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E-Groceries: A Channel Choice Analysis in Shanghai

Valerio Gatta [1], Edoardo Marcucci [1,2], Ila Maltese [1,*], Gabriele Iannaccone [1] and Jiarui Fan [1]

[1] Transport Research Lab (TRElab), Roma Tre University, Via Gabriello Chiabrera 199, 00145 Rome, Italy; valerio.gatta@uniroma3.it (V.G.); edoardo.marcucci@uniroma3.it (E.M.); gabriele.iannaccone@uniroma3.it (G.I.); jiarui.fan@uniroma3.it (J.F.)
[2] Department of Logistics, Molde University College, P.O. Box 2110, 6402 Molde, Norway
* Correspondence: ila.maltese@uniroma3.it

Abstract: E-grocery is becoming more and more popular, involving both pure e-commerce players and physical stores in its development and sales. As a consequence, the last mile delivery model has been heavily modified, with ambiguous final impact on the environment. This paper identifies the key elements germane to e-grocery (demand and supply), discusses e-grocery development and investigates the challenges ahead. In more detail, it presents the results of a stated preference survey on consumers' channel choices for the grocery market. The survey was carried out in Shanghai (China) in order to investigate different purchase attributes, such as product and delivery service price, product range, lead time, time window and travel time. The paper identifies heterogeneous reactions to alternative service configurations, which allows to estimate market shares for e-grocery, with the in-store option as a reference. Policy implications and operational solutions to improve the sustainability of this renewed last mile delivery model are thus proposed.

Keywords: e-grocery; last mile delivery; home delivery; City Logistics; urban freight transport; stated preference; discrete choice modeling; consumer behaviour; e-commerce; channel choice

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1. Introduction

Nowadays, the Internet has dramatically changed people's everyday lives and has also disrupted and re-combined, both in time and space, the traditional sequences formerly used when performing one's daily chores, including shopping [1]. Online shopping, indeed, allows consumers to purchase products/services over the Internet from a seller, drastically altering how to gather, compare and use information as well as the purchase and delivery processes. With e-commerce people do not need to abide by the specific opening and closing times of the store and can buy items online using their mobile devices when they are, for example, on the way to their office or waiting at the train station. The evolutional shopping process deeply changes consumers' behaviour, which has a close relationship with transport [2].

In particular, purchasing groceries (i.e., food, home and personal care items) being the most common and frequent shopping activity, this significantly affects urban freight transport and environment. Nonetheless, modifying channel-shopping choice from store to online can generate both positive and negative effects on transport, depending on both consumers' behaviour and last mile delivery schemes. In more detail, it is clear that when consumers purchase online and ask to have their groceries home delivered, freight trips shift from the consumer to the retailer's side.

The final impact on urban freight transport is, instead, uncertain, since it depends on the type of product, on the shopping frequency, on the purpose of shopping activities, on the trip chaining occurrence, and on the trade-off between efficiency and time constraints [3].

Moreover, if the trip is not dedicated, the online shopping will hardly save any trip [4]. At the same time, if consumers are going shopping for physical exercise or for entertainment, then, saving trips can reduce their overall utility (*ibidem*).

This paper focuses on the challenging impact e-grocery development might have on the environment through the investigation of consumers' shopping trips, as well as freight movements from distribution centers to consumers (home delivery). In particular, it investigates different shopping channels' transport implications and impacts of Shanghai grocery markets.

This case study was chosen because China, due to its population, is the largest (e-) grocery market in the world, and Shanghai is China's most populous urban area.

In more detail, the paper explores the current and potential demands for e-grocery shopping in Shanghai and the likely impact of the e-grocery market development on transport and environment.

Specifically, the paper investigates factors influencing consumers' preferences for online/offline grocery shopping.

After identifying the key attributes and levels, the paper describes the development of a stated choice experiment (CE) aimed at acquiring information on consumers' preferences. This is necessary to estimate consumers' willingness to pay (hereinafter, WTP) for alternative grocery-purchasing channel configurations. This, in turn, allows via discrete choice models to calculate alternative shopping channel choice scenarios and assess their likely impact on transport and environment.

In fact, based on given assumptions about the efficiency, organization and deployment of various activities, it is possible to determine the transport implications of these market share variations on the environment. Indeed, one could avoid consumer grocery-shopping trips by purchasing groceries online. This would, in turn, modify last mile deliveries substantially, since private grocery-shopping trips will be replaced by retailers' freight trips to consumers' houses. Urban freight transport might then be entirely changed with increasing e-grocery popularity. Nonetheless, the final impact on the environment can be uncertain. For example, if the modal shift is from customers' "green modes" (such as active travel or electric vehicles—EVs) to more polluting courier vans or trucks, the e-grocery impact on the environment can even be detrimental.

Within this context, this paper investigates different grocery purchase attributes (product and delivery service price, product range, lead time and time window, travel time) via a stated preference survey. Data analysis is based on a multinomial logit model (MNL) that allows estimating both the WTP for the attributes and the e-grocery channel market shares. Additionally, sub-samples are compared through a naïve-heterogeneity econometric analysis.

To this aim, in 2019, a questionnaire was administered in the city of Shanghai to 299 individuals who autonomously replied to a web-based interview (50%) or were directly interviewed by data collectors (50%).

The paper is organized in seven Sections. After this introduction, Section 2 discusses the results of other papers investigating this specific retail segment. Section 3 illustrates methodological issues, the questionnaire structure, and its administration process, while Section 4 succinctly describes current e-grocery market characteristics in China. Section 5 illustrates the data gathered and reports econometric results. Section 6 provides scenario analysis and policy implications. Finally, Section 7 concludes and clarifies the shortcomings of the paper and illustrates future research endeavors needed to overcome them.

2. Literature Review

This Section presents a brief literature review of e-grocery in order to clarify the current knowledge frontier. The review pays specific attention to previous studies on consumer channel choice when performing shopping/buying groceries (Section 2.1) and its transport implications (Section 2.2).

