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An Empirical Study of the Online Demand for Imports in China — A Product Analysis for International Trade

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Abstract

Considering the further opening of China's economy and the growth of the people's income, there is a lot of room of growth of demand for imports. This paper is an attempt to identify the demand of different types of imported products in China, which could be the guideline for the international trade for these trading corporations to maximize their profits. GRA and Fuzzy TOPSIS are employed to evaluate the demand of different types of imported products. The managerial implications are also discussed in this paper.

Keywords: *Online demand for imports, International trade, Fuzzy TOPSIS, GRA*

1. Introduction

For the past several years, e-commerce has changed the way of business transaction for its convenience of ordering and paying for the products online and have them delivered to the doorstep. According to a report by the China Internet Network Information Center (CNNIC, 2013), there are 242 million Internet users engaging in e-commerce activities in China, and the e-commerce market racked up a whopping 190 billion USD worth of transactions in 2012, an increase of 66.5 percents than 2011. According to the forecast of Ystats (2013), it is expected to grow by more than 30 percent annually between 2013 and 2016.

In the long run, considering the further opening of China' s economy and the growth of the people's income, there must be a lot of room of growth of the demand for imports, which has been proved by the online sales data of the e-commerce websites. For instance, the average sales volumes is eighty thousand boxes of imported milk (one liter per box) in tmall online supermarket, which is the largest B2C e-commerce website in China. However, not all the foreign products are very popular in China, it is necessary to identify the demand of different types of imported products, which could be the guideline for the international trade for these trading corporations to maximize their profits.

This paper is an attempt to identify the online demand for imports in China based on the products analysis. The paper is organized as follows. The next section introduces the related literature about online demand and the behavior of online consumers. Following is a brief introduction about the GRA (Grey Relational Analysis) and fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method used in this research. Section 4 describes the data analysis of different types of the imported products in China to identify the products that suitable for import. Finally, the online demand for import in China are identified and discussed along with the related managerial implications of international trade for the trading corporations.

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2. Literature Review

There is not a widely accepted definition for e-commerce, which is generally classified as B2B, B2C, C2C and C2B e-commerce (Madu & Madu, 2002). Vijayaraman and Bhatia (2002) define e-commerce as a process to buy and sell products through computerized business transaction. According to this definition, buying food from a vending machine with a smart card can be seen as e-commerce (Turban *et al.*, 2002). In this paper, online consumers are restricted to those who buy products via internet websites.

The consumer online behavior is studied by many researches. Szymanski and Hise (2000) study more than a thousand online consumers and find perception of convenience is the most important factor in terms of e-satisfaction assessments. This conclusion has been supported by the research of Corbett (2001), indicating convenience and time saving factors are the primary motivators of the online consumers. A research by Park (2002) puts forward a model of consumer buying intention online which includes five main factors that influence online purchase: product type, product interest, shopping orientation, experience of online buying and website trust. Laforet and Chen (2012) examine Chinese and British consumers' evaluations of Chinese, and international brands, and factors affecting the brand choice. Mathwick (2002) study more than 800 shoppers, and argues that consumers enter into online purchasing because they expect to receive positive value from their online participation. Sindhav and Balazs (1999) propose a conceptual model for on-line retailing, including three factors (the company, the environment, and the perceived consumer benefits) affect the growth of e-commerce. Grunert and Ramus (2005) review literature on factors that may have an impact on consumers' probability to buy food over the internet, and suggest a modified model that delineates five groups of factor affecting perceived consumer benefits (Figure 1).

