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**Article**

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## MARKETING | REVIEW ARTICLE

# Modeling consumer's behavior for packed vegetable in "Mayadin management organization of Tehran" using artificial neural network

Vali Borimnejad<sup>1\*</sup> and Roya Eshraghi Samani<sup>2</sup>

**Abstract:** The major factor in successful marketing and development strategies is a correct understanding of consumer behavior. Recognizing the consumer behavior is the key to market development. It is impossible to establish systematic relationship between producers and consumers while the consumer behavior is not recognized. Demand elasticities seem very important in decision-making processes and in causing different behavior of consumer in buying occasions. Producers, food processors, and retailers need to recognize consumer's behavior in forming the demand to plan well their production and selling, thus, demand elasticities are of crucial importance. The shortage of studies in the field of estimating demand and elasticity using artificial neural networks (ANN) among the economic issues was the most important motivation of this study. Parameters were estimated using the ANN that is widely used and is called multi-layer feed-forward neural network (MLFN). It is important to point out that among the input variables, some socio-demographic variables were included, it seems that beside the traditional economic variables some non-economic factors can affect the consumers' choices as well. In this paper the consumer's behavior in the "Mayadin Management Organization" of Tehran for vegetable crops, summer crops like potato, onion, tomato was modeled using the ANN and particularly the demand curve and the elasticities were estimated.

### ABOUT THE AUTHORS

My research activities focused on the agricultural marketing field. Also, my group's researches are in this field. I have written books and essays about agricultural marketing and related issues such as the behavior of producers and consumers of food and the food supply chain. This article is based on academic research plan in title "consumer's behavior in purchasing fresh produce from" Mayadin organization of Tehran using artificial neural networking." Mayadin is a distribution unit in Tehran which covers a wide range of customers and provides them with agricultural products. This unit has been constructed to decrease the transaction costs and to omit the dealers and mediators who try to increase the prices. In recent years, Mayadin has tried to supply organic and healthy products to the customers as well, that has been welcomed by so many customers.

### PUBLIC INTEREST STATEMENT

This article aims to model the consumer's behavior in purchasing of "Mayadin management organization of Tehran" using artificial neural network. The Mayadin is a distribution unit in Tehran which covers a wide range of customers to provide them with agricultural products. This unit has been constructed to decrease the transaction costs and to omit the dealers and mediators who try to increase the prices. In recent years, the Mayadin has tried to supply the organic and healthy products to the customers as well, that has been welcomed by so many customers. The proposed models of consumer's behavior will cause no adverse impact upon purchasing of Mayadin organization. The purchase will give the Mayadin a parent organization that is focused on both consumers and producers.

**Subjects: Business; Management and Accounting; Economics, Finance, Business & Industry; Marketing**

**Keywords: modeling; artificial neural network; demand; elasticity**

**JEL Codes: Q11; C14; C45**

### 1. Introduction

The “Mayadin management organization” of Tehran, having had 160 supply locations in all over the city and supplying 5% of fruits and vegetables, by the end of 2011 is the biggest concentrated market of agricultural products in Iran. The main function of this organization is to provide the facilities to shorten the marketing margins and consequently to support both the producer through accessing the market and the consumer through facilitating the access to food products.

In the present era, it is almost universally accepted, that the main purpose of marketing is not finding and persuading people to buy what a company produces, but satisfying the consumer which is the essence of consumer orientation (Mihart, 2012). In food industry, consumer choice behavior is driven by a number of complex lifestyle factors. These include not only convenience aspects, nutritional-and health-related motives, product sensory attributes and price, but also environmental and ethical aspects (von Meyer-Höfer, Olea Jaik, Padilla Bravo, & Spiller, 2013).

Consumer behavior is the study of the processes involved when individuals or groups select, purchase, use or dispose the products, services, ideas, or experiences to satisfy needs and desires (Solomon et al., 2006). Consumer behavior is a complex issue and rarely follows traditional economic theories of decision-making. When choosing what products to buy or what services to use, people often think they are making smart decisions and behaving in ways that are highly rational and congruent with their values and intentions. However, daily life illustrates that this is often not the case. People routinely deviate from the ‘rational choice’ model of human behavior, in which one objectively weighs up the costs and benefits of all alternatives before choosing the optimal course of action (Frederiks, Stenner, & Hobman, 2015).

Market segmentation is a process that requires identifying homogeneous groups of consumers described by a set of similar characteristics, in order to improve marketing activities through a better allocation of resources and formulation of customizable strategies. When target groups are a priori known, the problem becomes a classification task under a process of supervised learning. Increased interest in identifying new liquidity sources forces financial institutions to investigate new ways of detecting individuals with high propensity toward saving money (Badea, 2014).

In the agricultural industry, many consumers have been willing to purchase products that are labeled as locally grown or produced (Loureiro & Hine, 2001).