2.1. Consumers' Behaviour Change in Grocery-Shopping Channel Choice

The Internet has changed consumers' behaviour with a significant advantage in terms of time and effort saving. Ramus and Nielsen [5] noticed that a virtual shop, being always

open, allows customers to shop at any time of day and night, while [6] reported how different grocery purchasing activities can be performed at different times and in different places. Likewise, following [7], customers buying online do not need to dedicate many hours for shopping, since they can purchase with minimal time and effort. This also allows customers with reduced mobility to overcome their physical disability constraints and people with no transport means or free time to purchase to do their necessary grocery shopping. On the other hand, the authors also identified the disadvantages of purchasing grocery online: there is no direct or physical contact with items; furthermore, the customer needs detailed information and, if possible, comments or reviews from previous customers (*ibidem*).

Nevertheless, according to [8], once consumers have gained experience in e-grocery—which is an easy task, due to the grocery-shopping frequency—other choice elements, such as price, product range, lead time, become more important.

In particular, concerning grocery as a good experience [9], the drivers of consumers' channel choices can thus be influenced by demand or supply characteristics.

The Internet actually affects both grocery consumers and retailers. In order to investigate how it influences consumers' channel choices, it is necessary to understand the shopping process. According to [3], it consists of "desire, information gathering/receiving, trial/experience, evaluation, transaction, delivery/possession, display/use and return." Ref. [1] observed that the Internet has fragmented the previously holistic shopping process (experience, evaluation, transaction and delivery) and reorganized it.

Nonetheless, following [10], when focusing on consumers' behaviour, the challenge is to generalise models, since the e-grocery logistics is deeply connected to spatial aspects, such as cultural eating habits and the geographical location of suppliers and retailers.

There are extensive studies on consumers' e-grocery determinants, whose understanding is crucial for grocers/retailers, supply chain managers, and urban planners [11]. Nevertheless [12] noticed that there are still few works scrutinizing the behavioral determinants of grocery consumer channel choice by means of discrete CEs.

The stated preference (SP) approach is actually used to ask people questions with respect to hypothetical situations; through the investigation of these choice options, one can estimate the economic value attached by respondents to the different available options [13].

Choice modelling has been widely used in previous studies on consumer channel choice.

Ref. [14] used a two-stage choice modelling framework to test price sensitivity and brand loyalty between online and offline grocery shoppers. Ref. [15] used random utility maximization principles and a MNL to estimate demand for multi-channel retailers in the UK using a data set from a large grocery retailer in the UK. Results suggested that, when consumers start buying groceries online, they tend to select the online stores belonging to the same chain as their preferred offline stores. Similarly, [16] found out that many UK grocery companies added an online channel to complement their traditional/offline in-store portfolio.

Ref. [2] studied consumers' choice behavior by developing different discrete choice models (DCMs) for joint choice of channel, shopping destination and travel modes. The study collected consumer panel data from two selected boroughs in London and developed a two-stage model to represent the channel choice behaviour for each shopping occasion. Results indicated that online alternatives attract earlier online adopters for large basket shopping and within high-income groups.

Finally, [17] used SPs to estimate market shares for e-grocery, distinguishing between home deliveries and click and pick, in Norway.

2.2. E-Grocery Impact on Transport

The transport impact of e-grocery affects both consumers' shopping trips as well as freight distribution. Ref. [3] stated that, theoretically, consumer shopping trips will be reduced if more customers start buying groceries online. However, this rests on the assumption that consumers perform dedicated trips to the store. In many cases, shopping

trips are instead chained with other activities; hence, the incremented distance added by shopping trips can be negligible. Moreover, shopping trips can be performed by walking, cycling or public transport, thus reducing the potential e-grocery benefits in terms of congestion, emission, or energy consumption (*ibidem*). The same can be said if consumers cover the distance to the supermarket using an EV [18].

In this context, an interesting study by [19] explored how non-motorized accessibility to groceries and consequent willingness to walk influenced the channel choice of elderly people.

Furthermore, [20] noticed that consumers might also make a special trip to the stores just because of something they saw online and would like to see and touch offline.

Following [21], online shopping can substitute for customers' shopping trips; on the other hand, more freight traffic might be generated due to the higher demand of home delivery service. However, according to [22], as the last mile delivery by retailers or wholesalers substitutes for shopping trips, it is reasonable to assume that total volumes of freight and passenger transport in terms of vehicle-km will not change so much. Actually, some empirical studies have indicated a limited or no impact on the number of trips and distance travelled [23].

Freight distribution system is thus influenced by e-shopping [24], and inter-city transport can be de-consolidated, with the last mile transport performed by small vans or trucks [22] or, instead, by EVs [25].

More specifically, [26] analysed the implications of the click and pick e-grocery option for shopping travel behaviour spread by carrying out a survey among about 600 French households, finding out that the interest in reorganizing the grocery shopping, particularly concerning time, was greater than the interest in substituting shopping trips.

To summarise, the review of previous studies on e-commerce transport impacts highlighted the relevance of the topic investigated and the need for exploring transport implications related to the growing demand for e-grocery.

3. Methods

Notwithstanding the few relevant studies illustrated above, there has been an overall lack of attention to modelling online/offline grocery shopping. This paper studies this issue by creating a detailed database concerning consumer channel choice in grocery shopping in the Chinese context. This includes consumers' current grocery-shopping behaviour, stated choices and acceptability of attributes/levels characterising physical stores, home delivery and click-and-pick options.

This Section illustrates the research method used in the project.

3.1. The Survey

The approach consisted of a three-step survey process. First, supporting qualitative studies were carried out in order to refine a list of attributes with their levels, compiled in accordance with the available literature on this subject and, in particular, with a previous work conducted in Norway [17]. Secondly, two in-depth interviews were conducted, followed by a focus group interview, whose goal was to define important attributes to be used in the SP survey. Finally, in order to refine the list of attributes and levels, a pilot small-scale (30 respondents) SP survey was performed.

The final questionnaire was thus tested using a preliminary pilot study to detect possible undetected mistakes and unclear segments/parts. The pilot run provided qualified (i.e., correct) answers only in very few cases (5), thus recommending a coordinator to supervise the administration process.