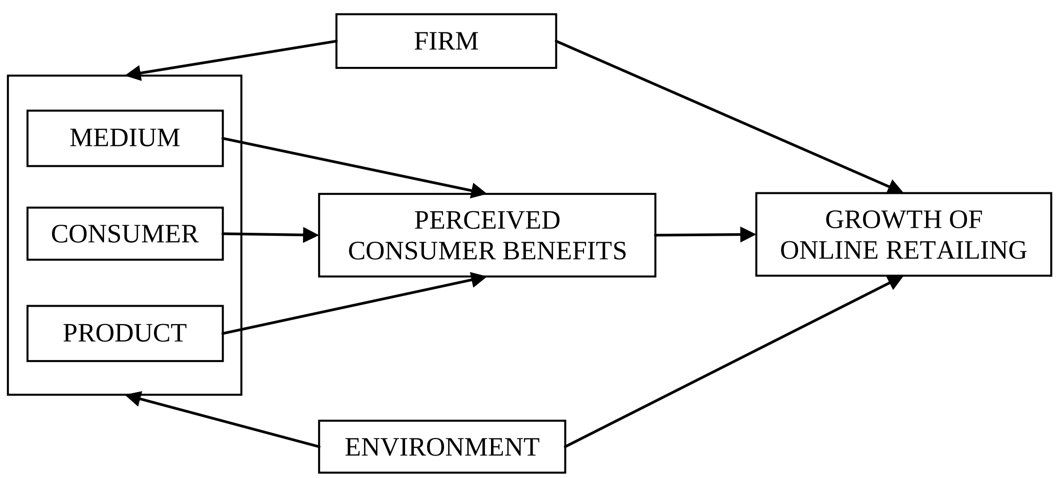

Figure 1. A Conceptual model for online retailing

Truett and Truett (1997) apply a translog cost function to investigate Korea' demand for imports and the effects of trade liberalization on the demand for the country's domestic inputs, and their study suggest that the domestic inputs and imports are substitutes and that as the proportion of investment goods in Korea's GDP increase, the demand for imports will also increase. Truett and Truett (2002) also investigate some of the issues that face the Italian economy as the internationalization of Europe continues by examining Italy's demand for imports in the context of a translog cost function. The conventional specification for the import demand function reveals that the volume of imports demanded responds to domestic activity and relative price. Tang (2002) analyzes the long-run relationship of China's aggregate import demand function for the period 1970-1999, and the empirical results indicate domestic activity and relative prices are inelastic in the long-run.

The TOPSIS method selected for the data analysis purposes in this research was first proposed in 1981 (Hwang and Yoon, 1981), and it is employed to solve the related multiple criteria decision-making (MCDM) problems under the fuzzy environment (Ataei, *et al.*, 2008; Muralidhar et al., 2013; Zeki and Rifat, 2012). Many proposed numerical examples have shown that the TOPSIS method can avoid some weaknesses of the existing multi-attribute methods (Byun and Lee, 2005; Deng, 2006; Ecer, 2007). Fuzzy TOPSIS is employed to solve the multi-criteria decision-making problems under fuzzy environment (Muralidhar *et al.*, 2013; Ataei, *et al.*, 2008; Zeki and Rifat, 2012).

In summary, there have been limited researches in the current literature focusing on the online demand for imports in China based on the products analysis, which is the primary motivation of this research.

3. Methodology

3.1. Fuzzy sets and fuzzy numbers

First, it is necessary to review the related Fuzzy Theory:

Definition 1: A Fuzzy set $\tilde{a}$ in a universe of discourse X is characterized by a membership function $\mu_{\tilde{a}}(x)$ which associates with each element x in X , a real number in the interval [0, 1]. The function of $\mu_{\tilde{a}}(x)$ is termed the grade of membership of x in $\tilde{a}$. The present study uses triangular Fuzzy numbers. $\tilde{a}$ can be defined by a triplet (a_1, a_2, a_3) . Its conceptual schema and mathematical form are shown as below:

$$\mu_{\tilde{a}}(x)\begin{cases} 0 & x \le a \\ \dfrac{x-a_1}{a_2-a_1} & a_1 \prec x \le a_2 \\ \dfrac{a_3-x}{a_3\text{-}a_2} & a_2 \prec x \le a_3 \\ 1 & x \succ a_3 \end{cases}$$

Definition 2: Let $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b} = (b_1, b_2, b_3)$ be two triangular fuzzy numbers. A distance measure function ($\tilde{a}$, $\tilde{b}$) can be defined as below:

$$d(\tilde{a},\tilde{b}) = \sqrt{\frac{1}{3}[(a_1-b_1)^2+(a_2-b_2)^2+(a_3-b_3)^2]}$$

Definition 3: Let a triangular Fuzzy number $\tilde{a}$, then α -cut defined as below:

$$\tilde{a}_\alpha = [(a_2-a_1)\alpha + a_1, a_3-(a_3-a_2)\alpha]$$

Definition 4: Let $\tilde{a} = (a_1, a_2, a_3)$, $\tilde{b} = (b_1, b_2, b_3)$ be two triangular Fuzzy number and $\tilde{a}_\alpha$, $\tilde{b}_\alpha$ be α -cut, $\tilde{a}$ and $\tilde{b}$, then the method is defined to calculate the divided between $\tilde{a}$ and $\tilde{b}$ as follows (Kwang, 2005):

$$\frac{\tilde{a}_\alpha}{\tilde{b}_\alpha} = [\frac{(a_2 - a_1)\alpha + a_1}{-(b_3 - b_2)\alpha + b_3}, \frac{-(a_3 - a_2)\alpha + a_3}{(b_2 - b_1)\alpha + b_1}]$$

When $\alpha = 0$,

$$\frac{\tilde{a}_0}{\tilde{b}_0} = [\frac{a_1}{b_3}, \frac{a_3}{b_1}]$$

When $\alpha = 1$

$$\frac{\tilde{a}_1}{\tilde{b}_1} = [\frac{(a_2 - a_1) + a_1}{-(b_3 - b_2) + b_3}, \frac{-(a_3 - a_2) + a_3}{(b_2 - b_1) + b_1}]$$

$$\frac{\tilde{a}_1}{\tilde{b}_1} = [\frac{a_2}{b_2}, \frac{a_2}{b_2}]$$

So the approximated value of $\tilde{a} / \tilde{b}$ will be

$$\frac{\tilde{a}}{\tilde{b}} = [\frac{a_1}{b_3}, \frac{a_2}{b_2}, \frac{a_3}{b_1}]$$

Definition 5: Assuming that both $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b} = (b_1, b_2, b_3)$ are real numbers, the distance measurement $d(\tilde{a}, \tilde{b})$ is identical to the Euclidean distance (Chen, 2000).

