J. Appl. Environ. Biol. Sci., 1(7)142-147, 2011

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ISSN 2090 – 424X
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Estimating the Demand and Supply Functions of Shrimp Export by Using Fuzzy Neural Network in Iran within 2001-2010

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ABSTRACT: Recent years have witnessed that non-oil exports have found an important role in our country's plans. Since there are some potential facilities to fish and grow different types of marine animals including shrimp and its high capacity for export, it sounds necessary to consider this section as a potential source for providing currency for the country through a precise planning method. In this paper, limitations of supply and demand of export have been studied and the shrimp data related to the period of 2001-2010 using the simultaneous equations and supply and demand of shrimp export and Fuzzy Neural Network (FNN) have been anticipated. The results indicate that shrimp export has no benefit in short term and in long term, the increase in the income of oil export, despite all the odds, has not limited the shrimp export. Moreover, if the local prices decrease, it won't be available for export.

Key words: Fuzzy Neural Network (FNN), export supply and demand function, shrimp.

INTRODUCTION AND LITERATURE REVIEW

Export of agricultural products forms a huge amount of non-oil exports of Iran and in this regard, fishing industry products especially shrimp has a significant role. Many countries use marine animals to meet their necessary protein source and it can be exported along with providing job opportunities for the unemployed. In Iran, due to dependability on oil, the economy follows the feature of oil export and if it fluctuates, the other exports face ups and downs. Therefore, it is essential to consider them for a stable development in economy. At present, there is a great potential in fishing industry for fishing and growing marines for export. If the officials consider this source and plane for that, many problems such as providing the necessary protein and currency for the country, and employment will be solved. The researches show that in the southern shore of Iran, there are around one hundred thousand hectares for growing shrimp and this area is twice bigger than the area in Thailand which has the largest shrimp growing area in the world. Since shrimp can be an important part of non-oil exports of Iran, this research investigates the effective factors on the export of this product.

There have been a number of studies in the world regarding import and export of agricultural products and their effective factors. Feris (1971) has used OSL, 2SLS and 3SLS to study the effective elements of cow skin in the United States.

Khen (1974) used the statistics from 15 developing countries between 1951 and 1956 to calculate the price tendency of export and import. Arize (1998) evaluated the demand and requirements of import and export in Nigeria using the statistics of 1953-81 by the 2SLS method. Sarwar and Anderson (1990) studied the soya bean market and its effective factors in the United States. Reiye Athukorala & Riedel (1994) showed that Hong Kong is a country that accepts the prices related to the export price using the supply and demand functions through the OLS method. Warr & Wollmer (1996) showed that Philippines accepted the coconut prices using the statistics of the period in 1977-90 through the cumulative method. in Iran, Noori (1997) approximated the supply and demand functions by studying the effective elements on the supply and demand of caviar export. Sharzei et.al (2000) also evaluated the supply and demand of pistachio using the simultaneous system and 3SLS method and it was concluded that the demand of pistachio in Iran is not absorption in short term, but it is absorption in long term.

The situation of shrimp in Iran and the world

Planting shrimp in the pools has developed in recent years. There are more than 40 countries which plant shrimp in the pools. Statistically, shrimp farmers have succeeded to grow around 900 thousand tons in 1998 (Ghasemi, 1997).

Indeed, world production of shrimp has had some fluctuations in 90s in that it declined to 850 thousand tons in 2001.

Thailand is the greatest producer with about 280 thousand tons annually and then China, India and Indonesia stand with 90-100 thousand tons.

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Shrimp export reached the record of 1.5 million tons in 2000 which showed 8% increase compared to 1999. Thailand stood first in 2000 with the production of 250 thousand tons of export. Imports in 2000 were more than 1.5 million tons among which the US (the biggest shrimp market) attracted around 20%. This amount reached 400 thousand tons for the first time in 2001. After the US, Japan has the greatest market for the shrimp in which buying and selling have been around 267 to 319 thousand tons in 90s. EU countries have imported more than 378 thousand tons from non-EU ones in 2000 which shows a 9% increase compared to 1999. Spain has been the most important shrimp importer among EU countries with a boom of 20% in 2000 to have more than 115 thousand tons (Public Relations of Iranian Fisheries, 2000,). Shrimp fishing has been long around in the southern part of Iran, however, there is no exact data on its history, but it can be claimed that it goes back to the first residents in the area. Since the shore facilities have been equipped, the traditional fishermen have been fishing by the advanced methods. Despite all these developments, there is no discipline in data gathering on fishing in the area and the statistics are from FAO or regional and international seminars in the presence of fishing industry experts. Recent years have observed a new consideration in shrimp plantation in that the ground has been made through developing concentrated shrimp farms and providing facilities for the private sector. It was in 2002 that 2485.1 hectares were devoted to shrimp plantation (Iranian Shrimp quarterly periodical, 2002).

