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Development Trends of Aquaculture in the World

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Abstract: In this study, development trends corresponding to the period 1980-2003 of the countries that have a voice in world aquaculture production are analyzed, taking into consideration the variables like their production, consumption, import and export. In the study, panel data set has been used in the analysis of the factors affecting fish import and export of the selected countries. In panel data set there are 12 horizontal cross-section data and 24 time series. The study includes the explanation of import and export of 12 countries performing the highest fish production in the world. In order to explain import and export, two models have been established and Chow test has been applied for both models. According to the results of the analysis, while import increases export at a rate of 17.04%, export increases import at a rate of 7.06%. While, relative increase in production decreases import at a rate of 5.66%, it increases export at a rate of 4.96%. Production affects import and export at the same rate but in opposite directions. The signs of consumption coefficient are harmonious with the expectations and while, its relative increase decreases export at a rate of 5.57%, it increases import at a rate of 5.99%. Income affects import positively and its relative increase increases import at a rate of 152%. Decrease in the value of country currencies against dollar decreases export at a rate of 0.25% ,while its increase increases import at a rate of 7.08%.

Key words: Import, export, chow analysis, panel data analysis, development

INTRODUCTION

Fishery products are very important for balanced and healthy nutrition of humans. Fishery production has rapidly increased after the Second World War. Fishery sector was determined as the most rapidly growing food sector in the world by FAO. For solving world nutrition problems, fishery products are the most significant food in terms of nutrition content. Firstly, fish and fishery products are one of the basic sources of animal protein, which has an important place in human nutrition. Fishery sector constitutes one of the important economic activities in some developed countries due to the fact that it creates added value and employment and due to its share in foreign trade as well.

Until 1960s, acting with the idea that fish potential in the seas is limitless, fishing efforts utilized in fishing have been increased day by day all over the world. While, world fish production was around 18 million tones in 1950, this amount has reached to 156 million tones in 2007. It is believed that this increase basically is due to the addition of new resources to the existing ones rather than well management of the available resources. There is much evidence that there is loss of efficiency in stocks, where fishing is continued. Moreover, use of wild fish in feeding farmed fish, pollution of coastal waters and habitat destruction also negatively affect the fish population in the world (Longer, 2000). FAO has monitored in 2 year periods for 23 years fish stocks and development in fishery that is the change in the amounts of fishery products brought to the ports through out the world and on regional basis.

As a result, when world fishing is evaluated, it is determined that although the amounts of fish hunted in the seas reach a record high, annual increase rate has decreased and almost, 70% of the stocks were aged (SPO, 2006). The increase rate, which was 12% in the year 1950 has decreased to 0.2% in 2007.

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Now-a-days, the areas where developing in terms of fishing is observed and thus, increase in production can be achieved are eastern and western Indian Ocean and the midwestern and northwestern parts of the Pacific Ocean.

Ninety percent of fishery production in the world is performed in Asia and 80% of it is performed in China. India, Indonesia, Japan, Bangladesh and Thailand follow China in fishery production. Fishery production had increased rapidly in the last three decades and its share reached to 58 billion USD on the international market. 80% of the total import of fishery products was performed by EU, USA and Japan and 73% of the total export was made by the above mentioned countries. The share of the developing countries within the total fishery products on the international market is 50%.

MATERIALS AND METHODS

In this study, development trends corresponding to the period 1980-2003 of the countries that have a voice in world aquaculture production (China, Japan, Peru, Chili, Thailand, Norway, Philippines, Vietnam, United States of America, India and Indonesia) and Turkey are analyzed, taking into consideration the variables like their production, consumption, import and export and the differences among these countries were compared according to the variables mentioned above, using statistical methods.

Panel data set has been used in the analysis of the factors affecting fish imports and exports of the selected countries. Panel data analysis is defined as the estimation of economic relations via using section series of time dimension (Pazarlioglu, 2001). Observations in panel data set have recurrence by years. When, viewed from this perspective, it is seen that there are repetitive variance analyses and models of variance analyses (Grene, 2003) at the hearth of the panel data analyses. In the panel data set used in this study, there are 12 horizontal cross-section data and 24 time series. The study covers the explanation of imports and exports of 12 countries performing the highest fish production throughout the world. Import, export, production, consumption, income and exchange parities of these 12 countries have been collected for the period between the years 1980-2003 and a panel data set consisting of a total of 288 observation values was formed.

