7.56 *yuan* and 2.44 *yuan*, respectively. Average income also has a positive effect on the prices of greens in supermarkets; greens are sold

at higher prices in supermarkets located in districts with a higher average income. In wet markets, only the gloss attribute and the roots attribute to pass a significance test and have a significant effect on the price of greens. Greens with a fine gloss and normal green colour have prices that are higher by 0.26 *yuan*. Similar to the results of the supermarket model, greens with roots in wet markets have a negative effect on prices, with a decrease of 0.46 *yuan*. The roots attribute is not significant in the supermarket model because supermarkets control greens prices better than wet markets, but wet markets are influenced more by market supply and demand.

The regression results for cucumbers are shown in Table 5. In supermarkets, carpopodium, cucurbit body, labelling and brand certification all pass the significance test. A short carpopodium, labelling and brand certification all have a positive effect on the price of cucumbers, increasing prices by 0.95 *yuan*, 1.92 *yuan* and 4.31 *yuan*, respectively. However, a curved main body has a negative impact on prices and will lower prices by

Table 4. Hedonic Price Regression for Leafy Vegetables (Greens)

Variables	Supermarkets (n=309)		Wet markets (n=266)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	0.12	0.35	0.25*	0.14
Roots: with roots	-2.79***	1.06	-0.46**	0.20
Labelling	-0.29	0.58		
Brand certification	7.55***	0.51		
Packaging	2.44***	0.60		
Degree of plant diseases and insect pests: no	2.10	2.10	2.10	2.10
Degree of plant diseases and insect pests: a little	0.39	0.55		
Degree of plant diseases and insect pests: no less than 25%	2.10	2.10	2.10	2.10
Freshness of leaves: very good	2.10	2.10	0.25	0.25
Freshness of leaves: good	0.75	0.69	0.68	0.42
Freshness of leaves: poor			0.20	0.35
Freshness of stems: very good	1.28	0.95		
Freshness of stems: good	1.41	1.24	0.02	0.46
Freshness of stems: poor	1.16	1.03	-0.31	0.38
The first week			-0.64***	0.19
The second week	0.48	0.53		
The third week	0.07	0.51	-0.00	0.18
The fourth week	0.23	0.53	-0.52***	0.19
The fifth week	-0.24	0.52	-0.08	0.18
Average income	1.55**	0.64	-0.34	0.24
Constant	-4.43	3.06	4.91***	1.13
F-statistics	29.18***		5.68***	

Notes: *, **, and *** denote a 10%, 5% and 1% significance level, respectively

Table 5. Hedonic Price Regression for Cucurbit Vegetables (Cucumbers)

Variables	Supermarkets (n=276)		Wet markets (n=232)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	-0.13	0.36	0.12	0.10
Carpodium	0.94**	0.44	-0.00	0.11
Labelling	1.92***	0.54		
Brand certification	4.30***	0.53		
Packaging	0.36	0.59		
Degree of hardness: very hard	0.58	0.58	0.58	0.58
Degree of hardness: hard			0.73**	0.30
Degree of hardness: soft	-0.16	0.53	0.74**	0.31
Cucurbit body: very straight			0.08	0.13
Cucurbit body: straight	-2.05***	0.44	0.08	0.12
Cucurbit body: curved	-2.55***	0.52		
Mechanical injury: no	-0.52	0.90	-0.23	0.18
Mechanical injury: a little	-0.66	0.87	-0.29	0.20
The second week	0.31	0.56	-0.35***	0.16
The third week	0.55	0.56	-0.93***	0.14
The fourth week	0.26	0.54	-1.02***	0.15
The fifth week	-0.17	0.55	-1.51***	0.14
Average income	-1.28	0.82	0.05***	0.20
Constant	12.57***	3.80	4.35***	1.08
F-statistics	17.43***		11.38***	

Notes: *, **, and *** denote a 10%, 5% and 1% significance level, respectively.

2.06 *yuan* to 2.56 *yuan*. In wet markets, among the quality attributes, the only degree of hardness passes the significance test. Hard cucumbers sell at a higher price than soft cucumbers by 0.74 *yuan*. There is a positive correlation between average income and the price of cucumbers, illustrating that the price of cucumbers is higher in wet markets in districts where people have a higher average income. Time dummies also have a positive effect on prices, as shown in the green model.