The basic operations on Fuzzy triangular numbers are as follows (Yang and Hung, 2007):

For approximation of multiplication: $\tilde{a} \otimes \tilde{b} = (a_1 \times b_1, a_2 \times b_2, a_3 \times b_3)$

For addition: $\tilde{a} \oplus \tilde{b} = (a_1 + b_1, a_2 + b_2, a_3 + b_3)$

3.2. GRA (Grey Relational Analysis)

Below is a briefly review of relevant definitions and the calculation procedure for the GRA approach.

GRA uses several small sub-problems to present the decision problem, and the problem is decomposed into a hierarchy with a goal at the top, criteria and sub-criteria at levels and sub-levels and decision alternatives at the bottom of the hierarchy.

The comparison matrix involves the comparison in pairs of the elements of constructed hierarchy. The aim is to set their relative priorities with respect to each of the elements at the next higher level.

$$D = \begin{matrix} & C_1 & C_2 & C_3 & \cdots & C_n \\ C_1 & x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ C_2 & x_{21} & x_{22} & x_{23} & \cdots & x_{2n} \\ C_3 & x_{31} & x_{32} & x_{33} & \cdots & x_{3n} \\ \vdots & \vdots & & & & \\ C_m & x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{matrix}$$

Where x_{ij} is the degree preference of i^{th} year over j^{th} criterion. Before the calculation of vector of priorities, the comparison matrix has to be normalized into the range of [0, 1] by the equation below:

The larger, the better type (Yang and Hung, 2007):

$$y_{ij} = \frac{\left[x_{ij} - \min\left\{x_{ij}\right\}\right]}{\left[\max\left\{x_{ij}\right\} - \min\left\{x_{ij}\right\}\right]}$$

The smaller, the better type:

$$y_{ij} = \frac{\left[\max\left\{x_{ij}\right\} - x_{ij}\right]}{\left[\max\left\{x_{ij}\right\} - \min\left\{x_{ij}\right\}\right]}$$

The normalized decision matrix is denoted by $Y = [y_{ij}]_{m \times n}$.

Assume Y is a factor set of grey correlation. Let $y_0(k)$ and $y_i(k)$ denote the initial criteria values of y_0 and y_i on company k respectively.

As average correlation value $r(y_0, y_i)$ of $\{r(y_0(k), y_i(k)) | k = 1, 2, ..., m\}$ is a real number, the value can be defined by grey correlation.

Let $r(y_0, y_i) = \frac{1}{m}\sum_{k=1}^{m} r(y_0(k), y_i(k)) = r_{0i}$,where

$$r(y_0(k), y_i(k)) = \frac{\min_i \min_k |y_0(k) - y_i(k)| + \rho \max_i \max_k |y_0(k) - y_i(k)|}{|y_0(k) - y_i(k)| + \rho \max_i \max_k |y_0(k) - y_i(k)|}$$, where ρ is the distinguished coefficient ($\rho \in [0,1]$).

Grey correlation matrix $R = (r_{ij})$ is derived by grey correlation analysis, where $i = 1, 2, ..., m$, $j = 1, 2, ..., n$. The definition of clustering financial ratios based on the entries of the grey correlation matrix is presented as follows.

Definition 3.1 As $r_{ij} \geq r$ and $r_{ji} \geq r$, Y_i and Y_j belong to the same cluster, where r is a threshold value of clustering.

Definition 3.2 When $r_{ij} \geq r$, $r_{ji} \geq r$, $r_{ik} \geq r$ and $r_{ki} \geq r$, but $r_{jk} < r$ or $r_{kj} < r$, if $min\{ r_{ij}, r_{ij} \} \geq min\{ r_{ki}, r_{ik} \}$, then Y_i , Y_j and Y_k belong to the same cluster.

As those indices can be partitioned into several clusters, the finding of representative indices of clusters is stated as follows.

Definition 3.3 As Y_i and Y_j belong to the one cluster, the representative index of the cluster is determined according to the maximum value of r_{ij} and r_{ji}. If $r_{ij} \geq r_{ji}$, the representative index of the cluster is financial ratio *i*.