There are basic advantages of horizontal cross-section and time series data of panel data set, for their separate usages (Balgati, 1995; Balestra, 1992).

- Panel data analysis eliminates the data limitations and increases the number of observations. This provides an increase in the degree of freedom and ensures reliable estimations
- It resolves the correlation problem emerging between variables (multiple connection)
- It can explain the effects that cannot be set forth by horizontal cross-section and time series data separately

The model taken as basis in panel data analysis is as follows (Grene, 2003).

$$Y_{it} = \alpha_i + \beta' X_{it} + u_{it}$$

X_{it}, includes K regressor. However, it does not include the constant term. α_{it} is constant in time t and it explains the special effect for section units i. This is an ordinary regression model. If all units of α_{it} are the same, this data set can be analyzed via least squares method and the parameters become consistent and unbiased. Panel data models are examined under two groups; fixed effects method and random effects method. The difference between these two methods is the determination of a constant for each group. In the fixed effects method, each group is assumed to be heterogeneous and a constant is estimated for each group. But in random effects method, the same constant is estimated for each group. In panel data models, some tests are needed to decide, which method is to be used. In this study Chow test is used. Overall presentation of Chow test is as follows (Erkan, 1999):

$$F = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT - N - K)}$$

Where:

F = Calculated F-value
RRSS = The error square sum of the equation restricted
N = Number of sections
T = Time interval
K = Number of variables

The limited equation expressed in this equality is the model, in which a single fixed term was calculated for all the groups and which accepts each group as homogeneous.

In the study, two models have been established in order to explain import and export and Chow test has been applied for both models. Variables in the model are as the following:

Import (IM): Explains the import per capita of the total aquaculture products of the countries (kg).

Export (EX): Explains the export per capita of total aquaculture products of the countries (kg).

Production (PR): Explains total aquaculture production per capita of the countries (kg).

Consumption (CM): Explains total aquaculture consumption per capita of the countries (kg).

Income (IN): Explains total per capita income of the countries.

Parity (PR): Explains dollar parity of the currency of the countries (USD).

In the study, all the data except parity have been divided by total population and per capita values have been taken. In the explanation of the import and export of the countries, production and consumption variable is used. Production and consumption amounts are affected by population density. Due to the fact that population densities of the countries are different; per capita amounts of import, export, production, consumption and income variables have been taken into consideration. Moreover, the logarithms of all variables were taken in the model in order to reduce dependence on the sequential addition.

Fishery sector in the selected countries (production, consumption, trade): Aquaculture is the most rapidly growing food production sector for nearly the last two decades. Total world fishery production has been reported to be 140 million tones approximately in 2003 and production performed through hunting is determined to be 95 million tones and fishery products obtained by aquaculture is 45.5 million tones. Production performed through hunting was 95.6 million tones in 2000 and has dropped by 0.2% in 2001; however, the total world aquaculture production was approximately 35.5 million tones in 2000 and has increased by 28% in 2003.

In the selected countries, fishery production has approximately been 107 million tones in 2003. This amount is almost 75% of the world production. The most important producer is China, which performs 36% of the total production and 71% of culture fishery production on its own (Celiker, 2004). Since 1992, after a decline in 1987, China has showed a growth rate of approximately 0.4% each year and after 1995, a tendency towards decline is observed in China (Fig. 1). The share of fish protein products within the total world animal protein sources was 14.9% in 1992; it increased to 16.0% in 1996 and decreased to 15.5% in 2003.