The regression results for turnips are shown in Table 6. In supermarkets, gloss, brand certification and mechanical injury have a significant influence on the price of turnips. A fine gloss and brand certification positively influence prices, increasing prices by 0.55 *yuan* and 4.01 *yuan*, respectively. However, mechanical injury negatively influences prices. In wet markets, the variables that have a significant effect on prices are mechanical injury and degree of hardness. The more mechanical injury turnips suffer, the lower the selling price is. Hard turnips bring a positive price premium of 0.11 *yuan*, but the price of soft turnips decreases by 0.29 *yuan*. As shown in the table, time dummies cause no significant price fluctuations in supermarkets and wet markets.

The regression results for tomatoes are shown in Table 7. In supermarkets, size, degree of hardness, labelling, brand certification and packaging all have a significant impact on prices, such that there is a positive correlation between these five attributes and prices. The prices of tomatoes with a suitable size, degree of hardness, labelling, brand and packaging increase by 0.58 *yuan*, 0.88 *yuan*, 0.71 *yuan*, 3.34 *yuan* and 1.15 *yuan*, respectively. In wet markets, surface, degree of hardness and mechanical injury all have a positive effect on prices. Smooth tomatoes, hard tomatoes and tomatoes without injury can bring a premium of

0.57 *yuan*, 0.38 *yuan* and 0.23 *yuan*, respectively. The difference between the models is that time dummies in the wet market model bring significant fluctuations to the price of tomatoes. This finding may further explain why wet markets are passive in controlling prices.

The regression results for scallions are shown in Table 8. In supermarkets, characteristics that have a significant impact on prices are labelling, brand certification, packaging and freshness of leaves. Scallions with labelling, brands and packaging are associated with price premiums of 0.87 *yuan*, 4.26 *yuan* and 0.60 *yuan*, respectively. However, scallions with leaves that are not fresh will be 0.88 *yuan* cheaper. In wet markets, three quality attributes have a remarkable effect on the price of scallions: roots, the freshness of stems and mechanical injury. Scallions with roots and scallions with injury will be 0.94 *yuan* and 0.43 *yuan* cheaper. Of course, the fresher the stems are, the higher the positive premium is. Fresh scallions increase prices by 2.05 *yuan*, while extraordinarily fresh scallions increase prices by 2.17 *yuan*. Similarly, week dummies have a significant effect on the prices of scallions in wet markets.

The regression results for French beans are shown in Table 9. In supermarkets, mechanical injury, brand certification and packaging have a significant effect on prices. Brands and packaging lead to a price premium for French beans of 2.13 *yuan* and 2.43 *yuan*, respectively. French beans without injury are 1.23 *yuan* more expensive than those with mechanical injury. However, in wet markets, none of the quality attributes has a significant effect on prices. Only average income has a positive influence on the prices of French beans, indicating that the price of French beans is higher in wet markets that are located in districts with a higher average income. In addition, week dummies have a significant effect on the prices of French beans in wet markets.

Table 6. Hedonic Price Regression for Root Vegetables (Turnips)

Variables	Supermarkets (n=202)		Wet markets (n=226)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	0.54**	0.27	-0.08	0.06
Surface	-0.07	0.26	0.03	0.07
Label	0.31	0.43		
Grand certification	4.00***	0.55		
Package	0.62	0.59		
Mechanical injury: a little	-0.56*	0.30	-0.08**	0.03
Mechanical injury: no less than 25%	-0.45	0.32	-0.09*	0.05
Hard degree: hard	-0.00	0.26	0.10***	0.04
Hard degree: soft	-0.13	0.40	-0.29***	0.07
The first week	-0.74**	0.34		
The second week	-0.50	0.33	0.01	0.05
The third week	-0.22	0.33	-0.00	0.04
The fourth week	-0.20	0.34	-0.02	0.05
The fifth week			-0.09**	0.05
Average income	-0.56	0.45	-0.07	0.06
Constant	4.29**	1.98	1.85***	0.30
F-statistics	15.19***		6.24***	

Notes: *, **, *** displays a 10%, 5% and 1% significance level, respectively.