Since various factors affect consumers when they are choosing a shopping channel, one needs to discover which main attributes are used in their utility functions when they decide how to shop for groceries. Among the possible attributes first selected in the literature, after a small sample of in-depth interviews, a focus group in Shanghai and a small pilot study, the list was shortened to the six following attributes:

(1) Product price (PP): grocery cost;
(2) Product range (PR): % of groceries available online compared to the stores;
(3) Service cost (SC): extra cost for preparing and (or) deliver the goods;
(4) Travel time (TT): time spent to reach the store and (or) pick-up points for dedicated grocery-shopping trip;
(5) Time window (TW): Expected time of arrival range;
(6) Lead time (LT): time elapsed between order placement and delivery.

Table 1 below reports attributes and levels that were finally used in the SP CEs.

Table 1. Summary of the attributes and attribute levels.

	Attributes					
Alternatives	**Product Price (PP)**	**Service Cost (SC)**	**Travel Time (TT)**	**Product Range (PR)**	**Lead Time (LT)**	**Time Window (TW)**
In store	Stated	n.a.	Stated	100%	n.a.	n.a.
Home Delivery	90%, 100% (stated), 110%	0 RMB, 20 RMB, 50 RMB	n.a.	50%, 100% (*status quo*), 150%	0.5 h, 6 h, 12 h	30 Min, 60 Min, 120 Min
Click & Pick	90%, 100% (stated), 110%	0 RMB, 10 RMB	50%, 75%, 100% (stated)	50%, 100% (*status quo*), 150%	0.5 h, 6 h, 12 h	n.a.

The purpose of the questionnaire was thus to acquire information for estimating and predicting consumers' channel choices for the e-grocery market.

It was administered in Shanghai in 2019. Half of the questionnaires (149) were sent through social media by one coordinator, while the remaining (150) were compiled during face-to-face interviews carried out by another coordinator in schools, restaurants, shopping centers, libraries, train stations, and other locations.

3.2. The Questionnaire

The questionnaire included three sections: pre-choice, choice, and post choice (examples of choice tasks in the questionnaire are available upon request).

The first one aimed at acquiring data on the respondents' grocery-shopping behaviour and attitude. This allowed to include more sensible and personalized options in the choice set, as travel time and product cost attributes were pivoted on the levels previously stated. For example, if stated PP equalled 50, levels 45 (90%) or 55 (110%) were presented in the choice set. Indeed, respondents were asked to reply to questions about their habits, such as their favorite shop size/kind, the day and hour they do grocery shopping, their shopping carts (value and product category), their modal choices for going to the shop.

The second part of the questionnaire was devoted to CEs. Respondents were thus asked to choose among three different options in six different scenarios, which differed in terms of attribute levels. As concerned the three options, the *status quo* situation, i.e., the in-store grocery shopping, was included in the survey to increase realism in the hypothetical scenario choice. One can split e-grocery into two specific options: home delivery and click and pick. Home delivery (HD) refers to the shopping option whereby products are purchased online and delivered at home (or to pre-defined destinations). Click and pick (CP) means that, once the order has been placed online, the goods can be collected at a pick-up point or at the supermarket itself [22].

3.3. The Model

Within a random utility maximization framework one assumes utility (U) consists of two parts: a deterministic (V) and a random (ε) component.

This is true whatever the e-grocery delivery option is.

According to this, one can state that

$$U_{store} = V_{store} + \varepsilon_{store},$$

$$U_{HD} = V_{HD} + \varepsilon_{HD},$$

$$U_{CP} = V_{CP} + \varepsilon_{CP}.$$

One can express the deterministic component using the attributes previously discussed (Section 3.1) for each alternative/option (in-store, HD or CP) as follows:

$$V_{store} = \beta_{0\_store} + \beta_{PP}\, PP_{store} + \beta_{TT}\, TT_{store},$$

$$V_{HD} = \beta_{PP}\, PP_{HD} + \beta_{SC\_HD}\, SC_{HD} + \beta_{TW}\, TW_{HD} + \beta_{PR}\, PR_{HD} + \beta_{LT}\, LT_{HD},$$

$$V_{CP} = \beta_{0\_CP} + \beta_{PP}\, PP_{CP} + \beta_{TT}\, TT_{CP} + \beta_{SC\_CP}\, SC_{CP} + \beta_{PR}\, PR_{CP} + \beta_{LT}\, LT_{CP}.$$

The coefficient β is an estimated parameter representing the marginal utility of each attribute variation, β_0 refers to the alternative-specific constant, while other acronyms are: PP—Product price; SC—Service cost; TW—Time window; TT—Travel time; PR—Product range; LT—Lead time.

3.4. The Sample

The 299 respondents generated 1794 observations. The sample had a good coverage with respect to gender, age, income level and location. Table 2 below summarises the main socio-demographic characteristics of the sample.

Table 2. Sample characteristics.

Gender		**GS Responsible**		**Willingness to Use E-Grocery**		**Trip Chaining**	
male	45%	yes	72%	yes	95%	dedicated trip	62%
female	55%	no	28%	no	5%	not dedicated trip	38%
Age		Family size		Household monthly budget (RBM)		Mode choice for GS	
18–28	62%	1	18%	<500	9%	car	32%
29–37	21%	2	8%	500–1000	24%	public transport	11%
38–53	11%	3	28%	1000–2000	21%	on foot	35%
54–72	5%	4	24%	2000–5000	29%	bycicle	17%
>73	1%	>4	22%	5000–8000	11%	other	5%
				>8000	6%		

GS = grocery shopping.

The sample included 165 females (55%) and 135 males (45%). The age of the respondents ranged from 18 to above 70. The largest part of the sample fell within the 18–28 years old range (62%). Family budget level ranged from less than 500 RMB to more than 8000.

Among the 299 respondents, 216 (72%) were usually responsible for purchasing groceries for the family. Eighteen percent lived alone, 8% in a couple, 28% belonged to a three-member family, 24% in a family of four people, while for the remaining 22% the family size was five or more.