Neural networks are considered as the input-output models group which was created by cognitive scientists. These models can learn and retain the knowledge from sample’s information and are able to predict and forecast with no use of sample’s information. Neural networks belong to a certain group of nonlinear parametric methods. In neural network, “learning” is equal to the statistical estimation of model’s parameters in econometrics (Kuan & White, 1994). They are machine learning techniques which integrate a series of features upholding their use in financial and economic applications. Backed up by flexibility in dealing with various types of data and high accuracy in making predictions, these techniques bring substantial benefits to business activities (Badea, 2014). The interest of researchers of different fields in applying the neural network models in their studies, perhaps is linked to the nature of neural networks which is not confined by restrictive presumptions like linearity (which is often essential to classic mathematical models) (Moshiri & Norman, 2000). Although it is very popular, neural networks applications are different so that the individuals use

them in different ways. For example, statisticians use them as nonlinear regression and classification models or apply them as nonparametric models along with other conventional tools (White, 1989); engineers and other researchers use such models where they need nonlinear procedures in continuous data or simulating functions (Funahashi, 1989). In data mining analysis, neural networks are also used to find special patterns out of mass data as an information system or knowledge learning mechanisms and decision-making supportive systems (Bigus, 1996). Modeling data with artificial neural networks allows a flexible approach toward independent variables (Badea, 2014).

Artificial neural networks are a very simplified model of human neural network with the capacity of learning which are able to derive the characteristics by receiving input patterns and to attribute them to a certain category. Accordingly, during learning process, they memorize the patterns' characteristics and their category by adapting a series of weight coefficients. If the learning process is carried out in a correct way, they will be able to classify the patterns (Poulton, 2001).

The great advantage of neural network is its ability in modeling complex nonlinear relations, with no need of applying special hypothesis pertaining to variables' behavior; it acts like a black box (Karayiannis & Venetsanopoulos, 1993). Thus, given the high volume and the potential capacity of consumption markets among women, marketing managers need to evaluate their marketing strategy in order to make their products and services suited for women (Campbell, 2000).

Other stimuli are the basic forces and events in buyer environment. These forces are mainly economical, technological, political, and cultural. All of these stimuli enter the buyer's black box, where after going through some stages, they are transferred into observable responses of the buyer (Kotler, 2000).

Badea (2014) investigated how consumer behavior can be identified using ANN, based on information obtained from traditional surveys. Results highlight that neural networks have a good discriminatory power, generally providing better results compared with traditional discriminant analysis.

Chowdhury and Samuel (2014) studied the usefulness of neural network to explain the gap between behavior intention and actual behavior in the consumption of green products. ANN were used to analyze the data. The results showed that neural network provides inconclusive evidence for the intention behavior gap.

Kuruville, Joshi, and Shah (2009) in their paper entitled "Do men and women actually buy differently?" sought to discover shopping habits of Indian people and try to identify the possible differences between genders through examining 2,721 consumers of shopping centers of seven cities in India. The findings show that there is a significant difference among shopping behaviors that can be related to gender. Generally, women have a more positive attitude toward shopping centers and they buy more updated things than men. But men look more and pay more time and money for them.

Vallini, Ciampi, and Gordini (2009) used neural networks, multiple discriminant analysis, and logistic regression to predict the default event at SMEs on a sample of 6,113 Italian firms. Compared with the traditional MDA and logistic regression techniques which reached overall detection rates of 65.9% and 67.2%, respectively, ANNs with a correct classification rate of 68.4% generated better results.

Sae-Ueng, Pinyapong, Ogino, and Kato (2007) studied and observed the consumer behavior by collecting all kinds of consumers' actions and applying the ubiquitous environment which are RFID and camera sensors to gather log data which was analyzed using ANN. Neural network model allows us to categorize the consumers into three groups which are: (A) the consumers who were certain in buying a product, (B) the consumers who intended to buy a product but could not decide what to buy, and (C) the consumers who did not intend to buy but to view the product. The true power and advantage of neural networks lies in their ability to represent both linear and nonlinear. Traditional linear models are simply inadequate when it comes to modeling data that contains nonlinear characteristics.

Hruschka, Fettes, Probst, and Mies (2002) specified deterministic utility by means of a certain type of neural net for discovering nonlinear effects on brands' utilities and compared the performance of this model with different MNL models.

## 2. Methodology of research

The neural networks model is used to modeling consumer's behavior for packed vegetable in using the following inputs: gender ( $x_1$ ), age ( $x_2$ ), marital status ( $x_3$ ), education level ( $x_4$ ), geographic position ( $x_5$ ), economic status ( $x_6$ ), and price ( $x_7$ ). The model used in consumer's demand for packed vegetable in consumption is given in the following equation:

$$D = f(X) \quad (1)$$

where  $D$  is the demand of packed vegetable and  $X$  is the vector of inputs (Table 1).

The function of those factors is highly nonlinear and is difficult to represent explicitly, and hence forecasting the system accurately with traditional statistical methods is a rather complex problem. The neuron model is made up of a number of simple and highly interconnected processing elements, called neuron. Its mathematical model is expressed as follows:

$$O_j = f_j \left( \sum W_{jk} X_k \right) \quad (2)$$

where  $O_j$  is the output of neuron;  $f_j$  is a transfer function, which is differentiable and nondecreasing, usually represented using a sigmoid function;  $W_{jk}$  is an adjustable weight that represents the connection strength;  $X_k$  is the input of a neuron. Literature shows that the back propagation is the most commonly used technique in training the neural network. The process of determining the neural networks models depends on the structure of the network, the transfer function and the learning algorithm. Thus, using the back propagation technique, the MLP process is determined (a) using different combinations of number of hidden layers and nodes in a hidden layer, (b) using different transfer functions, and (c) learning algorithms that lead to select the best model architecture which leads to minimize the sum squared error (Ekonomou, 2010).