Due to this decent growth in shrimp plantation in recent years, it seems that the country has the potential to increase this product. Economically speaking, it can be claimed that the product of each one-hectare pool is equal to 90 tons of wheat and if two tons of shrimp are farmed in each pool, 70-80 million Rials will be the income of the farmer (Barzegar Journal, 2005).

The studies show that the southern part of the country has an appropriate 100 thousand hectares for this business which is twice more than the area in Thailand which has the greatest area for shrimp plantation in the world. The most important varieties of shrimp are banana, tiger, pink and white which are all bought in Japan and Europe. The Iranian shrimp is mainly exported to Japan, Spain, and Portugal and sometimes to Egypt and Dubai.

Material and Methods

In this research paper, the data are related to the period of 2001-2010 collected from FAO and Iran's fishing industry. The minimum three-stage squares (I 3SLS) and regression equations of SURE have demonstrated the supply and demand equations of shrimp product in Iran and some suggestions have been made to develop the export of this products.

A) Balanced or Stable model:

In order to determine an export supply and demand model, two models have been studied. The first is a balanced or stable model in which there is no delay in the system i.e. the amounts of export and prices get balanced in a moment. In other words, balance is made in one period (Goldstien & khan,1976),(Noori, 1996,1997) :

$$X_D = \beta_0 + \beta_1 P_x + \beta_2 P_{xw} + \beta_3 GDP + \beta_4 ER + \beta_5 WP \qquad (1)$$

P_x: export price,

ER: exchange rate

WP: World shrimp production except for Iran

P_{xw}: Universal export price

GDP: Gross Domestic Product of demanding countries

X_D: the demand for the export

It is expected that

$$\beta_1 < 0 \quad \beta_2 < 0 \quad \beta_3 < 0 \quad \beta_4 < 0 \quad \beta_5 < 0$$

Export depends on some factors including the product export price, domestic price and the oil export income. The demand function can be shown as the following:

$$X_s = b_0 + b_1 Px + b_2 P + b_3 Q + b_3 OX \qquad (2)$$

XS: the amount for export

Q: domestic supply

P: domestic price

OX: income of oil export

It is expected that $b_1 > 0 \quad b_2 < 0 \quad b_3 > 0 \quad b_4 < 0$ since the model patterning is simultaneous, equation (2) can be written as the following:

$P_x = C_0 + C_1 XS + C_2 P + C_3 Q + C_4 OX$ In which

$$C_0 = b_0/b_1 \quad C_1 = 1/b_1 \quad C_2 = b_2/b_1 \quad C_3 = b_3/b_1 \quad C_4 = b_4/b_1 \qquad (3)$$

Considering b_i, it is expected that the C_i will be as the following:

$$C_1 > 0 \quad C_2 < 0 \quad C_3 > 0 \quad C_4 < 0$$

Equations (1) and (2) are the balanced model. In order to calculate the structural coefficient, equations should be solved simultaneously.

B) Imbalanced or Non-stable model

In order to show the delay attitudes in one model, the balanced mechanism of Hootheir and Tailor is used. In this model, it is assumed that export based on the difference between demand for export in t time and the real export in the previous time (t-1) will be balanced. Therefore, the export price is determined in the exporting country.

$$\Delta X_t = \gamma\{X_t^D - X_{t-1}\} = U_t \qquad (4)$$

γ is the balanced coefficient. The function assumes that the amount of export, in case there is over-demand in other countries, will be balanced (Goldnstien, and Khan, 1976).