Table 7. Hedonic Price Regression for Solanaceous Vegetables (Tomatoes)

Variables	Supermarkets (n=343)		Wet markets (n=270)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	-0.31	0.27	-0.03	0.08
Size	0.58**	0.26	0.13	0.09
Surface	0.14	0.51	0.57**	0.26
Hard degree	0.88*	0.39	0.38**	0.18
Maturity	0.19	0.31	0.06	0.14
Label	0.71*	0.38		
Brand certification	3.34***	0.36		
Package	1.15***	0.40		
Mechanical injury: no	0.40	0.45	0.23***	0.09
Mechanical injury: a little	0.20	0.44		
Mechanical injury: no less than 25%			-0.21	0.17
The first week			0.60***	0.12
The second week	0.31	0.35	0.55***	0.12
The third week	0.20	0.34	0.41***	0.12
The fourth week	0.37	0.34	0.20*	0.12
The fifth week	0.00	0.33		
Average income	0.29	0.47	0.26	0.17
Constant	1.45	2.16	1.08	0.79
F-statistics	23.02***		6.43***	

Notes: *, **, *** displays a 10%, 5% and 1% significance level, respectively.

Table 8. Hedonic Price Regression for Scallion Vegetables (Scallions)

Variables	Supermarkets (n=181)		Wet markets (n=111)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	0.16	0.30	0.38	0.38
Roots: with roots	0.28	0.25	-0.94**	0.38
Cleanliness	0.19	0.30	-0.04	0.27
Label	0.87**	0.35		
Brand certification	4.26***	0.50		
Package	0.60*	0.32		
Freshness of leaves: very good			0.08	0.40
Freshness of leaves: good	-0.25	0.36		
Freshness of leaves: poor	-0.88**	0.42	0.42	0.43
Freshness of stems: very good	0.02	0.31	2.17**	0.82
Freshness of stems: good			2.05***	0.74
Freshness of stems: poor	-0.30	0.41		
Mechanical injury: a little	0.06	0.28	-0.43*	0.25
Mechanical injury: no less than 25%	-0.01	0.33	-0.19	0.37
The first week	-0.08	0.36	-0.14	0.40
The second week	0.17	0.35		
The third week			-0.66*	0.38
The fourth week	0.08	0.36	-0.81**	0.39
The fifth week	0.15	0.36	0.18	0.39
Average income	-0.65	0.49	-0.34	0.42
Constant	7.89***	2.15	4.32**	2.18
F-statistics	13.48***		2.19**	

Notes: *, **, *** displays a 10%, 5% and 1% significance level, respectively.

Table 9. Hedonic Price Regression for Bean Vegetables (French beans)

Variables	Supermarkets (n=176)		Wet markets (n=197)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	0.08	1.11	0.25	0.52
Hard degree	-1.17	1.20	0.78	0.74
Label	0.48	0.74		
Brand certification	2.13***	0.58		
Package	2.43***	0.74		
Skin spots: no	-1.07	0.84	0.24	0.44
Skin spots: a few	-0.69	0.82	-0.07	0.44
Skin spots: no less than 25%				
Mechanical injury: no	1.23**	0.52	-0.03	0.19
Mechanical injury: a little				
Mechanical injury: no less than 25%	-1.49	1.36	-0.43	0.84
The first week	-0.26	0.70		
The second week	-0.51	0.69	0.52**	0.25
The third week	0.30	0.66	0.38	0.26
The fourth week			0.15	0.25
The fifth week	-0.70	0.69	-0.56**	0.26
Average income	0.71	0.90	0.66**	0.30
Constant	4.07	4.18	1.90	1.67
F-statistics	5.93***		3.94***	

Notes: *, **, *** displays a 10%, 5% and 1% significance level, respectively.

The regression results for potatoes are shown in Table 10. In supermarkets, surface, brand certification and packaging all have a significant effect on prices. Smooth potatoes, branded potatoes and packaged potatoes will be more expensive by 0.91 *yuan*, 5.04 *yuan* and 1.65 *yuan*. In wet markets, cleanliness, mechanical injury and germination degree have a remarkable impact on prices. Clean potatoes are more expensive by 0.21 *yuan*, and potatoes without germination are more expensive by 0.42 *yuan*, but potatoes scarred with no less than 25% mechanical injuries are cheaper by 0.41 *yuan*.