In this study, MATLAB 2011 software is used to estimate the MLFN function with logarithmic sigmoid activation function in the first and the second layers (two hidden layers). There are eight and three neurons on the first and the second hidden layers, respectively. Assuming that the purpose was modeling in order to estimate demand curve, the data was used solely in learning and test phases and there was no need of assessment phase.

## 3. Calculating the elasticity of demand

Given the definition, own price elasticity of demand for goods is the proportionate rate of change in demand quantity divided by the proportionate rate of change in its price, while the other item's price and income are constant (Henderson & Quandt, 1980). Classical methods of determining price elasticity and income elasticity need to be estimated through econometrics models. The relationship between price and consumption quantity are reciprocal, nonlinear, and asymmetric; therefore: (a) the models bearing more expectable characteristics including AIDS and Rotterdam models (Deaton & Muellbauer, 1980) and (b) alternative methods were developed for ANN which seems to be quite suitable to complex relations.

## 4. The data-set

The population includes the customers of three outdoor markets of "Tehran Fruits & Vegetable Management Organization." Required data were collected through questioning people above 18 years within 2 weeks. To estimate the sample size, the following formula was used according to the nature of society, type of investigation, and desired accuracy (Krejcie & Morgan, 1970):

$$S = \frac{X^2NP(1 - P)}{d^2(N - 1) + X^2P(1 - P)} \tag{3}$$

Regarding to approximate size of population of market customers (3,500 individual), the sample size would be 346, thus, we prepared 350 questionnaires in this study.

### 5. Results and discussion

Desired number of repetition was obtained through a presumed combination of different amounts of MSE and  $R^2$  indices in different structures of neural networks and they were compared (Table 2).

General regression of demand for foreign packed products (Equation (2)) has been illustrated in diagram 1 with respect to both conventional (price and income) and demographic variables.

Figure 1. General regression.

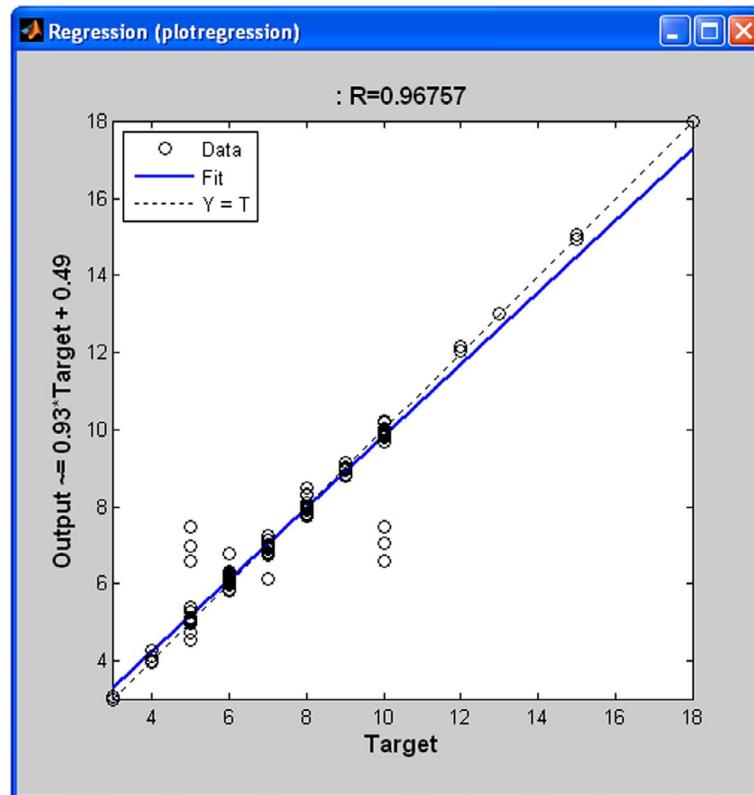
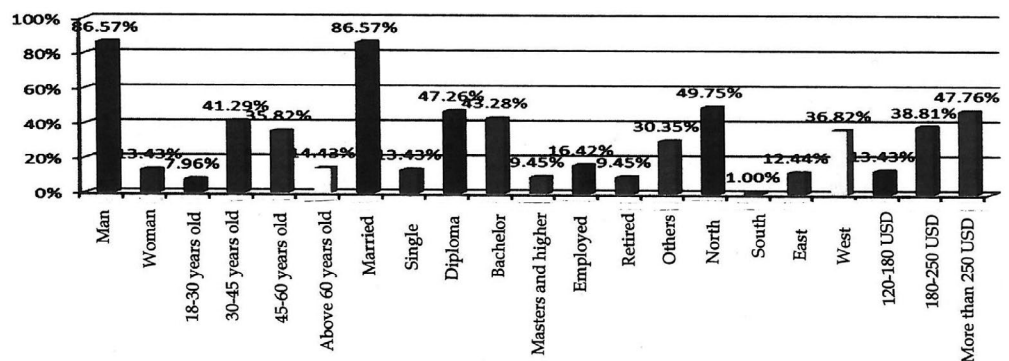


Figure 2. Frequency of different variables in the sample.