If equation (1) is replaced in equation (4), the function for approximation will be as the following:

$$X_t = d_0 + d_1 Px + d_2 Pxw + d_3 GPD + d_4 ER + d_5 WP + d_6 X_{t-1} + U_t \quad (5)$$

In which d_i coefficients are:

$$d_0 = \gamma\beta_0 \quad d_1 = \gamma\beta_1 \quad d_2 = \gamma\beta_2 \quad d_3 = \gamma\beta_3 \quad d_4 = \gamma\beta_4 \quad d_5 = \gamma\beta_5 \quad d_6 = 1 - \gamma$$

Regarding the signs of β, the signs of d_i will be determined:

$$d_1<0 \quad d_2<0 \quad d_3<0 \quad d_4<0 \quad d_5<0 \quad d_6<0$$

The export price will be balanced regarding the over-demand feature:

$$\Delta P_x = \delta(X_t - X_{t-1}) + \varepsilon_t \qquad \delta > 0 \quad (6)$$

The balanced coefficient is δ and change in the export price will be demonstrated as $\Delta P_x = (Px_t - PX_{t-1})$. In this respect, an increase in over-demand will result a reduction in the world price and vice versa. When equation (3) is replaced in (6), and it is solved based on Px, there will be:

$$Px_t = e_0 + e_1 X_t + e_2 P + e_3 Q + e_4 OX + e_5 Px_{t-1} \quad (7)$$

In these two presented models in this research, a non-stable model has been used. In order to evaluate this unstable model, the systematic model of 3SLS has been used. SURE has been used for the study of interruptive sentences and OSL has been applied for comparison. Since the approximation of these equations occurs simultaneously, these methods have no results related to the relationships of the variables. On the other hand, in order for the approximation of the supply and demand equations of shrimp, based on theoretical assumptions, the necessary variables are entered and after their research of static and non-static features, the approximations have been happened in the method of unit square testing and Dicky Folwer statistics and stabilizing non-static variables. This model is eliminated due to no access to P_{XW} variable (the universal shrimp price).

Tables (1) , (2) and (3) show the results of approximated coefficients and absorption using the 3SLS, SURE and OLS methods. The results show that there is a difference among these methods. Therefore, of these methods, because more R^2 and more meaningful variables and since the obtained coefficients are matched with the theoretical assumptions, SURE method will be interpreted in the following. (However, in simultaneous equation systems, instead of usual R^2 definition, another method called Cater-negar which has the similar interpretation to R^2 has been used. This statistics has been defined as $R^2_{cn} = [1 - Mse/\delta^2_y]$ in which MSE is the average of mistake and variance of variables) (Khan and Knight, 1981).

Neural networks and fuzzy neural networks

Recent decades have witnessed the success of artificial neural networks. The idea of teaching to solve complex models using intelligent elements for academic researchers has been challenging. Neural networks are a simple calculating means to test the data and create a model from the structure. The data used to create a model are known an educational data. When a neural network uses educational data to learn the existing models in data, they can be used to access different outputs and results. (Majazi, 2011)

There are many different types of artificial neural networks regarding the research purpose, among which Multilayered Feed forward Neural Network (MFNN) is the most important one. MFNN is an example of an educational neural network using a supervisor. As the recent studies show (23), more than 50% of commercial practical studies of neural network use MFNNs with the educational algorithm regulations of back propagation. This neural network, due to it widespread application such as management, principle prediction, classification and modeling, has been favorable. MFNN is appropriate to solve the problems which include learning a relationship between a particular input collection and output one. In fact, this is a learning technique using a supervisor for learning the relationship between the data and the education data collection.

The learning algorithm of back propagation, the network makes an output of Z_k (or a set of outputs) for an input model and this reaction is compared to the favorable reaction of each neuron of d_k. This amount is constant for predictive issues. Network weights are reformed for correction or reduction of mistake and the next model is presented. Weight reforming happens constantly until the number of mistakes is fewer than what has been predicted. The reason that input updating gradually minimizes the square of the error average (MSE) is that all input models depend on the fact that the learning algorithm of back propagation has a downward tendency.

In general, artificial neural networks don't have sufficient ability for our purpose in a logical time. On the other hand, fuzzy modeling needs experiences and the collected data for blending decisions. Artificial neural networks and fuzzy modeling are used in practical fields and each of them has pros and cons. Therefore, mixing these two points successfully artificial neural network and fuzzy modeling can be the subjects for further studies.

When artificial neural networks and logical fuzzy are compounded, a successful fuzzy system will be created which has the learning potential. This system works as the following: in every learning cycle, when moving forward, the nodes outputs are calculated up to the last layer and then the result parameters are calculated by the minimum mistake square sum. In the following, after calculating backward mistake regarding the contributed parameters and using the downward steep of mistake, the amount will be corrected. Different

structures have been suggested for a fuzzy system by a neural network is the strongest one proposed. The structure of the reasoning system of the artificial neural fuzzy has been shown in figure 1.