Results also indicated that 286 respondents (96%) had already experienced buying online, while 97% were aware of the possibility to buy groceries online, with 281 respondents stating they had considered purchasing grocery online, and 91% that they had done it before. Ninety-six interviewees (32%) preferred a private car as their main transport mode for grocery-shopping trips, followed by 105 (35%) that preferred to go shopping on foot.

Among the 299 respondents, 187 (62%) usually performed dedicated trips when buying groceries and 62 (30%) of them used their private cars. The sample revealed a range of travel time for a round trip from 1 to 120 min.

The most frequent answer with respect to the favorite expected time range from order placement to groceries reception was from a half-hour to one hour (25%).

4. Case Study

China was very suitable for this case study, being the largest grocery market in the world, with a consequently huge potential for the development of the e-grocery market. This study focuses on the biggest urban area in China, Shanghai, whose potential demand for e-grocery shopping is investigated.

A comprehensive understanding of Chinese grocery retailing market was, thus, a fundamental prerequisite. This Section summarises the current situation in China (Section 4.2) compared to the rest of the world (Section 4.1).

4.1. China in the World

China is the largest e-commerce market in the world with retail sales amounting to USD 366.1 billion in 2016 and a compound annual growth rate (CAGR) of 51.2% from 2012 to 2016. Although smaller (only 6.5% of the sales) than other e-commerce sectors (e.g., apparel and footwear), the e-grocery sector in China has witnessed significant growth, with a CAGR of 52.9% from 2012 to 2016 [27].

China is, thus, also the largest e-grocery market in the world, worth USD 23.9 billion in 2016, and makes up 32% of the top 10 e-grocery markets in the world [27].

The market growth is mainly driven by the rising middle-class population, which is endowed with an increasing disposable income and higher purchasing power, resulting in a huge jump in grocery spending among Chinese consumers. Sales keep increasing with further mobile device penetration and more players emerging, and retailers are making huge efforts to draw consumers to their websites. The supply side of the market also deserves attention.

4.2. China Grocery Market

In recent years, Chinese consumers' shopping habits have become more and more diversified. An increasing number of grocery shoppers in China are nowadays focusing more on convenience and product quality when buying groceries online.

Currently, supermarkets and hypermarkets are dominating China's grocery markets in all major regions, and their ongoing expansion to smaller cities is expected to increase competition further. Among all the sale channels over the next few years, hypermarkets are expected to experience the highest growth rate, followed by convenience stores.

Improvements in distribution infrastructure and support from local governments have allowed supermarkets to expand into rural areas and contribute to market growth; a combination of online marketplaces and bricks and mortar retailers have made China a leading online grocery player.

In 2018, Shanghai, the biggest Chinese urban area (out of a population of a little less than 1.44 billion in 2020, Shanghai hosts about 27 million inhabitants, while the second largest Chinese city by population, Bejing, has "only" 20 million people, according to NBS data set, 2021), achieved an e-commerce transaction volume of RMB 2.8 trillion, a year-on-year increase of 19.3%; online retail sales exceeded RMB 1 trillion, an increase of 29.7% over the same period last year [28], thus deserving attention as a case study at urban scale.

Alibaba's Tmall and JD.com, the two largest online grocery retailers in China, are one-stop shops for all domestic and international brands and categories. They offer a nationwide logistics network, rapid delivery, innovative and simple payment solutions in China's grocery market.

Together with Vipshop, they are the top three fastest growing e-grocery retailers in China [29], putting more efforts into developing mobile apps, especially for rural markets, focusing on online groceries, engaging with consumers through social media platforms, and improving fulfillment logistics infrastructure, and also providing night-time delivery service to meet consumers' needs.

According to the much lower growth rate of the Chinese retailers with only in-store grocery retailing (*ibidem*), these efforts have been rewarded by the Chinese consumers who

require five basic elements: easy navigation, wide range of payment options, wide range of product options, detailed product information and value for money [29].

In addition, they particularly value online ratings, reviews, and recommendations from other shoppers when making purchase decisions online.

Furthermore, it is worth investigating the channel choice in terms of last mile delivery impact on the urban environment in China. The European Commission's white paper on transport stated that the EU needs to reduce greenhouse gas (GHG) emissions by 80–95% (compared to 1990 levels) by 2050 [30]. The goal set for urban freight is to have an essentially CO_2-free urban distribution by 2030. China has been the highest carbon-emitting country in the world since 2000 [31] and has decided to follow a similar CO_2 reduction target goal by 2030.

5. Results

This Section provides a description of the econometric results.

In particular, the analysis performed rested on a MNL estimation that allowed to determine the WTP for each attribute considered, for the sample as a whole (Section 5.1), and compare econometric results for different sub-samples (Section 5.2).

5.1. Econometric Estimations

This Section discusses the econometric results (Table 3).

Table 3. Econometric results for the whole sample.

General Output				
ANS_1|	**Coefficient**	**Standard Error**	**z**	**Prob |z| > z**
Product price (PP)	−0.00895 ***	0.00160	−5.61	0.0000
Service cost home delivery (SC_HD)	−0.02936 ***	0.00262	−11.21	0.0000
Time window (TW)	0.00127	0.00137	0.93	0.3545
Product range (PR)	0.01058 ***	0.00098	10.79	0.0000
Lead time (LT)	0.00650	0.01634	0.40	0.6906
Alternative specific constant Click and Pick (ASC_CP)	−0.91862 ***	0.14076	−6.53	0.0000
Travel time (TT)	0.00445	0.00316	1.41	0.1587
Service cost Click and Pick (SC_CP)	−0.05641 ***	0.01167	−4.84	0.0000
Alternative specific constant in store (ASC_IS)	−0.74955 ***	0.14292	−5.24	0.0000
R^2	0.10			

***, **, * ==> Significance at 1%, 5%, 10% level.

Estimation based on N = 1785

The pseudo-R2 of the model is approximately 0.10. Parameters estimates (coefficient column) are in line with expectations.

An important characteristic of the parameters is their statistical significance. In fact, the TW, LT and TT coefficients are not significant, indicating one can not reject the null hypothesis (i.e., the coefficient is equal to 0). What follows discusses some possible underlying motivations that might explain the results and their robustness.