Globally, as of 2003, China, Peru, Japan, Indonesia, India and the United States are the first six countries that has the highest fish production. It is understood that there appeared major fluctuations in fish production of the countries in question in the last decade (Fig. 1). Sixty one percent of world production of fishery products is obtained from the Pacific, 28.3% from the Atlantic, 6% from the Indian Ocean and 2.5% from the Mediterranean and Black Sea. Approximately, 70% of aquaculture products obtained from inland waters is hunted in Asia; and Asia is followed respectively by Africa, Europe, South America and North America (Celikkale *et al*., 1999). While, fish production of Peru had an increasing production trend until 1995, after this year it has tended to decline. During the same years, fish production of Japan

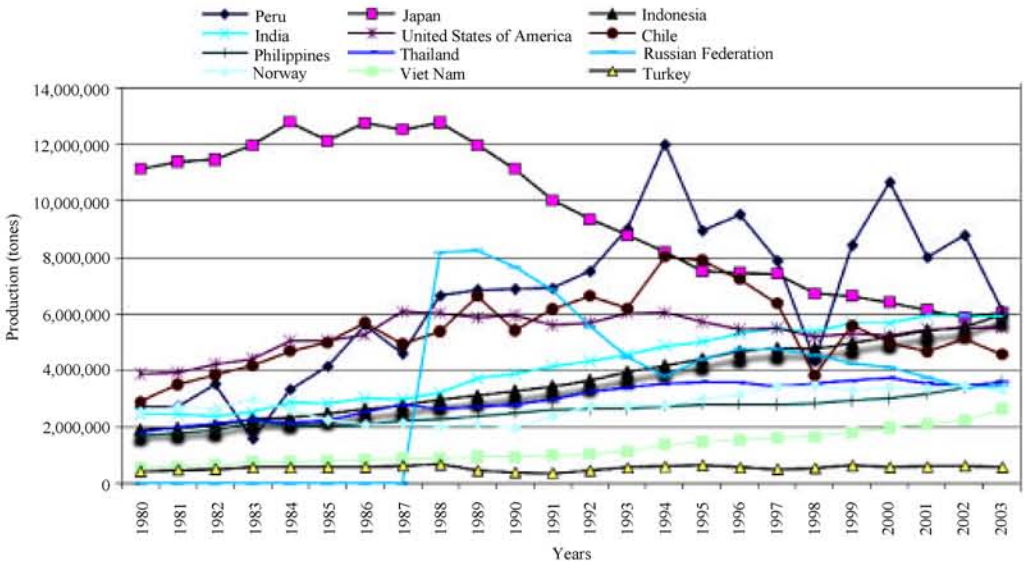

Fig. 1: Fish production 1980-2003

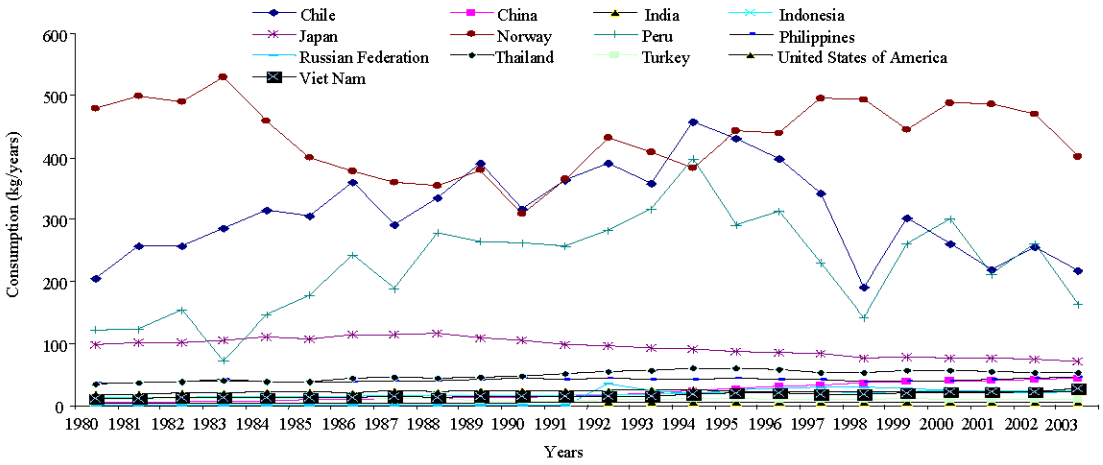

Fig. 2: Per capita fish consumption

shows a declining trend. The decline in the amount of fish caught in Pacific and Atlantic after 1995, has caused a decrease in world fish production. Although there is an increase in the amount of fish caught in the Mediterranean and the Black Sea, it is not an amount that can change world fish production to a significant extent.