Definition 3.4 As $Y_{i,}$ Y_j and Y_k are in the one cluster, the representative index of the cluster is decided according to the maximum value of $r_{ij} + r_{ik}$, $r_{ji} + r_{jk}$ and $r_{ki} + r_{kj}$. If $r_{ij} + r_{jk}$ is the maximum value, then the representative index of the cluster is financial ratio i.

3.3 Fuzzy membership function

In the evaluating process, the weights expressed with the linguistic terms, represent the important degrees of criteria from experts via surveys on subjective assessments. These linguistic terms are categorized into very low (VL), low (L), medium (M), high (H) and very high (VH). Assume that all linguistic terms can be transferred into triangular fuzzy numbers, and these fuzzy numbers are limited in [0, 1]. As a rule of thumb, each rank is assigned an evenly spread membership function that has an interval of 0.30 or 0.25.

Based on assumptions above, a transformation table can be found as shown in Table 1. Figure 2 illustrates the Fuzzy membership function (Yang and Hung, 2007).

Table 1. Transformation for Fuzzy Membership Functions

Rank	Sub-criteria grade	Membership function
Very Low (VL)	1	(0.00,0.10,0.25)
Low (L)	2	(0.15,0.30,0.45)
Medium (M)	3	(0.35,0.50,0.65)
High (H)	4	(0.55,0.70,0.85)
Very High (VH)	5	(0.75,0.90,1.00)

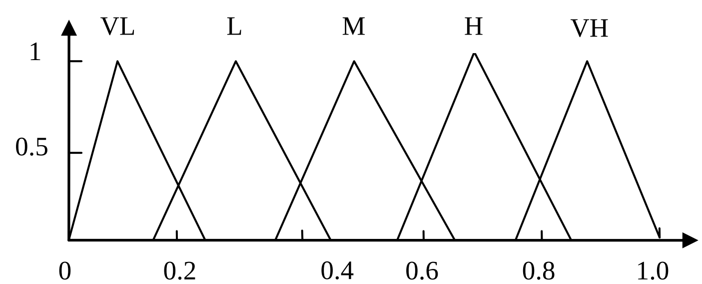

Figure 2. Fuzzy triangular membership functions

3.3. Fuzzy TOPSIS model

To describe the evaluation method clearly, the procedure of fuzzy TOPSIS is presented as below. It is formulated that a Fuzzy Multiple Criteria Decision Making (FMCDM) problem about the comparative evaluation of the websites of those laptop manufacturers. The FMCDM problem can be concisely expressed in matrix format as follows:

$$
\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_n \end{array}
\begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\
\begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \tilde{x}_{13} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \tilde{x}_{23} & \cdots & \tilde{x}_{2n} \\ \tilde{x}_{31} & \tilde{x}_{32} & \tilde{x}_{33} & \cdots & \tilde{x}_{3n} \\ \vdots & & & & \\ \tilde{x}_{n1} & \tilde{x}_{n1} & \tilde{x}_{n1} & \cdots & \tilde{x}_{n1} \end{bmatrix} \end{array}
$$

$$\tilde{W} = [\tilde{w}_1, \tilde{w}_2, \cdots \tilde{w}_n]$$

Where $x_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$ and $\tilde{w}_j, j = 1, 2, \cdots, n$ are linguistic triangular Fuzzy numbers, $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ and $\tilde{w}_j = (a_{j1}, b_{j2}, c_{j3})$. The normalized Fuzzy decision matrix is denoted by $\tilde{R} = [\tilde{r}_{ij}]_{m \times n}$.

The weighted Fuzzy normalized decision matrix is shown as follows:

$$
V = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \tilde{v}_{13} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \tilde{v}_{23} & \cdots & \tilde{v}_{2n} \\ \tilde{v}_{31} & \tilde{v}_{32} & \tilde{v}_{33} & \cdots & \tilde{v}_{3n} \\ \vdots & & & & \\ \tilde{v}_{n1} & \tilde{v}_{n1} & \tilde{v}_{n1} & \cdots & \tilde{v}_{n1} \end{bmatrix}
$$

$$
= \begin{bmatrix} \tilde{w}_1\tilde{r}_{11} & \tilde{w}_2\tilde{r}_{12} & \tilde{w}_3\tilde{r}_{13} & \cdots & \tilde{w}_n\tilde{r}_{1n} \\ \tilde{w}_1\tilde{r}_{21} & \tilde{w}_2\tilde{r}_{22} & \tilde{w}_3\tilde{r}_{23} & \cdots & \tilde{w}_n\tilde{r}_{2n} \\ \tilde{w}_1\tilde{r}_{31} & \tilde{w}_2\tilde{r}_{32} & \tilde{w}_3\tilde{r}_{33} & \cdots & \tilde{w}_n\tilde{r}_{3n} \\ \vdots & & & & \\ \tilde{w}_1\tilde{r}_{m1} & \tilde{w}_2\tilde{r}_{m2} & \tilde{w}_3\tilde{r}_{m3} & \cdots & \tilde{w}_n\tilde{r}_{mn} \end{bmatrix}
$$

Given the above Fuzzy theory, the proposed Fuzzy TOPSIS procedure is then defined as follows:

Step 1: choose the $x_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$ for alternatives with respect to criteria and $\tilde{w}_j, j = 1, 2, \cdots, n$ for the weight of the criteria.