**Figure 3. General demand curve of packed vegetable crops.**

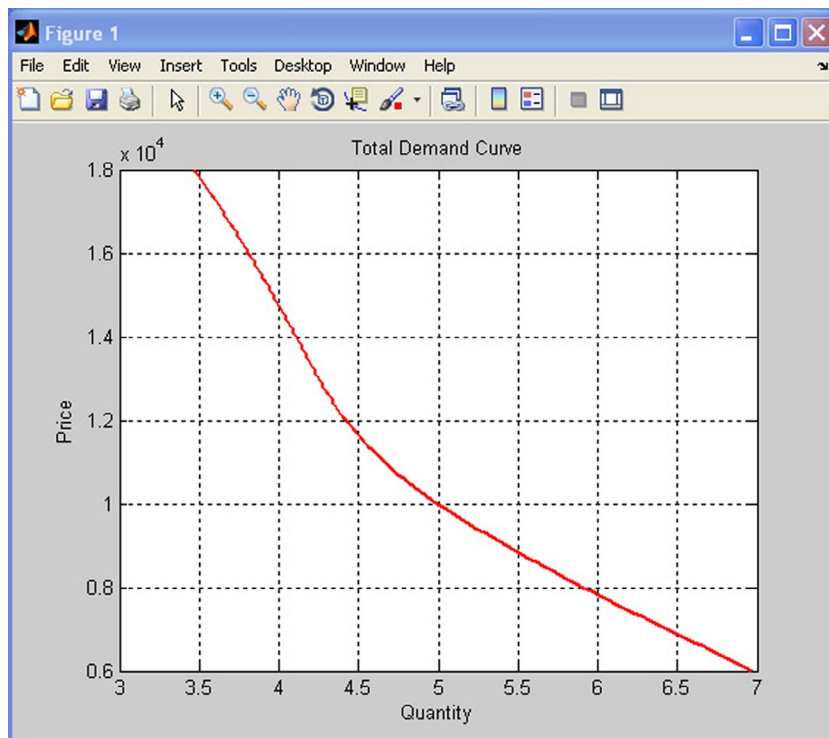


Figure 1 shows that the designed neural network has been well adjusted to the data and also the data dispersion from the fitted function is very low that indicates a good estimation.

Figure 2 shows the data frequency separately with respect to the demographic variables. 86.57% of respondents were men and 13.43% were women. The frequency percentage of the group of respondents between 18 and 30 years is 7.96%, for the group of respondents between 30 and 45 years is 41.29%, for the group of respondents between 45 and 60 years is 35.82%, and for the group of respondents who are above 60 years old is 14.42%, which means that 77.1% get a range between 30 and 60 years. The major clients are married and about 90% have the education level of bachelor or less.

In Figure 3, as it can be seen, after ensuring that the estimation is good enough, we proceeded to estimate the demand function by designed neural network using the gathered data, so that, it has the main characteristics of demand curve, and as it's clear in the figure, it has a negative slope.

The main point as shown in Figure 4 is the changes in own-price elasticity in different prices of foreign packed products. As it is shown in Table 3, own-price elasticity for 0.20\$ is  $-0.4555$ . As the price  $p$  increases up to 0.34\$ the price sensitivity increases and reaches to  $-0.7845$ ; however, from 0.34 to 0.44\$, the price sensitivity again declines as low as  $-0.4441$  and then after 0.44\$ as the price increases, it moves toward unit elasticity. It is assumed that in prices above 0.34\$, a group of customers with low income exited. It can be seen that above that price the curve does not have its normal route.