The selected countries' consumption of fish has doubled since 1980 and the developing world has been responsible for nearly all of this growth. Countries with rapid population growth, rapid income growth and urbanization tend to have the greatest increases in consumption of animal products, including fish products and the developing world has experienced all three trends. China, Thailand, Peru, where income growth and urbanization have been major factors, dominates the consumption of fish products (Fig. 2). It accounted for about 39% of global consumption in 2003. Although, total fish consumption declined somewhat in the developed countries, this decline was dwarfed by the increases in the developing world. Besides being used as food, fish is also increasingly demanded for use as feed. Nearly, one-third of the world's wild-caught fish are reduced to fishmeal and fish oil, which are then used in feeds for livestock like poultry and pigs and in feeds for farmed carnivorous fish. Because aquaculture is likely to grow rapidly over the next two decades, some experts are concerned that rising demand for fishmeal and fish oil could place heavier fishing pressure on already threatened stocks of fish used for feed.

To meet the burgeoning demand for fish, production has soared. The growth in reduction, like that in consumption, comes almost entirely from the selected countries. Exploitation of wild fish stocks rose rapidly during the 1970 and 1980s, thanks to expanded fishing fleets, new fishing technologies and increased investments in the fishing sector. Production jumped from 38,000 tones in 1980 to 51,000 tones in 2003. By the late 1980s, however, the stocks fished by many wild-fishing operations were fully exploited; even overexploited. Since then, despite increases in investment and fishing capacity, fish production from wild fisheries has slowed or stagnated.

From the selected countries, developing ones have taken the lead in producing fish from wild fisheries since the 1980s, partly because of the establishment of 200-mile Exclusive Economic Zones (EEZs) around coastal nations. Whereas from the selected countries, developed-country production from wild fisheries exceeded developing-country production, the developing countries were producing twice as much as the developed countries.

The wildest fisheries are near their maximum sustainable exploitation levels. Although fishers could probably produce more by targeting underexploited species that have been lowerly demand, it is not clear that consumers will accept these species. More importantly, such a change could cause large shifts in species composition and indirectly harm predator species, with severe consequences for the environment. With wild fish production stagnating, growth in overall fish production has come almost entirely from the global boom in aquaculture, especially in developing countries. Aquaculture now represents >30% of total food fish production and Asia accounts for 87% of global aquaculture production by weight. In the coming decades, aquaculture will likely be the greatest source of increased fish production as fish farmers expand the water surface area under cultivation and increase yields per unit of the area cultivated. But, the sector must overcome several major challenges if it is to sustain the rapid growth of the past two decades. It will face competition from other users

for land and water. Disease and the scarcity of fishmeal and fish oil derived from wild-caught fish may also constrain aquaculture production. Growth in aquaculture production will also depend heavily on the level of public and private investment in the sector. Because of the slow growth in wild fisheries, the level of aquaculture production will play a large role in determining the relative prices of fish commodities.

Fish products are a heavily traded commodity-roughly 40% of global fish output by value in 2003. It was traded across international borders and the enormous rise in fish production in the selected countries has caused an about-face in the direction of trade in fish products since the early 1980s. In 1980 the selected countries was a net exporter value of 5 billion $ of food fish, but by 1980 these countries were net importers value 6 billion $ of food fish. Fifty percent of fish exports came from Japan, Norway, US and Thailand (Fig. 3 and 4).

In the selected countries, fish production plays an important role. Chile takes up only 52% share his aggregate level. As can be shown in Table 1, it produced 56 thousand tones in report year. These numbers clearly demonstrate that the production level differ between Turkey and the comparison countries. The comparison with the selected countries illustrates this point, the difference for the fish products amounted 3%.

The comparison of the results for export value of Turkey with those of the selected countries shows that the results are virtually identical. It takes a share 0.5% total export value of selected countries. The highest export share belongs to China, Norway, Thailand and US. China has 19% of the total export value in the selected countries.