Step 2: Construct the weighted normalized Fuzzy decision matrix V.

Step 3: Identify positive ideal (A^+) and negative ideal (A^-) solutions:

$$
\begin{aligned} A^+ &= \left\{ \tilde{v}_1^+, \tilde{v}_2^+, \cdots \tilde{v}_n^+ \right\} \\ &= \left\{ (\max_i \tilde{v}_{ij} \middle| i = 1, 2, \cdots, m), j = 1, 2, \cdots, n \right\}. \end{aligned}
$$

$$
\begin{aligned} A^- &= \left\{ \tilde{v}_1^-, \tilde{v}_2^-, \cdots \tilde{v}_n^- \right\} \\ &= \left\{ (\min_i \tilde{v}_{ij} \middle| i = 1, 2, \cdots, m), j = 1, 2, \cdots, n \right\}. \end{aligned}
$$

Considering that the elements $\tilde{v}_{ij}$ are normalized positive triangular fuzzy numbers and their ranges belong to the closed interval [0, 1], the positive ideal and negative ideal solutions can be defined as $\tilde{v}_j^+ = (1,1,1)$ and $\tilde{v}_j^- = (0,0,0)$, $j = 1,2,\cdots,n$ (Isiklar and Buyukozkan, 2006).

Step4: Calculate separation measures. The distance of each alternative from A^+ and A^- can be identified as follows:

$$d_i^+ = \frac{1}{n}\sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^+), i = 1,2,\cdots,m$$

$$d_i^- = \frac{1}{n}\sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-), i = 1,2,\cdots,m$$

Step 5: Calculate the similarities to ideal solution:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}$$

Step 6: Rank preference order. Rank alternatives according to CC_i in descending order (Yang and Hung, 2007).

4. Data Collection and Results Analysis

The classification of the imported products is based on the website of Amazon, as shown in Table 2:

Table 2. The classification of the imported products

No.	Category	Detailed Category
A_1	Books	Books; Kindle Books ; Children's Books; Textbooks ; Audiobooks ; Magazines
A_2	Electronic & Computers	TV & Video Home Audio & Theater; Camera, Photo & Video ; Cell Phones & Accessories; Video Games; MP3 Players & Accessories; Car Electronics & GPS ; Appliances; Musical Instruments ; Electronics Accessories; Laptops & Tablets; Desktops & Monitors ;Computer Accessories & Peripherals; Computer Parts & Components; Software; PC Games; Printers & Ink; Office & School Supplies;
A_3	Home, Garden & Tools	Kitchen & Dining ; Furniture & Décor ; Bedding & Bath Appliances; Patio, Lawn & Garden; Arts, Crafts & Sewing; Pet Supplies; Home Improvement; Power & Hand Tools; Lamps & Light Fixtures; Kitchen & Bath Fixtures; Hardware; Home Automation
A_4	Grocery & Food	Grocery & Gourmet Food Wine
A_5	Health & Beauty	Natural & Organic Health & Personal Care Beauty
A_6	Toys, Kids & Baby	Toys & Games; Baby; Kids' Clothing; Baby Clothing; Video Games for Kids; Baby Registry
A_7	Clothing, Shoes & Jewelry	Clothing; Shoes; Handbags; Accessories; Luggage; Jewelry Watches

A_8	Sports & Outdoors	Exercise & Fitness; Outdoor Recreation; Hunting & Fishing Cycling; Athletic & Outdoor Clothing; Boating & Water Sports Team Sports; Fan Shop; Sports Collectibles; Golf
A_9	Automotive & Industrial	Automotive Parts & Accessories; Automotive Tools & Equipment; Car Electronics & GPS; Tires & Wheels; Motorcycle & Powersports; Industrial Supplies; Lab & Scientific; Safety

The specific original measures are listed and named in Table 3. The conceptual model for Grunert and Ramus (2005) is adopted by this research which including the perceived consumer benefits, environment and firm. The decision problem consists of three levels: at the highest level, the objective of the problem is situated while in the second level, the criteria are listed, and in the third level, the sub-criteria are listed. Some of the data are collected from the tmall website, while the others are derived from the rater who is asked to make an appropriate rating, and the selected items from all websites are rated with the widely used Little Scale, *i.e.*, from a scale of 1 (being the worst or little effect) to 5 (meaning excellent or great effect) accordingly.