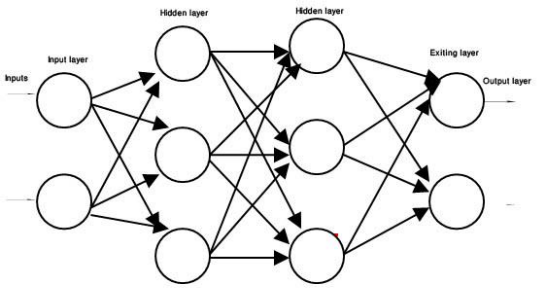

Figure 1- structure of the fuzzy neural network

The main teaching method of ANFIS is the back propagation. In this method, the amount of mistake towards the inputs is contributed by the algorithm of the steepest downward trend and the parameters are corrected. The main difference of the fuzzy neural networks and artificial neural networks is that the weights of the fuzzy neural networks are defined in fuzzy and they are not precisely determined. (Majazi, 2011)

6-2-Prediction with the method of fuzzy neural networks

In designing fuzzy neural networks, MFNN with the learning algorithm of back propagation and the Takagi Sogno deductive fuzzy systems have been used. In order to design an appropriate fuzzy neural network, the appropriate typology of the neural networks has been studied through constant layer changes and the number of neurons in hidden layers. The suitable typology of neural network of this research comes into three layers including input, hidden and output ones in which the number of neurons are . An appropriate deductive fuzzy system is designed by constant changes of different membership functions and the number of membership functions. 100 functions are used in this membership function and "Sigmond's difference of two functions" has been used for input function (in which one function is common) and linear function is used for output function and for non-fuzzy, a harmonic average function has been used.

The number of input time series of this research is 520 among which 50% are educational data, 25% testing data and 25% are credential data. Using these credential data guarantees the precision of prediction and network responsiveness in that it prevents overmatching of the data. Two methods have been used to prevent the network trapping in regional points;

1) The network has been taught by different accidental weights and the best response is chosen,

2) When the response is somehow satisfactory, the network is performed by the same response.

For prediction issues, some performance indicators are used to show how learning relationship is in the fuzzy neural network and they are mainly related to the predicted mistakes and the real favorable output. Six indicators have been used in this research and first three ones are the calculations of the mean of standard error family: MSE, RMSE and NMSE. The mistakes are to fine bigger mistakes, and to neutralize the positive and negative effects, the differences are with the power of two. R^2 is a determining coefficient and it is related to NMS. NMSE is equal to $1-R^2$. R^2 is between zero and one and one shows the perfect match of data while zero shows a performance in which real average output can be the base for the prediction. The mean of absolute error (MAE) is the next benchmark about the pure mistake. Since every performance evaluative indicator evaluates a specific feature. (Majazi, 2011)

RESULTS AND DISCUSSION

Tables (1) and (2) have shown the supply and demand functions in three methods of 3SLS, OLS and SURE. The approximate coefficients of export supply function are the same as e_i which shows the reverse absorption of demand. The approximate demand coefficients of export demand show d_i which demonstrate short-term absorption in the logarithm form. The approximate results in SURE method show that supply and demand of shrimp export in short term is without any absorption. Using these coefficients and considering the theoretical assumptions the coefficients of β and C_i can be calculated and they all have long term absorption.

Table1: the result of supply estimation of export of shrimp

Method	3SLS	SURE	OLS	FNN
Constant value	2.191	1.81	1.73	1.62
Ln X	0.491	0.472	0.468	0.394
Ln P	-0.037	-0.072	-0.061	-0.059
Ln Q	-0.521	-0.492	-0.485	-0.479
Ln ox	0.031	0.029	-0.001	-0.006
LnPx(-1)	0.856	0.909	0.921	0.995
R^2cn	0.89	0.92	0.94	0.99.8

Table2: the result of demand estimation of export of shrimp

Method	3SLS	SURE	OLS	FNN
Constant value	-21.218	-2.41	-0.95	-0.004
Ln X	-0.921	-0.395	-0.154	0.56
Ln P	4.263	1.005	0.592	-0.918
Ln ER	0.198	0.268	0.194	0.191
Ln WP	-0.115	-0.227	-0.231	-0.343
Ln GDP	0.019	0.015	0.01	0.13
LnPx(-1)	0.051	0.0631	0.038	0.0015
R^2cn	0.52	0.76	0.68	0.98