**Figure 4. Different own-price elasticities in different prices.**

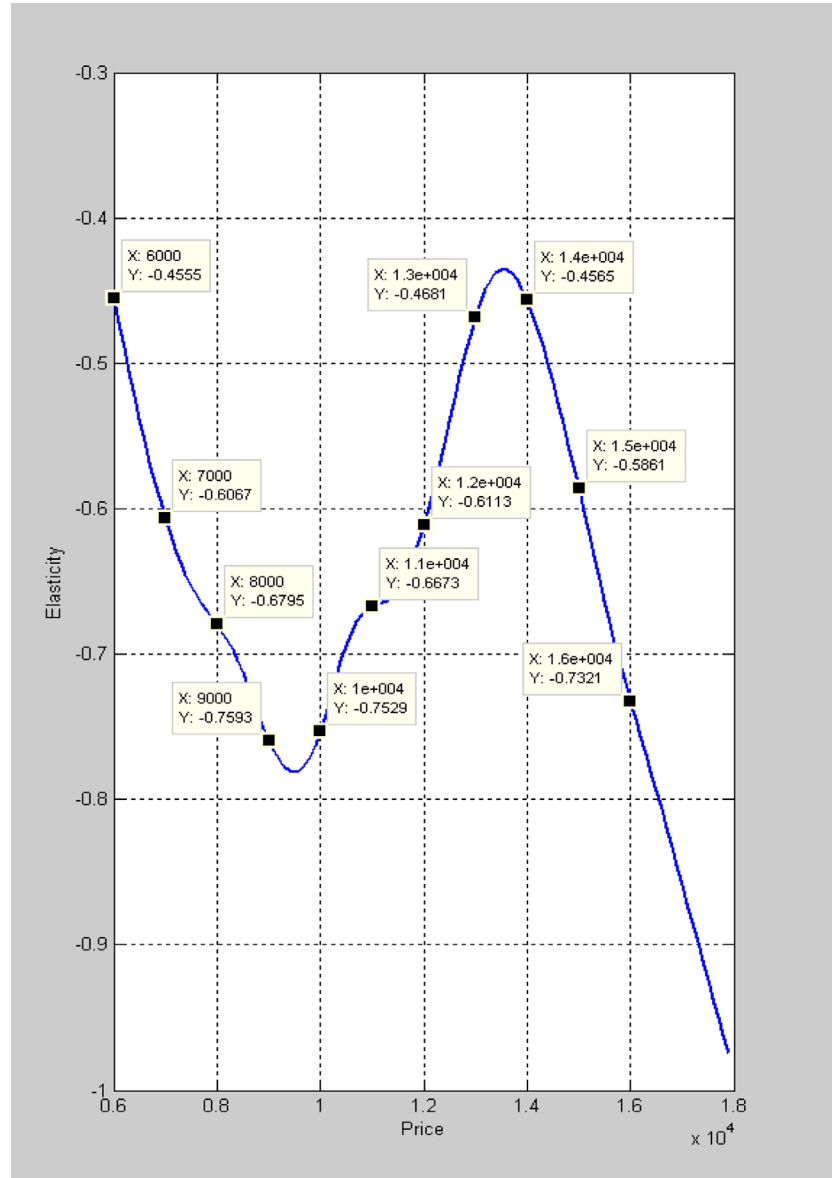


Figure 5 shows that as the respondent's age increases, the price sensitivity will grow, thus, the demand function would have smaller slope and more sensitivity. According to the slope of the demand functions in Figure 6, the demand for the fourth group (Misc) has more price sensitivity than first group (Employed), second group (Unemployed) and third group (Retired).

The behavior of different income groups is shown in Figure 7. The slope of demand function is the same in all three groups, which means that the price elasticity is the same for the different income groups.



**Table 1. Input variables applied to the artificial neural network**

Variable	Name of the input variable	Description
Gender	Man/Woman	0-Female and 1-Male
Age		<i>Dummy:</i>
	AgeGroup1	Below 30 years old = 1
	AgeGroup2	30 to 45 years old = 2
	AgeGroup3	45 to 60 years old = 3
	AgeGroup4	Above 60 years old = 4
Marital status		<i>Dummy:</i>
	Married	Married = 0
	Unmarried	Single = 1
Education level		<i>Dummy:</i>
	EduGroup1	Primary school, no diploma = 1
	EduGroup2	BS-BA degree = 2
	EduGroup3	MA-MS or higher = 3
Geographic position		<i>Dummy:</i>
	North	North = 1
	South	South = 2
	East	East = 3
	West	Wes = 4
Social level		<i>Dummy:</i>
	Employed	Employed = 1
	Unemployed	Unemployed = 2
	Retired	Retired = 3
	-----	Other = 4
Economic status		<i>Dummy:</i>
	IncomeGroup1	120 to 180 dollars = 1
	Income Group2	180 to 250 dollars = 2
	Income Group3	Income more than 250 dollars = 3
Price	VegC1	Quantitative
Quantity of goods	VegQ1	Quantitative

**Table 2. Indices' values of artificial neural network**

Indices	Values
Epoch	100
R <sup>2</sup>	0.96757
MSE	0.39636

Figure 5. Demand curve for packed vegetable crops according to age variable.

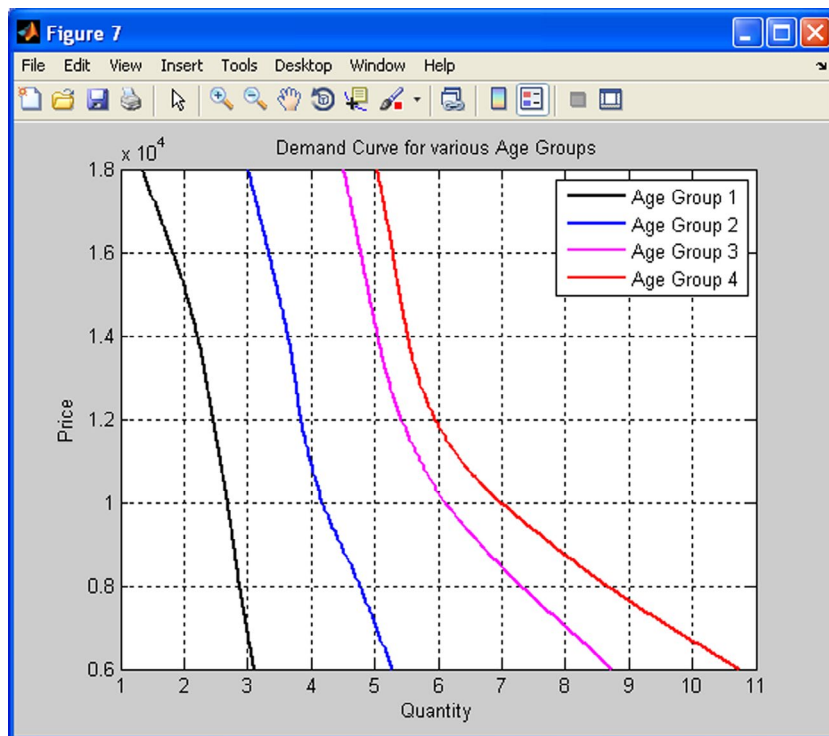


Figure 6. Demand curve for packed vegetable crops according to social-level variable.