Table 3. The original measures of evaluating demand for imports in China

Goal	Aspects	Criteria
Demand for imports in China	C_1 Perceived Consumer Benefits	TSC_1 Quality TSC_2 Selectivity of similar products TSC_3 Wide variety of products TSC_4 Popularity TSC_5 Cost Performance TSC_6 Quantity Demand
	C_2 Environment	TSC_7 Average Income TSC_8 Environment Pollution TSC_9 RMB exchange rate TSC_{10} Import Duty TSC_{11} Security
	C_3 Firm	TSC_{12} Loyalty programs TSC_{13} Benefits to consumers TSC_{14} Brand Awareness TSC_{15} Efficient logistic systems

As shown in Table 3, there are fifteen original measures, so GRA is employed for the representative selection. Grey Correlation matrix is derived from the DPS 9.0 (software which can determine the grey correlation matrix) as below (He & Zhai, 2009):

$$R_{c1} = \begin{bmatrix} 1.0000 & 0.4073 & 0.3911 & 0.3556 & 0.6023 & 0.3926 \\ 0.3944 & 1.0000 & 0.5204 & 0.3644 & 0.5104 & 0.3329 \\ 0.3732 & 0.4645 & 1.0000 & 0.4144 & 0.5054 & 0.5118 \\ 0.3702 & 0.3662 & 0.4329 & 1.0000 & 0.3602 & 0.4421 \\ 0.6172 & 0.4772 & 0.5310 & 0.3828 & 1.0000 & 0.2805 \\ 0.3926 & 0.3436 & 0.5058 & 0.4248 & 0.3016 & 1.000 \end{bmatrix}$$

$$R_{c2} = \begin{bmatrix} 1.0000 & 0.2513 & 0.3448 & 0.3943 & 0.4957 \\ 0.2943 & 1.0000 & 0.1746 & 0.4467 & 0.2638 \\ 0.4022 & 0.1690 & 1.0000 & 0.2625 & 0.3531 \\ 0.4521 & 0.4273 & 0.2604 & 1.0000 & 0.4058 \\ 0.5048 & 0.2077 & 0.3202 & 0.3305 & 1.0000 \end{bmatrix}$$

$$R_{c3} = \begin{bmatrix} 1.000 & 0.5929 & 0.4780 & 0.4740 \\ 0.5239 & 1.0000 & 0.4200 & 0.4090 \\ 0.3857 & 0.3665 & 1.0000 & 0.46463 \\ 0.5185 & 0.4286 & 0.5077 & 1.0000 \end{bmatrix}$$

In matrix Rc_1, The value of r_{51} is 0.6172, which implies a relatively strong relationship between TSC_1 and TSC_5, while the value of r_{41} is 0.3556, implying the relationship of TSC_1 and TSC_4 is relatively weak. According to the above matrices and the definitions described earlier, the measures can be grouped into several clusters by threshold value r = 0.55. The classification result is shown in Table 4, and the final measures of evaluating demand for imports in China are identified as shown in Table 5.

Table 4. The classification of the representative measures

Criteria	Measures with each cluster	Representative measures
C_1 Perceived Consumer Benefits	TSC_1 , TSC_5	TSC_5
	TSC_2	TSC_2
	TSC_3	TSC_3
	TSC_4	TSC_4
	TSC_6	TSC_6
C_2 Environment	TSC_7	TSC_7
	TSC_8	TSC_8
	TSC_9	TSC_9
	TSC_{10}	TSC_{10}
	TSC_{11}	TSC_{11}
C_3 Firm	TSC_{12} , TSC_{13}	TSC_{12}
	TSC_{14}	TSC_{14}
	TSC_{15}	TSC_{15}

Table 5. The final measures of evaluating demand for imports in China

Goal	Aspects	Criteria
Demand for imports in China	C_1 Perceived Consumer Benefits	SC_1 Cost Performance SC_2 Selectivity of similar products SC_3Wide variety of products SC_4 Popularity SC_5Quantity Demand
	C_2 Environment	SC_6 Average Income SC_7 Environment Pollution SC_8RMB exchange rate SC_9 Import Duty SC_{10}Security

	C_3 Firm	SC_{11}Loyalty programs SC_{12}Brand Awareness SC_{13}Efficient logistic systems

The important degrees of the above sub-criteria weights are given with linguistic terms, *i.e.*, VL, L, M, H, and VH, employed by five experts E_1, E_2, E_3, E_4, and E_5, as shown in Table 6.