It must be noted in the interpretation of this fact that the import value of Turkey is clearly lower than that of the other selected countries. The countries performing the

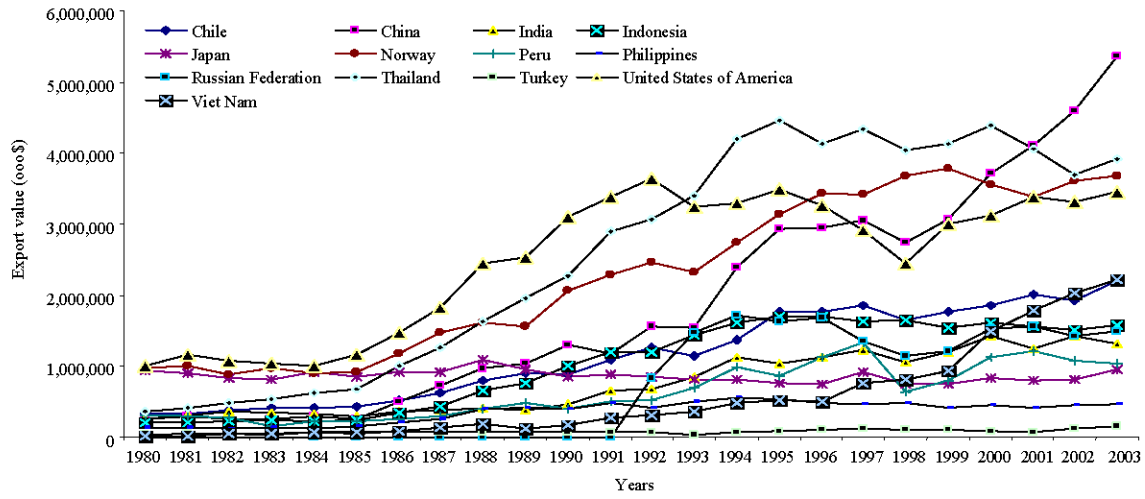

Fig. 3: Export value

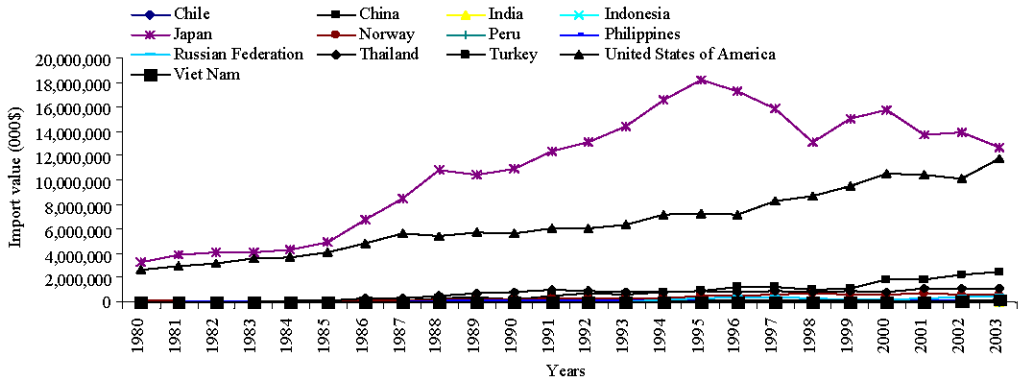

Fig. 4: Import value

Table 1: Production, consumption and trade in the selected countries (2003)

Countries	Production (tones)	Consumption (kg/year/capita)	Export value (000$)	Import value (000$)	Production (kg/capita)	Export (kg/capita)	Import (kg/capita)
Chile	55,687,878	217.01	2,194,610	86,141	288.73	138.86	5.45
China	6,111,342	42.64	5,362,366	2,426,254	42.45	4.09	1.85
India	6,036,834	5.22	1,311,250	50,491	5.55	1.23	0.05
Indonesia	5,960,930	23.75	1,579,783	76,088	27.11	7.18	0.35
Japan	5,913,334	69.58	952,419	12,623,644	47.29	7.46	98.89
Norway	5,533,020	400.86	3,669,067	583,268	724.78	809.41	128.67
Peru	4,563,441	162.89	1,032,725	26,026	224.95	38.01	0.96
Philippines	3,620,756	44.85	465,734	86,445	45.26	5.82	1.08
Russian Federation	3,590,452	21.05	1,485,646	554,931	23.94	10.37	3.87
Thailand	3,429,141	52.00	3,919,824	1,133,815	57.14	62.38	18.04
Turkey	3,285,416	8.56	150,667	46,586	8.24	2.11	0.65
United States of America	2,634,388	21.97	3,457,908	11,757,993	18.82	11.76	39.99
Vietnam	587,715	27.18	2,211,050	164,216	32.37	27.17	2.02