TW—In China, and especially in Shanghai, it is common practice to have most of the groceries delivered at home and, if no one is present, the package will be left at the reception. Since this is normal practice, this might explain why TW is not statistically relevant.

LT—In China food-related groceries account for less than 30% of the total and this might explain why Chinese consumers seem less sensitive to this attribute.

TT—The customers using a regular or electric bike account for 20% of the total in China, and thus TT travel time reductions might not have a substantial impact.

Notwithstanding the statistical significance of the estimated parameters, TW, LT, and TT attributes were not removed from the model since they might not be significant in a relatively small sample, but could still prove significance with a larger one or even when considering specific classes of our sample.

It is common practice to use WTP for measuring the amount of money individuals are ready to pay for a benefit, i.e., an improvement in a given attribute. For instance, one can calculate the amount of money individuals are willing to pay for an improvement in terms of saving a unit of travel time. WTP is calculated as the ratio between a given attribute coefficient and the one related to a monetary attribute. In order to ensure that the measure of WTP is meaningful, the two compared attribute coefficients have to be statistically significant [32].

According to Table 4, which reports the different WTP measures, the results of different WTP values considering product price (PP) and service cost (SC) are calculated.

Table 4. Willingness to pay (WTP) values (RBM).

WTP	Values of WTP (RBM)
WTP_1 PR:PP	1.182
WTP_2 PR:SC_HD	0.360
WTP_3 PR:SC_CP	0.188

Clearly, PR has a positive impact on different types of costs, whereas different types of time generate a negative effect on cost, which is consistent with the expectations. Consumers are actually willing to pay more for a wider product range and a shorter travel time, time window or lead time.

Taking travel time as an example, 1 min TT equals to RMB 0.503 product price (PP), and RMB 0.080 service cost (SC) for CP choice. It implies that if the person has to invest a substantial amount of time to travel for grocery shopping, he or she would prefer to pay higher for the products rather than for the delivery service to save his or her travel time.

In the data description section it emerged that the most popular acceptable TW was 0.5 to 1 h, so generally, it has a monetary value equal to RMB 2.58 ($0.043 \times 60 \times 1$).

The value of LT is estimated as 0.115 RMB/minute on average, therefore the value of LT for one hour is approximately RMB 6.9. Finally, consumers are willing to pay around RMB 10 for the delivery service.

5.2. Dealing with Heterogeneity

This Section proposes a simple characteristics-based segmentation of the sample carrying out econometric models for different subgroups, which improves understanding specific market segments and develops targeted marketing strategies.

Furthermore, attributes like TW, TT, LT, which in the whole sample did not prove to be statistically significant, were indeed so for specific sub-samples.

Table 5 reports the results for subgroups of interviewees that had and had not a previous e-grocery experience. Only 20 (7%) of the 299 interviewees did not have a previous e-grocery experience.

The ASCs suggest that consumers with a previous e-grocery experience prefer HD. The TW, LT, and TT attributes have less influence on consumers' choices because they are not significant and this is in line with the general results of Table 3.

By comparing the WTP between these two subgroups, the interesting point is that PP is non-significant in the subgroup of those that had never purchased groceries online before.

At the same time, this attribute is significant for the subgroup of those who had purchased groceries online before. In the current state of affairs, the e-grocery price is typically lower than that in a physical store. Indeed, online stores can benefit from tax advantages or make use of loopholes so to lower their average prices.

Table 5. Econometric results for the subgroups who have (never) purchased groceries online before.

	No E-Grocery before		E-Grocery before	
ANS_1|	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Product price (PP)	0.01429	0.01385	−0.00926 ***	0.00164
Service cost home delivery (SC_HD)	−0.02047 *	0.01184	−0.03038 ***	0.00271
Time window (TW)	−0.00320	0.00634	0.00151	0.00142
Product range (PR)	0.00969 **	0.00430	0.01074 ***	0.00101
Lead time (LT)	0.04354	0.07134	0.00415	0.01685
Alternative specific constant Click and Pick (ASC_CP)	−0.30941	0.65437	−0.96629 ***	0.14531
Travel time (TT)	−0.00621	0.02111	0.00519	0.00321
Service cost Click and Pick (SC_CP)	−0.08963 *	0.05016	−0.05496 ***	0.01204
Alternative specific constant in store (ASC_IS)	0.51446	0.67090	0.85216 ***	0.14782
R^2		0.153		0.109

***, **, * ==> Significance at 1%, 5%, 10% level.
Estimation based on N = 114 (no purchased grocery before) and N = 1672

This also explains why in general there are more people with a pre-existing experience of e-groceries in China.

In July 2007, the first online trade tax evasion case in China was taken to court and the online company was found guilty in Putuo district court in Shanghai. The verdict provoked a heated discussion about whether e-commerce should be taxed or not.

The case is worthy of greater attention, especially considering e-commerce taxation as a whole, which is still taking place in a regulatory vacuum [33].

Since China is a large and articulated country, it encounters special difficulties in administering a tax system, especially when it comes to e-commerce transactions. This is a serious problem, since technology and its use are moving fast in practice, when compared to the administrative capabilities public bodies have in arranging a proper regulatory framework and having it duly deployed and enforced.

In addition, China adopted the EIT (Enterprise Income Tax) in its current form as a modern and international tax system just few years ago, and it has limited capabilities and experience in running such a system in the modern era [34].

Table 6 below suggests there are some differences between those interviewees indicating that they perform dedicated trips and those who do not when buying groceries.

Table 6. Econometric results for the subgroups who usually (do not) perform dedicated trips.

	Dedicated Trips		Not Dedicated Trips	
ANS_1|	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Product price (PP)	−0.00590 ***	0.00145	−0.03036 ***	0.00472
Service cost home delivery (SC_HD)	−0.03341 ***	0.00342	−0.02285 ***	0.00416
Time window (TW)	0.00207	0.00177	0.00026	0.00223
Product range (PR)	0.01131 ***	0.00125	0.00950 ***	0.00160
Lead time (LT)	0.00618	0.02055	0.00951	0.02719
Alternative specific constant Click and Pick (ASC_CP)	−0.83029 ***	0.17812	−1.07670 ***	0.23257
Travel time (TT)	0.00292	0.00405	0.00728	0.00536
Service cost Click and Pick (SC_CP)	−0.06108 ***	0.01465	−0.04918 **	0.01952
Alternative specific constant in store (ASC_IS)	−0.71641 ***	0.18225	−0.78257 ***	0.23299
R^2		0.110		0.118

***, **, * ==> Significance at 1%, 5%, 10% level.
Estimation based on N = 1114 (perform dedicated trips) and N = 677

The ASC_IS is statistically significant, implying that interviewees understood quite well that there was significant difference between HD and shopping in store.