Table 6. The linguistic weights given by five experts

Criteria	Sub- Criteria	E_1	E_2	E_3	E_4	E_5
C_1 Perceived Consumer Benefits	SC_1	VH	H	VH	VH	VH
	SC_2	H	H	H	H	M
	SC_3	H	M	M	H	H
	SC_4	VH	VH	VH	VH	H
	SC_5	VH	VH	H	H	H
C_2 Environment	SC_6	H	M	H	H	M
	SC_7	L	H	M	H	H
	SC_8	M	L	M	L	M
	SC_9	M	H	M	M	M
	SC_{10}	M	H	H	M	M
C_3 Firm	SC_{11}	M	L	H	M	H
	SC_{12}	H	VH	VH	M	H
	SC_{13}	H	VH	H	H	M

In the next step, we calculate the average of the elements of each row, then the average criteria weights are derived as follows: $W_1=(0.71,0.86,0.97)$, $W_2=(0.51,0.66,0.81)$, $W_3=(0.47,0.62,0.77)$, $W_4=(0.71,0.86,0.97)$, $W_5=(0.63,0.78,0.91)$, $W_6=(0.47,0.62,0.77)$, $W_7=(0.43,0.58,0.73)$, $W_8=(0.27,0.42,0.57)$, $W_9=(0.39,0.54,0.69)$, $W_{10}=(0.43,0.58,0.73)$, $W_{11}=(0.39,0.54,0.69)$, $W_{12}=(0.59,0.74,0.87)$, $W_{13}=(0.55,0.70,0.84)$.

In order to identify the demand for imports in China, the TOPSIS, as a quantitative tool, is employed in this research. The normalized decision matrix is shown in Table 7.

Table 7. Normalized decision matrix for TOPSIS analysis

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6	SC_7	SC_8	SC_9	SC_{10}	SC_{11}	SC_{12}	SC_{13}
A_1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00
A_2	1.00	1.00	1.00	1.00	0.50	1.00	0.75	1.00	0.75	0.50	0.25	1.00	1.00
A_3	0.33	0.50	1.00	0.50	0.50	0.67	0.75	0.00	0.75	0.50	0.25	0.50	0.50
A_4	0.67	0.75	1.00	0.75	1.00	1.00	0.00	0.50	1.00	1.00	0.75	0.50	1.00
A_5	1.00	1.00	1.00	1.00	0.50	1.00	0.00	1.00	0.00	0.75	0.75	1.00	1.00
A_6	1.00	1.00	1.00	0.75	1.00	1.00	0.00	0.50	0.75	1.00	0.50	0.75	1.00
A_7	0.33	1.00	1.00	0.75	0.00	0.67	0.75	0.00	0.75	0.25	0.50	0.50	1.00
A_8	0.00	1.00	0.75	0.50	0.00	0.33	1.00	0.00	0.75	0.75	0.25	0.25	0.00
A_9	0.67	0.75	1.00	1.00	0.50	1.00	1.00	1.00	0.75	1.00	1.00	0.75	0.00

In the next step, the Fuzzy membership function discussed in Section 3.3 is applied to transform Table 7 into Table 8 as explained by the following example. If the numeric rating is 0.46, then its Fuzzy linguistic variable is "M" (Isiklar and Buyukozkan, 2006). Therefore, the new pairwise comparison matrix is shown in Table 8:

Table 8. Normalized decision matrix using Fuzzy linguistic variables

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6	SC_7	SC_8	SC_9	SC_{10}	SC_{11}	SC_{12}	SC_{13}
A_1	VL	VL	VL	VL	VL	VL	VH	VL	VH	VL	VL	VL	VL
A_2	VH	VH	VH	VH	M	VH	H	VH	H	M	L	VH	VH
A_3	L	M	VH	M	M	H	H	VL	H	M	L	M	M
A_4	H	H	VH	H	VH	VH	VL	M	VH	VH	H	M	VH
A_5	VH	VH	VH	VH	M	VH	VL	VH	VL	H	H	VH	VH
A_6	VH	VH	VH	H	VH	VH	VL	M	H	VH	M	H	VH
A_7	L	VH	VH	H	VL	H	H	VL	H	L	M	M	VH
A_8	VL	VH	H	M	VL	L	VH	VL	H	H	L	L	VL
A_9	H	H	VH	VH	M	VH	VH	VH	H	VH	VH	H	VL

The fuzzy linguist variables of the above matrix are then transformed into a Fuzzy triangular membership function, as shown in Table 9:

Table 9. Part of the fuzzy decision matrix

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)
A_2	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.75,0.90,1.00)
A_3	(0.15,0.30,0.45)	(0.35,0.50,0.65)	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.35,0.50,0.65)	(0.55,0.70,0.85)
A_4	(0.55,0.70,0.85)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.75,0.90,1.00)
A_5	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.75,0.90,1.00)
A_6	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.75,0.90,1.00)
A_7	(0.15,0.30,0.45)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.00,0.10,0.25)	(0.55,0.70,0.85)
A_8	(0.00,0.10,0.25)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.35,0.50,0.65)	(0.00,0.10,0.25)	(0.15,0.30,0.45)
A_9	(0.55,0.70,0.85)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.75,0.90,1.00)
W	(0.71,0.86,0.97)	(0.51,0.66,0.81)	(0.47,0.62,0.77)	(0.71,0.86,0.97)	(0.63,0.78,0.91)	(0.47,0.62,0.77)

Following the resulting Fuzzy weighted decision matrix can be derived based on Table 9 and the weights identified before, as shown in Table 10.