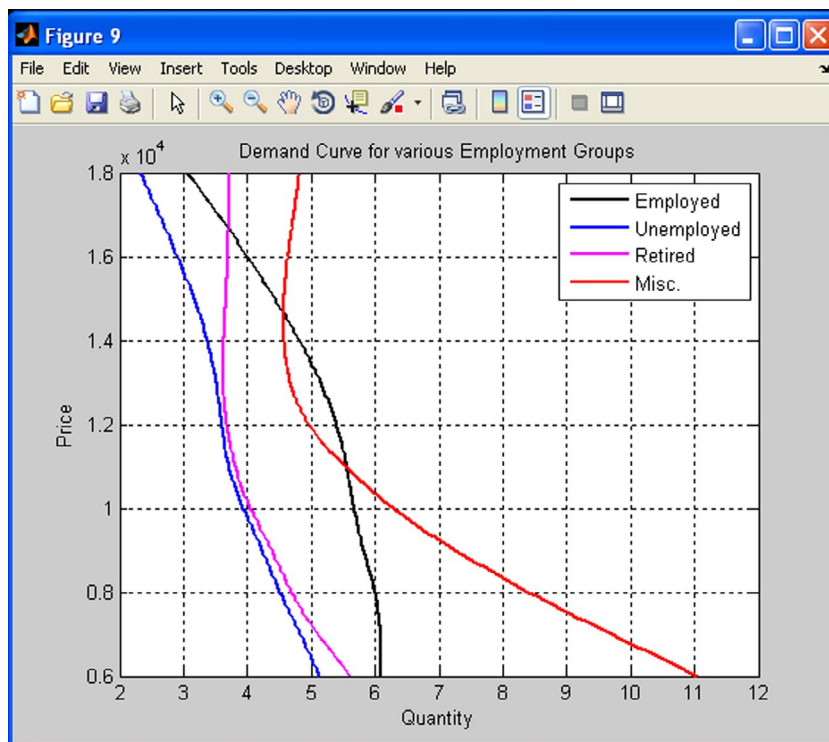


Figure 7. Demand curve for packed vegetable crops according to income variable.

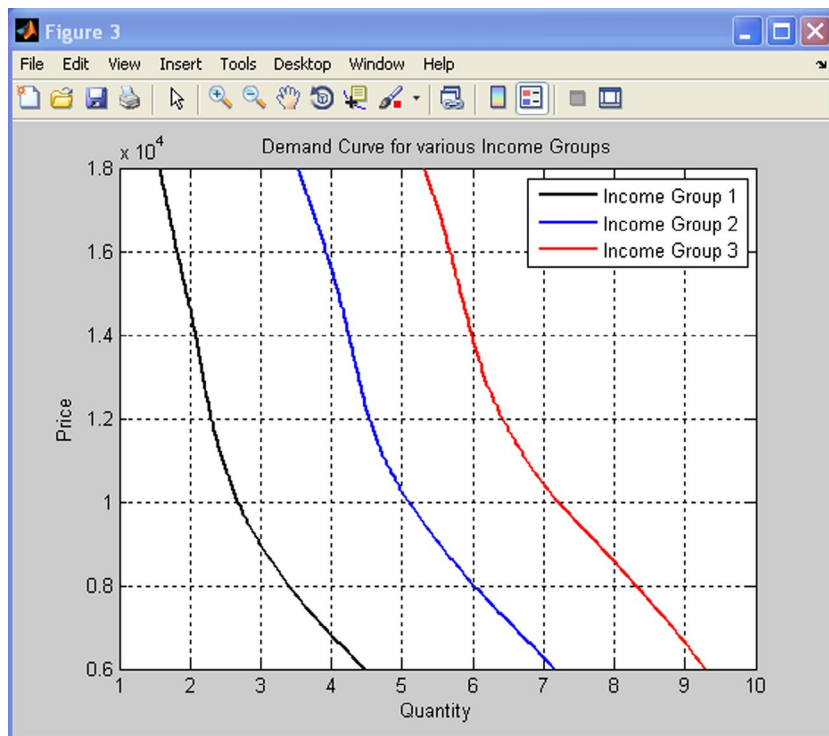
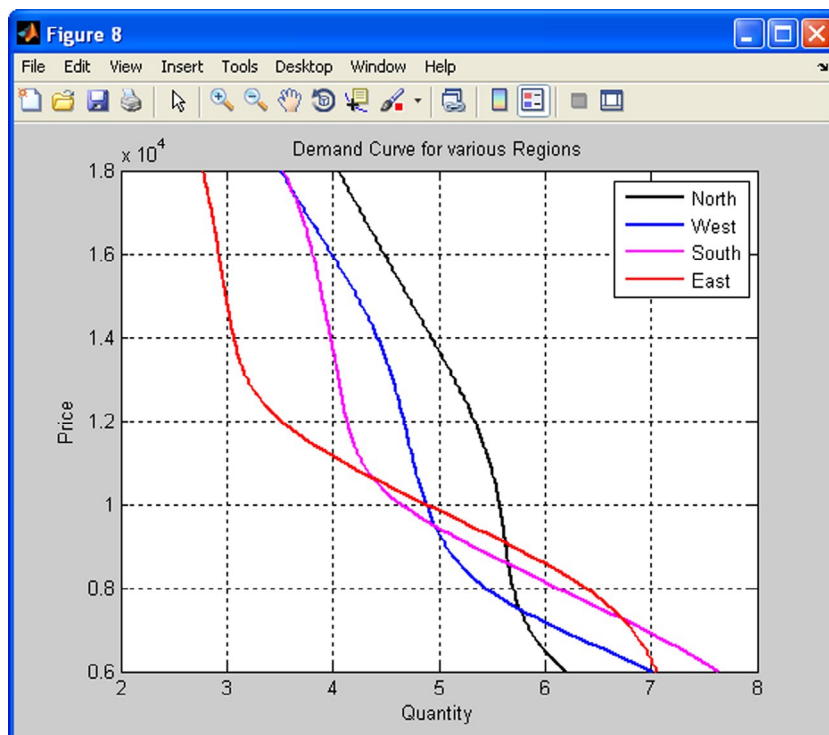