In summary, the regression results for the seven vegetables reveal that quality differences partly influence prices. This result was also found by Vandeplass *et al.* (2009) for rice and tomatoes in Madagascar, by Minten *et al.* (2010) for various fruits and vegetables in India and by Schipmann *et al.* (2011) for two kinds of vegetables in Thailand. Apart from the inherent attributes, sales attributes, such as labelling, packaging and brand certification, are also associated with a significant price premium. This premium appears mainly in supermarkets.

In general, supermarkets offer higher-quality fresh vegetables than wet markets and sell them at higher prices. Therefore, can quality differences between supermarkets and wet markets totally explain their price differences? To answer this question, this study introduces the retail channel as a dummy variable, making the supermarket value 1 and the wet market value 0. Then, this study mixes the entire sample data collected from supermarkets and wet markets in one model and analyses the regression results. The Chow test previ-

ously proved that the price effect of quality attributes is not the same in different retail channels; therefore, it is difficult to explain the marginal effect of various quality attributes on prices in the models with pooled data. All the quality attributes are treated as control variables. Thus, in Table 11, we do not show variables such as product attributes, sales attributes, district average income and time. Table 11 shows that after controlling quality differences, the price differences between supermarkets and wet markets are not entirely consistent for different vegetables. Among the seven vegetables, turnips, French beans and potatoes from both supermarkets and wet markets are almost the same prices. However, in supermarkets, greens, cucumbers, tomatoes and scallions are more expensive than in wet markets by 0.50 *yuan*, 0.70 *yuan*, 0.74 *yuan* and 1.42 *yuan*, respectively. The respective price premiums are 2.46 *yuan*, 3.16 *yuan*, 1.94 *yuan* and 2.06 *yuan* before controlling the quality differences. This finding reflects the quality differences and explains the price differences of vegetables. The remaining difference in prices may be explained by factors such as supermarkets offering better convenience (such as a 'one-stop' shopping environment, longer hours of operation and parking services) than wet markets.

CONCLUSIONS AND DISCUSSION

By investigation, we compared the quality differences and price differences of fresh vegetables between supermarkets and wet markets. Using hedonic models, we analysed the market orientation and competition strategies of these two retail channels in relation to the

Table 10. Hedonic Price Regression for Tuber Vegetables (Potatoes)

Variables	Supermarkets (n=259)		Wet markets (n=250)	
	Coefficient	Std. error	Coefficient	Std. error
Gloss	0.12	0.62	-0.17	0.14
Surface	0.91**	0.44	-0.19	0.10
Hard degree	1.43	1.33	0.42	0.37
Size	0.29	0.42	0.13	0.09
Cleanliness	-0.46	0.47	0.21***	0.08
Label	0.63	0.67		
Brand certification	5.04***	0.57		
Package	1.65**	0.74		
Mechanical injury: no	-0.28	0.58	-0.17	0.09
Mechanical injury: a little	0.04	0.54		
Mechanical injury: no less than 25%			-0.41***	0.11
Germination degree: no	0.76	1.20	0.42***	0.10
Germination degree: a little	0.11	1.22		
Germination degree: no less than 25%	0.48	0.48	0.48	0.48
The first week	0.06	0.56	-0.23**	0.11
The second week	-0.58	0.58		
The third week	0.45	0.57	-0.16	0.10
The fourth week			-0.33***	0.10
The fifth week	-0.78	0.56	-0.66***	0.10
Average income	0.67	0.79	0.17	0.14
Constant	-2.51	4.31	1.83**	0.75
F-statistics	16.67***		6.62***	

Notes: *, **, *** displays a 10%, 5% and 1% significance level, respectively.

Table 11. Multiple Analysis of Hedonic Price Regression with Pooled Data

Type of vegetable	Supermarkets vs. Wet markets			
	Coefficient	Std. error	t value	p value
Greens (n=575)	0.50**	0.21	2.35	0.019
Cucumbers (n=508)	0.70**	0.29	2.38	0.018
Turnips (n=428)	-0.02	0.11	-0.23	0.816
Tomatoes (n=613)	0.73***	0.15	4.80	0.000
Scallions (n=292)	1.41***	0.18	7.69	0.000
French beans (n=373)	-0.09	0.32	-0.28	0.781
Potatoes (n=509)	-0.35	0.21	-1.64	0.103