Table 10. Part of the fuzzy weighted decision matrix

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	(0.00,0.09,0.24)	(0.00,0.07,0.20)	(0.00,0.06,0.19)	(0.00,0.09,0.24)	(0.00,0.08,0.23)	(0.00,0.06,0.19)
A_2	(0.53,0.77,0.97)	(0.38,0.59,0.81)	(0.35,0.56,0.77)	(0.53,0.77,0.97)	(0.22,0.39,0.59)	(0.35,0.56,0.77)
A_3	(0.11,0.26,0.44)	(0.18,0.33,0.53)	(0.35,0.56,0.77)	(0.25,0.43,0.63)	(0.22,0.39,0.59)	(0.26,0.43,0.65)
A_4	(0.39,0.60,0.82)	(0.28,0.46,0.69)	(0.35,0.56,0.77)	(0.39,0.60,0.82)	(0.47,0.70,0.91)	(0.35,0.56,0.77)
A_5	(0.53,0.77,0.97)	(0.38,0.59,0.81)	(0.35,0.56,0.77)	(0.53,0.77,0.97)	(0.22,0.39,0.59)	(0.35,0.56,0.77)
A_6	(0.53,0.77,0.97)	(0.38,0.59,0.81)	(0.35,0.56,0.77)	(0.39,0.60,0.82)	(0.47,0.70,0.91)	(0.35,0.56,0.77)
A_7	(0.11,0.26,0.44)	(0.38,0.59,0.81)	(0.35,0.56,0.77)	(0.39,0.60,0.82)	(0.00,0.08,0.23)	(0.26,0.43,0.65)
A_8	(0.00,0.09,0.24)	(0.38,0.59,0.81)	(0.26,0.43,0.65)	(0.25,0.43,0.63)	(0.00,0.08,0.23)	(0.07,0.19,0.35)
A_9	(0.39,0.60,0.82)	(0.28,0.46,0.69)	(0.35,0.56,0.77)	(0.53,0.77,0.97)	(0.22,0.39,0.59)	(0.35,0.56,0.77)

The distance of each alternative from A^+ and A^-, as well as the similarities to an ideal solution, is obtained in Table 11.

Table 11. The distance of each alternative from A^+ and A^-

No.	Category	d_i^+	d_i^-	CC_i
A_1	Books	0.440	0.068	0.133
A_2	Electronic & Computers	0.080	0.428	0.843
A_3	Home, Garden & Tools	0.239	0.269	0.530
A_4	Grocery & Food	0.109	0.398	0.785
A_5	Health & Beauty	0.106	0.402	0.791
A_6	Toys, Kids & Baby	0.093	0.415	0.817
A_7	Clothing, Shoes & Jewelry	0.210	0.298	0.587
A_8	Sports & Outdoors	0.298	0.209	0.412
A_9	Automotive & Industrial	0.103	0.405	0.797

In order to see the result more clearly, the resulting Fuzzy TOPSIS analysis is shown in Figure 3.

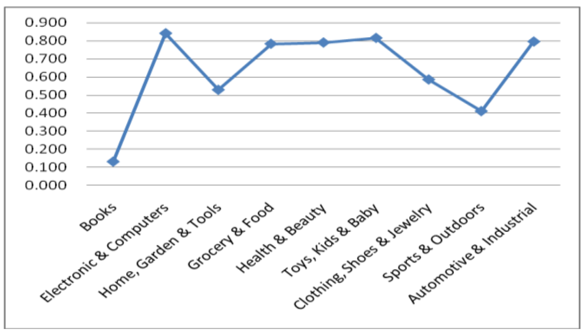

Figure 3. Summary of the evaluation of the demand of different types of imported products

5. Conclusions and Suggestions for Future Research

This research is focused on identify the demand of different types of imported products, which could be the guideline for the international trade for these trading corporations to maximize their profits. GRA and Fuzzy TOPSIS are employed to evaluate the demand and the priority of different types of imported products in China. According to the criteria weights derived from this section earlier, the relative top four important measures to evaluate the demand and the priority of different types of imported products in China are (1) Cost Performance; (2) Popularity; (3) Quantity Demand; and (4) Brand Awareness. As such, the trading corporations should pay more attention to these measures when make the decision of the selection of the imported product. Based on the results of this research, the electronic & computers, grocery & food, health & beauty, automotive & industrial should be the priorities of the trading corporations in order to make more profits.

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