Table3: Shrimp export elasticity demand and supply in Long-term

Method	Elasticity of demand of export				Elasticity of supply of Export		
	Px	WP	GDP	ER	OX	Q	P
SURE	-0.63	-0.26	0.42	0.43	0.013	0.24	-0.043
3SLS	-1.16	-0.18	6.589	0.276	0.015	-0.25	-0.018

According to table (3) which shows the long term absorption, the long term absorption in the SURE method is -0.63 which shows the non-absorption of this product regarding price changes. However, this variable is meaningful in 3SLS method and since it has no absorption, it is predicted that shrimp price increase causes an increase in the currency income of the country and it has no significant effect on the shrimp demand. WP variable which shows shrimp production in the world except for Iran has been entered in the model and it has a meaningful effect on the shrimp export demand of Iran. The approximate absorption of -0.26 shows that there is no absorption of Iranian shrimp regarding WP changes. It can be said that the world wide shrimp production changes have a little effects on Iranian shrimp export. However, there is exact access to the world wide shrimp production; it seems that this variable has an important effect on Iranian shrimp demand.

GDP variable is an indicator of countries' gross domestic production which has a demand of Iranian shrimp and it is as an export demand countries from Iran in SURE method with no meaningful effect while this variable is meaningful in the method of 3SLS.

ER exchange rate has been an effective element on exports in this model. Since there are many private companies in shrimp business, it is expected that exchange rates have a significant effect on the export f this product. In this paper, it is believed that as the exchange rate increases (a fact of a decrease of rial rate compared to the credential currencies of the world and the reduction of domestic prices regarding foreign currencies), the demand for shrimp export increases and the variables are positive. The approximation of the mentioned model shows that ER, as expectedly is positive and it has a meaningful effect on the export demand. However, considering the approximated absorption which is 0.43 which shows the non-absorption of the export demand of shrimp regarding the exchange rate, the reason can be in the nature of shrimp because its worldwide demand won't increase, but it is expected that it will have a stable position. Price absorption of export demand shows the non-absorption of shrimp export demand regarding domestic price changes and it proves that the country is not ready for the export demand in case that the domestic price reduces.

OX variable is the oil export income and although it has been assumed that if oil export income increases, it will have negative effects on non-oil export in this mode, the mentioned variable is positive. It shows that when the oil income increases, the shrimp export won't be limited. Q-the amount of shrimp production, is an important factor for the shrimp demand export and if this variable is negative, since this product can be stored, the demand and supply of this product has no relationship with its simultaneous demand and supply.

Due to low absorption of shrimp demand compared to the export price, world price changes have no significant effects on the export demands of this product in Iran. Non-absorption of shrimp export demand compared to the domestic prices shows that the country is not ready to increase the export (if the prices reduce). Therefore, it is necessary to consider this product from production point of view, and export and marketing.

Discussions:

Since shrimp industry is very new in our country and private section has a limited experience in having approaches and knowing the domestic and international market, public sectors especially the fishing industry can introduce them the market and domestic and international forces through having a close contact with international market and they can have an important role in this regard. Iranian shrimp which is fished in the Persian Gulf and Oman Sea can be successful in the international market in terms of the taste, color and size and it will attract more fans (Barzegar Journal, 2005). Therefore, due to good quality and reputation of Iranian shrimp in international markets, there are fewer problems in entering the shrimp plantation market. This cannot be a good justification for laziness for marketing and improving the situation in international markets. Shrimp exporters had better choose more than one market for their product and if their production meets the standards, they can be exported to Japan, Europe and America (if possible). There are two reasons for this recommendation; first of all, although shrimp markets are related to each other, it has been observed that in a particular time, shrimp has a higher price in one market than another one. Secondly, market variation reduces the business dependency on one market or one customer. Exporters should consider some elements such as size, type, quality of shrimp when receiving, market related information and marketing experiences when they try to choose a market or sign a contract. Making a correct business relationship and adaptable situation with international markets and determining confident policies for the business can play an important role in developing the export of this product.

Adapting the standards in Iran with the developed countries in this field, making supportive policies matched with this new industry such as tax exemption, banking supports, an appropriate planning for growing shrimp in the country and encouraging investors to

invest on shrimp food production are other important points to be taken into account.

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