Notes: *, **, and *** denote a 10%, 5% and 1% significance level, respectively.

selling of fresh vegetables. The main conclusions are as follows:

Supermarkets have a quality advantage, while wet markets have a price advantage in the competition for fresh vegetable retailing. Supermarkets offer significantly better vegetables than wet markets when considering sales attributes. Among the seven vegetables, only turnips and tomatoes in supermarkets are evidently better than those in wet markets concerning all the product attributes. Turnips, tomatoes and French beans in supermarkets have a higher overall sensory quality than those in wet markets, but greens, cucumbers, scallions and potatoes are almost the same. Thus, supermarkets have a quality advantage in the selling of fresh vegetables. Supermarkets mainly focus on the selling of high-

quality fresh vegetables at high prices. Wet markets mainly focus on offering vegetables with a fresh appearance and a lower price. The coexistence of the supermarket and the wet market is necessary because different sales terminals have different service radiuses, effectively ensuring the availability of fresh produce for consumers, and different sale terminals that target different markets effectively meet the diversified demand of urban residents.

Quality differences partly explain price differences, which means that high-quality vegetables can partially achieve high prices. As shown in the results of the empirical analysis, whether in supermarkets or wet markets, quality differences in vegetables only partly explain price differences. Some excellent quality attributes do

not have a significant effect on the prices of vegetables, which shows that fresh vegetables have not totally achieved high quality and high price. In supermarkets, labelling, packaging and brand certification have significant price effects. In wet markets, time dummies have a significant effect: prices fluctuate significantly over time. Vegetable prices are more sensitive to the market supply and demand, and wet market retailers generally can only passively accept the price. Significant price fluctuations in wet markets reveal that individual vendors do not have better control of seasonality.

In addition to the quality differences, supermarkets have other advantages, such as variety, convenience, environment and characteristic service. Our study shows that after controlling quality differences, price differences between supermarkets and wet markets are not completely consistent for different vegetables. Among the seven vegetables, turnips, French beans and potatoes from both supermarkets and wet markets have almost the same prices, but in supermarkets, greens, cucumbers, tomatoes and scallions are more expensive than they are in wet markets. This finding indicates that quality differences mostly explain the price differences of fresh vegetables, and the remaining differences can be explained by other differential advantages, such as variety, convenience, environment and characteristic service. These advantages may not directly reflect the quality of fresh vegetables but mainly meet the requirements of modern consumers; thus, the price of vegetables sold by supermarkets is higher.

In the retailing of fresh vegetables, supermarkets and wet markets each have their own market share and consumer groups, so they will continue to coexist for some time. Wet markets are still the major retail channel for fresh vegetables. Competition between supermarkets and wet markets in the retailing market will help improve the management level, operating efficiency and quality of services. Eventually, producers and consumers will benefit from this competition. Although the Nanjing market is typical among metropolises, the scope of the research sample is relatively narrow, and the sample numbers are limited. Therefore, the findings of this study may have limitations in terms of universal significance and the promotion of conclusions, especially for many small- and medium-sized cities. The correctness of the application should be further tested. Different fresh vegetables have their own characteristics, and differences in operational modes remain. This study is limited to an analysis of the competition between supermarkets and wet markets in terms of their management of fresh vegetables. It cannot comprehensively reflect their overall forms of competition in agricultural products retailing, especially for the channel differences regarding the sales of fresh fruits.

If possible, future studies should expand the number and size of samples. By conducting in-depth research of other large cities or small and medium-sized cities, researchers can investigate the universal competition situations of supermarkets and wet markets regarding the sales of fresh vegetables. Additionally, other fresh

agricultural products, such as fruit, meat and aquaculture products, can be added to analyse the competition situations of supermarkets and wet markets for different fresh farm products.

AUTHOR CONTRIBUTIONS

Xianhui GENG designed the study, analyzed the data, and wrote the paper; Kaiyuan CHEN assisted in conducting the survey, edited the article, and responded reviewers' feedbacks; Susumu FUKUDA reviewed the article and gave valuable comments to make the study more meaningful; Masahiro MORITAKA reviewed the article and provided good suggestions to improve the formats and methodology; Ran Liu reviewed the paper, decorated the tables and figures, and made necessary proofreading; Aijian WEI designed the questionnaire and conducted the survey.

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