The coefficents in this subgroup are in line with the general results, LT, TT, and TW still being insignificant.

It was no surprise that the TT values for both dedicated and non-dedicated trips are not significant.

The value of time in China is in line with the average hourly pay in the country (average yearly *per capita* GDP is approximately USD 10,000, according to NBS, 2021).

Focusing on age subgroups (Table 7), one discovers that ASC_IS is statistically significant for both groups—over 38 years old and 38 years old and below—implying a significant difference in the preferences between HD and in-store.

Table 7. Econometric results for age-based subgroups.

	Over 38		**Under 38**	
ANS_1|	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Product price (PP)	−0.00324	0.00334	−0.01071 ***	0.00198
Service cost home delivery (SC_HD)	−0.03244 ***	0.00648	−0.02956 ***	0.00290
Time window (TW)	−0.00169	0.00342	0.00196	0.00151
Product range (PR)	0.00891 ***	0.00259	0.01104 ***	0.00107
Lead time (LT)	−0.03675	0.04365	0.01329	0.01778
Alternative specific constant Click and Pick(ASC_CP)	−1.48411 ***	0.36588	−0.84289 ***	0.15420
Travel time (TT)	0.00832	0.00537	0.00538	0.00401
Service cost Click and Pick (SC_CP)	−0.06252 **	0.02991	−0.05496 ***	0.01274
Alternative specific constant in store (ASC_IS)	−1.74222 ***	0.38719	−0.60818 ***	0.15719
R^2		0.118		0.107

***, **, * ==> Significance at 1%, 5%, 10% level.
Estimation based on N = 281 (more than 38 years old) and N = 1504

TW, LT, and TT are not statistically significant, in line with general sample results. Interestingly, PP for those older than 38 years is not significant, while it is significant for those who are 38 or under 38. This is in line with the assumption that older interviewees are wealthier and operating under a less stringent income constraint.

The ASC_IS analysis suggests that females, in general, are more willing to shop in stores while males consider the two options equivalent.

One can suppose that females might enjoy the shopping process more psychologically, since they might like the atmosphere in the store and prefer feeling and touching the products.

However, Table 8 reveals that TT is significant for females alone and this might imply that males do not care about the TT spent along the way while females prefer saving TT to the store.

The salary subgroups were segmented according to three ranges: less than RMB 1000, between RMB 1000–5000, and over RMB 5000. Observing related data, one discovers that the ASC_IS is significant for the less than RMB 1000 and the between RMB 1000–5000 salary subgroups, while it is not significant for the over RMB 5000 salary subgroup. One can interpret this by saying that, for salary lower than RMB 5000, the HD and IS options differ one from the others significantly, while this does not apply to the over RMB 5000 salary subgroup.

Finally, the sample was segmented depending on the amount of products the customers typically buy. The respondents who usually shop for at least three bags do not have any statistically significant preference between HD and shopping in store. Moreover, only SC for HD and PR are significant, suggesting they might be attracted by HD if they can find more products and a low cost for the delivery service.

On the contrary, the respondents who shop for 1–2 bags seem to prefer HD, while only TW and LT are.not significant. This is not a surprise since they are likely to do grocery shopping more frequently, and thus are not particularly bounded by time constraints.

Table 8. Econometric results for gender based subgroups.

	Males		Females	
ANS_1|	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
Product price (PP)	−0.00791 ***	0.00217	−0.01008 ***	0.00230
Service cost home delivery (SC_HD)	−0.02717 ***	0.00405	−0.03185 ***	0.00351
Time window (TW)	0.00166	0.00211	0.00090	0.00185
Product range (PR)	0.01103 ***	0.00147	0.01047 ***	0.00133
Lead time (LT)	0.00848	0.02463	0.00833	0.02225
Alternative specific constant Click and Pick (ASC_CP)	−0.39546 *	0.20907	−1.39301 ***	0.19707
Travel time (TT)	−0.00153	0.00391	0.01215 **	0.00537
Service cost Click and Pick (SC_CP)	−0.08211 ***	0.01727	−0.03266 **	0.01596
Alternative specific constant in store (ASC_IS)	−0.23164	0.21050	−1.21479 ***	0.20226
R^2		0.10		0.125

***, **, * ==> Significance at 1%, 5%, 10% level.
Estimation based on N = 804 (male) and N = 981

6. Discussion

This Section investigates e-grocery's market share evolutions based on alternative channel configurations (Section 6.1).

Estimates and assumptions about customer-related parameters, such as TT, are based on the information collected from the questionnaires. It investigated how the market would, most likely, react to the deployment of specific managerial policies. Therefore, some scenario simulations were conducted to test market effects of possible changes in e-grocery retailing policies.

Based on the previous results, the paper also provides some suggestions on managerial policies (Section 6.2). Finally, since the growth of e-grocery will have impacts on freight distribution, the last Section discusses some implications regarding freight logistics (Section 6.3).

6.1. Market Simulation

After estimating a model, one can develop a policy analysis based on scenario simulations and test given policy configurations by modifying one or more attributes to tease out likely behavioral reactions. This allows estimating possible market share changes to be compared with the *status quo*.

E-grocery retailers pursue two broad pricing strategies: free shipping and partitioned prices. For store-based multichannel retailers, both strategies can lead to higher gross prices with respect to shopping in the store. However, for warehouse or dark-store-based purely online retailers, gross price may be lower than that in the store, due to low operation costs and market entry costs.