Figure 8 shows that the demand function is similar for the first group (in the north and west of Tehran) to the second group (in the south and east of Tehran), and as it can be seen, according to the slope of the demand function, the first group has a smaller price sensitivity than the second one.

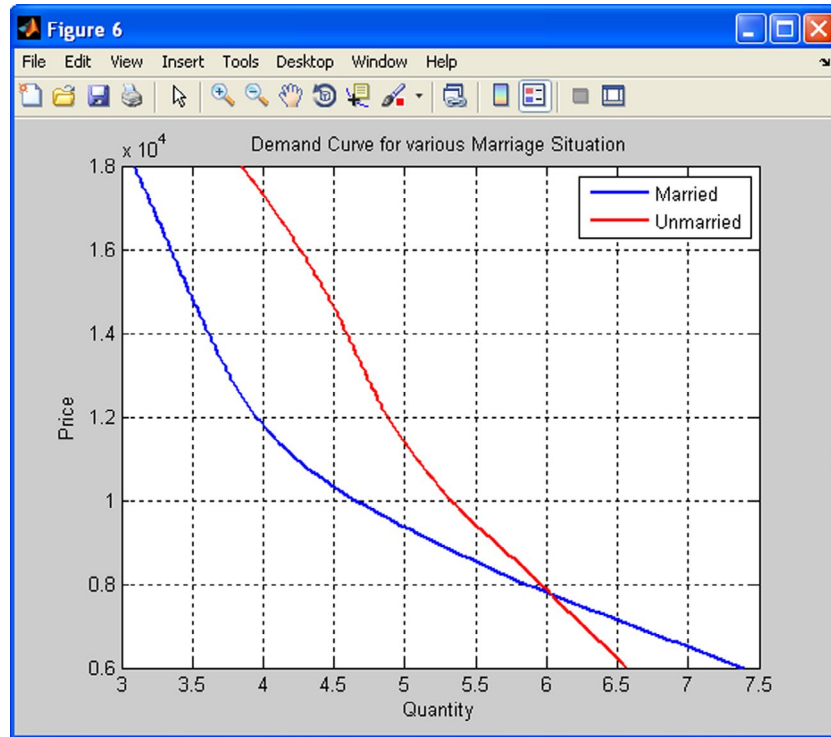
Figure 8. Demand curve for packed vegetable crops according to geographic position variable.



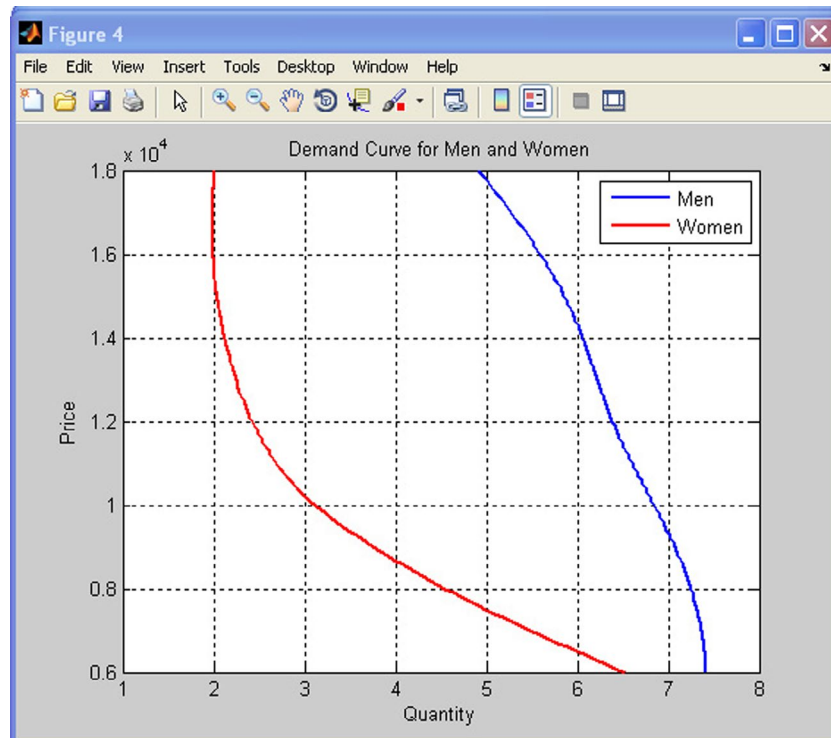
**Table 3. Different own-price elasticities according to price change**