It is of great interest to find out whether consumers in China prefer free service costs or partitioned prices, with price divided by the retailer into different components. Assume a Scenario 1, where PP is the same for all the three alternatives. The SC can be included in the gross price or set as a partitioned fee. Suppose the service fee is RMB 10 for HD and RMB 5 for CP (base scenario). The simulation performed shows that adopting free shipping (no service cost) increases the probability of choosing e-grocery (including HD and CP) by around 5%.

Currently, e-grocery retailers in China generally have similar product ranges, compared to their supermarket counterparts. However, in the future, one can conceive

warehouse-based e-grocers offering a wider range of products. Scenario 2 assumes e-grocery product range to be 120% with respect to the one available in a supermarket. This would allow an increase of the e-grocery share by 5% with respect to the total market share.

Table 9 reports the results of the different policies investigated: using the choice model defined above under current market conditions, in-store grocery shopping still has a large market share. However, the e-grocery market share can be further increased by implementing appropriate policies in line with customers' preferences.

Table 9. Market simulations.

China	In Store		Home Delivery			Click and Pick			P(i)		
	PP *	PR%	PP *	SC	PR%	PP *	SC	PR %	IS	HD	CP
BASE	200	100	200	10	100	200	5	100	31.1%	49.1%	19.8%
Scenario 1	200	100	210	0	100	205	0	100	26.7%	51.7%	21.6%
Scenario 2	200	100	200	10	120	200	5	120	26.8%	52.2%	21.1%
Scenario 5	250	100	200	0	100	200	0	100	17.8%	58.8%	23.5%
Scenario 8	200	100	200	0	150	200	0	150	16.6%	59.6%	23.8%
Scenario 9	200	150	200	10	100	200	5	100	43.4%	40.3%	16.3%
Scenario 10	200	150	200	0	100	200	0	100	36.4%	45.4%	18.1%
Scenario 13	200	150	200	50	100	200	30	100	72.5%	20.8%	6.6%
Scenario 14	200	100	200	50	100	200	30	100	60.9%	29.7%	9.5%
Scenario 15	300	100	200	50	100	200	30	100	38.9%	46.4%	14.8%
Scenario 16	300	100	250	0	100	250	0	100	17.8%	58.8%	23.5%
Scenario 18	200	100	200	100	100	200	50	100	86.0%	9.7%	4.3%

* Prices in RMB.

Other scenarios provide interesting results. In fact, market share changes are larger when the total cost of PP + SC_HD or PP + SC_CP are equal, but SC impact is stronger on market share. Scenario 18 is an extreme case when service cost is approximately half of PP in HD and $\frac{1}{4}$ of CP. In this case, the in-store market share increases to 86%. Lower but still significant increases occur in Scenarios 13 and 14, having a PR increase up to 150% compared to the Base scenario and higher SC for the online alternatives, respectively.

Interestingly, despite the market share reduction, HD is always preferred to CP in these three cases, the SC increase being more relevant.

On the contrary IS is losing appeal (a little less than −50%) when HD or CP services are free (Scenarios 5 and 8), even if the PR (5) or PP (8) have not changed compared to the IS option.

Customers seem more sensitive to PR than to PP or SC (Scenario 9 or 10) and less sensitive to PP than SC increases (15 or 16).

6.2. Implications for Grocery Retailers

Since pricing strategies obviously affect sales and market shares, it is crucial to understand whether it is better to charge shipping costs explicitly or to include them in the general product cost [35]. Partitioned price, i.e., total price separated into PP and SC, can make customers believe they know the cost structure of the retailer and thus motivate them to purchase, albeit their perception is barely right.

On the contrary, following the simulation results above, the e-grocery market share would increase if the delivery is provided for free. Actually, consumers are more sensitive to SC than to PP (even if they are both costs expressed by the same unit of measure); since e-grocery is associated with feelings of uncertainty, they may be skeptical about the payment of an extra shipping costs (*ibidem*) and more willing to buy online with a "free shipping offer".

A successful pricing strategy could propose a free SC, while at the same time, whenever possible due to disintermediation savings, decrease the net PP, thus attracting more customers toward the e-grocery channel. This would, in turn, reduce the number of physi-

cal stores for densely populated areas. Concerning PP, in China, online and in-store prices are currently the same.

Another strategy could be to differentiate SC by basket size (with reductions proportional to the value of the grocery shopping or to the number of items) or by TW (with reductions associated to off-peak delivery TWs or to larger ones) or by customer characteristics in terms of their grocery-shopping habits. This latter strategy, which can result in offering free SC for a given period of time to "new" or "first time" customers who are probably more skeptical about product freshness and quality, is in line with those affirming that these customers might be more responsive to a given marketing effort [36]. One can also differentiate messages emphasizing grocery quality and transaction safety in order to minimize new customers' skepticism.

Grocery retailers could also differentiate SC based on demographics, offering reductions to the elderly or to people with reduced mobility. Moreover, they could develop personalized marketing strategies based on gender, for example, targeting males who seem more willing to buy online than females. Actually, according to the survey results, males are usually those who buy groceries for the household, they do not mind the travel time while they are more annoyed at the queue and crowd in the store. Therefore, one should produce a stronger marketing effort with a focus on a specific segment to stimulate their interest and satisfy their preferences.

Last but not least, as family income range might influence attitudes toward e-grocery, retailers might provide personalized delivery services, associated with special gourmet items for high-income families or to convenience food for single salary families.

Finally, as regards the organization, e-grocery retailers can consider a collaborative strategy in order to improve efficiency and reduce the overall cost in the supply chain.

In Shanghai, different e-grocery retailers share resources and capacities by cooperating in the last mile delivery, thus reducing emissions and costs. Coordination issues represent the main concern of last mile delivery cooperation. In China, large third-party carriers developed very fast and covered most market shares [37]. Third-party carrier is the actual contact between customers and retailers and this implies a reduced brand recognition/fidelity for retailers, who could take advantage of a stronger cooperation with carriers.

6.3. Implications on Urban Freight Transport

The model results suggest an *a priori* preference for HD compared to the other options considered among respondents in Shanghai. The increasing HD trend could affect urban freight logistics, as grocery shopping is the most frequent shopping activity.

Assuming one performs dedicated and motorized grocery-shopping trips, developing home deliveries, instead, would prove beneficial from an environmental perspective, given the higher efficiency of logistic service providers in comparison to single agents doing the grocery shoppng. However, HD is also the most problematic option. The HD challenge depends on cost control, logistic planning and last mile delivery. Delivery to customers increases shipment fragmentation in the "last mile" [38].

It is thus worth discussing some transport implications below.

First, it is worth noticing that information technologies help increase both delivery effectiveness and customer satisfaction, on one side, but also efficiency and cost reduction for retailers and couriers, on the other side. Indeed, customers might experience delivery failure or delays, or need to wait at home (unless they can use a reception service). Unlike other types of goods, groceries are typically perishable and this heightens the costs retailers incur for a failed delivery. Real-time information sharing between customers and carriers increases logistic performance effectiveness and service quality, while reducing overall costs. In fact, logistic providers can improve their transport planning process and execution. At the same time, real-time grocery order-tracking minimizes customers' waiting times at home and allows greater flexibility.

Second, Intelligent Transportations System (ITSs) in e-grocery delivery systems can improve road capacity utilization, save on labor costs, improve road safety and reduce pollution [39], providing logistic operators with information on congestion, accidents and consequent delays in urban areas.

Third, as the environmental engagement among customers increases, new engine technologies might also contribute to improve home delivery planning and performance. EVs, hybrid and Fuel Cell Electric Vehicles (FCEVs) can dramatically lower noise and air pollution, as well as low-emission autonomous vehicles, which can also help to save on labor costs. Nevertheless, autonomous vehicles are not mature for market deployment yet, while battery duration and recharging times are still the main constraints when dealing with EVs. Therefore, e-grocery retailers need to consider many trade-offs before deciding whether to deploy new technologies.

Fourth, concerning an e-grocery alternative in terms of delivery, pick-up points optimize delivery routine and vehicle utilization degree; moreover, deliveries can be at night, when traffic is low. Therefore, this solution can be economically and environmentally beneficial and reduce time pressure by relinquishing the need of direct contact between courier and customer. Nevertheless, for fresh grocery products, the pick-up point must meet special storage conditions and regulations.

To sum it up, the diffusion of e-grocery might provoke a volume change in grocery freight transport with relevant implications for the urban environment. Thus, local governments might adopt transport policies aimed at reducing the negative external impact. For example, they could require special freight vehicle requirements (e.g., EVs) and set speed limits to improve energy efficiency in transport.

Authorities can subsidise fuel-efficient engines as well as smart and lightweight vehicles while also offering eco-driving courses. An incentive to reduce CO_2 emissions might derive from the promotion of alternative energy use such as biofuels or electricity. The Shanghai Fuel Cell Vehicle Development Plan released in September 2017 aimed at operating 3000 hydrogen fuel cell vehicles by 2020 and building 5–10 hydrogen refuelling facilities [40].

7. Conclusions

E-grocery has developed very fast in China, calling attention to what drives China households' demand of this grocery-purchasing channel and the implications in terms of market share and transport.

This paper used SPs and discrete choice modelling, finding out that China's current favorite mode for purchasing grocery is HD (around 50%). The study provided robust estimates of the potential demand for e-grocery in China, also exploring the factors driving consumers toward online shopping channels, preconizing the Chinese online grocery market trend and its changes. The results can provide suggestions to both grocery retailers and public policy makers, based on the several implications that can be learned from the Chinese experience.

According to the results, product price, service cost, and product range are the main factors affecting consumers' channel choices for grocery shopping. Results also suggested that travel time, lead time and time window do not have a significant impact for e-groceries. Since Chinese grocery products are less perishable, most residents can get their goods via online channels, thus increasing the e-grocery market in China. The WTP calculated for the whole sample and for specific subgroups showed that consumers in China are not willing to pay high service cost (SC); thus, free delivery service, together with higher product cost, will instead significantly further promote e-grocery.

With the current market conditions, in-store shopping is less popular than e-grocery in China, while HD is the most used e-grocery delivery mode. The findings of this study estimated that the e-grocery market share could be increased by adopting some managerial policies.

For example, a dynamic pricing strategy, offering free SC for e-grocery consumers, can increase HD and CP. Furthermore, preliminary investigation into different subsamples showed that for both males and females, whatever the previous e-grocery experience and the household income level, customized marketing strategies should be adopted.

In conclusion, the e-grocery market share will grow significantly if the overall price and service quality are improved. Understanding the potential demand is also relevant to public policy makers, who may provide tax support to reduce e-grocery PP and implement free SC policy.

The growing popularity of e-grocery will surely impact urban freight distribution, in terms of the introduction of information technologies, innovative vehicles, pick-up points or stations. Logistics operators are suggested to pursue last mile delivery horizontal integration and consolidation in order to be more efficient and improve resources allocation. Finally, concerning environmental measures, authorities willing to achieve a more sustainable urban mobility might apply policies to control emissions from freight transport, such as improving technologies and incentivizing EVs for freight delivery fleets. To this aim, many Sustainable Urban Mobility Plans (SUMPs) successfully include a section on logistics, dealing with the current e-commerce challenges.

As for the limitations of this study, when modelling the consumer channel choice for further comparison purpose, this study referred to generic channel attributes from previous research, without any focus on social, psychological and situational factors. In particular, econometric findings have shown that some attributes are not so relevant in China. Second, interviewees were not randomly chosen and the total database was also very limited, compared to the huge population of China. Although conducted in its biggest city, this survey could not represent the overall situation in China.

The literature on e-grocery being still in its infancy, while e-grocery is thriving, further research can focus on integration in last mile delivery and public policy dealing with tax reduction and emission compensation specifically on grocery delivery.

Furthermore, similar surveys should be carried out in different countries, in order to conduct a comparative study, both investigating the differences and searching for opportunities throughout the differences.

Last but not least, although this study did not consider interaction effects among attributes, it is also reasonable to design specific attributes from different countries. Therefore, a more sophisticated model can explore how these interaction effects influence consumer preferences and why countries' attributes are different towards grocery-shopping channel choice.

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