Price (dollars)	0.20	0.24	0.27	0.30	0.37	0.40	0.44	0.47	0.50	0.54
Elasticity	-0/4555	-0/6067	-0/6795	-0/7593	-0/6673	-0/6113	-0/4681	-0/4565	-0/5861	-0/7321

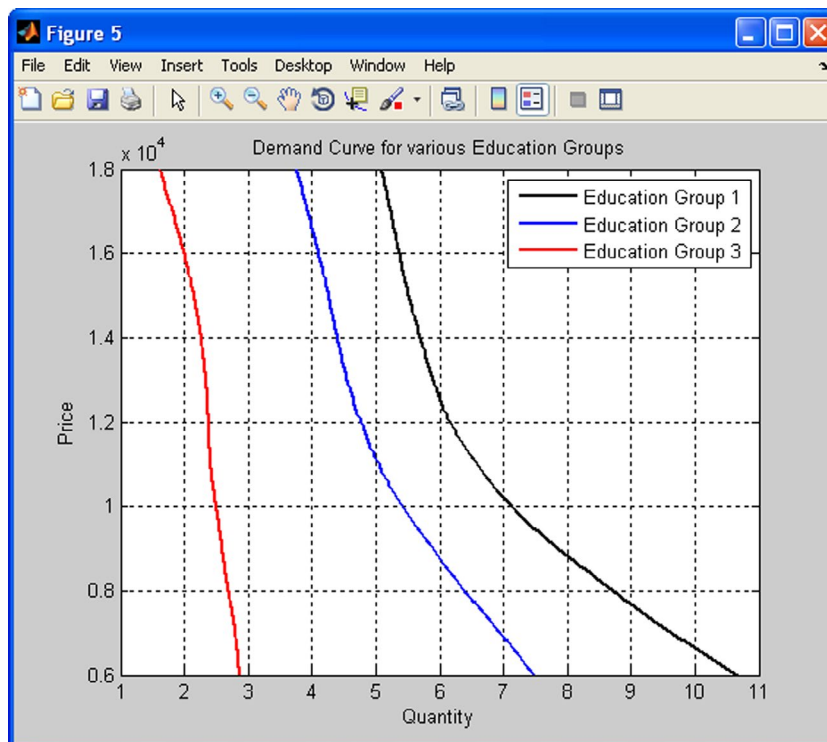
**Figure 9. Demand curve for packed vegetable crops according to marital status variable.**



**Figure 10. Demand curve for packed vegetable crops according to gender variable.**



**Figure 11. Demand curve for packed vegetable crops according to educational-level variable.**



The married respondents, who have the most frequency among the population, have more price sensitivity than the single ones, which is shown in the estimated demand function in Figure 9.

Gender is an important factor in consumer buying behavior. Women's shopping is different from that of men's. This difference is resulted from a different attitude. Consumer behavior is to investigate human's behavior in shopping in order to manufacture products based on consumers' tastes. Consumer behavior is the study of when, why, how, and where people do or do not buy a product. Behavior, because of the differences between men and women about expectation, want, need, lifestyle, etc. Gender has an important role in consumer (Ronaghi, Danae, & Haghtalab, 2013).

Figure 10 shows the different behaviors of men and women in forming the demand, as it can be seen, the women's demand function for the packed products has a greater price sensitivity to price changes than the men's.

The different group's behavior with respect to their education level indicates that the lower the education level, the more the price sensitivity would be (Figure 11, Table 1).

## 6. Conclusion and suggestions

This paper investigates how consumer behavior can be identified using ANN. The objective of this study was to model packed products demand, using ANN instead of conventional and parametric methods. By employing ANN we managed to estimate demand curve and own-price elasticity for Fruit & Vegetable packed products in Markets of Management Organization of Tehran. This study generally indicates that some of demographic variables as well as the conventional economic variables (price and income) influence the customer's choices and it is suggested to be included in the market segmentation and target definition.

Mainly, our interest was focusing on the reconstruction of the empirical distribution of the elasticities, since the theoretical one is not known and yet nothing can be said about the significance of the values.

Studying the elasticities and the price sensitivity for the packed products in Mayadin organization and also the effectiveness of the demographic variables like gender, education level, and the market location we need to pay more attention to the market development policies for the packed products.

- (1) Knowing that the most frequency belongs to the married clients and that the price sensitivity is more among this group, the Mayadin organization should be more prudent to this group of clients.
- (2) According to high price elasticity for the foreign packed products, in the group of clients with lower level of education, which have a high frequency in the population, the Mayadin organization can proceed to increase the awareness of such group of people in decreasing the price sensitivity and in changing their behavior in purchasing.
- (3) To develop the market of packed products, we should focus on the sectors which have the lower price sensitivity, like the markets in the north and west of Tehran.
- (4) Knowing that the effective factors in changing the consumer behavior in demanding the packed and sorted products have not yet been studied well, it can be suggested that should have more research to study the behavior of Mayadin's clients, since being aware of price sensitivity of the consumer and the factors affecting it, would help to gain consumer demand sustainability and the producer's revenue.

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