highest imports are Japan and US. Japan takes a share 43% of the total import value of the selected countries. The least share belongs to Turkey that is 0.16% of that of the compared countries.

Consumption per capita, production per capita, export value per capita and import value per capita are comparable between selected countries, as can be shown in Table 1.

RESULTS AND DISCUSSION

Chow test:

$$IM = EX + PR + CM + IN + PR + u$$

$$EX = IM + PR + CM + IN + PR + u$$

Ho: Coefficients of each group are equal to each other.

H_1: Coefficients of each group are not equal to each other.

According to the results of the Chow test made, for both models, $F_{calculation}$ value has been calculated to be larger than F_{table} value. Ho hypothesis has been refuted for both models and fixed effects method has been used again for both models (Table 2).

In fixed effects method, groups are assumed to be heterogeneous and the constant of each group is calculated. This method assumes that each group's junction point is different and slopes are the same. Thus, estimated parameters can be interpreted for each group. However, differences of the groups are evaluated with constants (Table 3).

The data set formed by import of 12 countries in the study has been explained with export, production, consumption, income and parities of the same countries. Import is always directly proportional with export. In the countries, where foreign trade volume is high, exports are also high like imports. Thus, export and import are directly proportional. In both models the signs of import and export are expected to be positive. In import model, the sign of export is positive, as expected. While, import increases export at a rate of 17.04%, export increases import at a rate of 7.06%. The fact that import increase export at a greater rate can be explained in two ways. One

Table 2: Chow test results for import and export models

Models	Error sum of squares	Chow test F-calculation	Chow test F-table
Restricted imports	104.51	-21.75	4.51
Unrestricted imports	893.90		
Restricted export	152.00	123.83	4.51
Unrestricted export	25.22		

Table 3: Parameters of import and export models

Variables	Import model	Export model
C	-8.9552 (-6.4295)	-5.7983 (-9.0638)
Export	0.7063 (5.7554)	-
Import	-	0.1704 (5.7554)
Production	-0.5662 (-1.9848)*	0.4956 (3.6002)
Consumption	0.5994 (4.5912)*	-0.5565 (-2.0256)
Income	1.5263 (9.7356)	0.4890 (5.7368)
Parity	0.0708 (2.8535)	-0.0025 (-2.2044)*
Fixed effects (cross)		
_CHINA-C	1.7107	-0.0885
_CHILI-C	-0.3328	-0.2018
_INDIA-C	-2.6295	1.8234
_INDONESIA-C	-0.5556	1.1228
_JAPAN-C	1.2373	-2.7523
_NORWAY-C	-0.3579	-0.5071
_PERU-C	0.2737	-0.3343
_PHILIPPINES-C	1.3956	0.1418
_THAILAND-C	1.3934	1.1839
_TURKEY-C	-1.7142	0.1069
_USA-C	-1.3544	-0.7811
_VIETNAM-C	-0.2583	2.2326
R^2	0.9429	0.9709
Adjusted R^2	0.9391	0.9689
S.E. of regression	0.6571	0.3228
F-statistic	249.8957	504.7838
Prob (F-statistic)	0.0000	0.0000
Durbin-Watson stat	1.9189	1.8616

Numbers in parentheses represent t-value. * is important at 5% and other parameters are important at 1%

of them is re-exporting. Countries can export products that they have imported with a lower cost than that of producing or hunting their own fishery products. The second is that countries can process and then export the products they have imported. Thus, in both situation export is dependent to import. In such cases import becomes the source of continuous export.

While, increase in production negatively affects import, it positively affects export. This situation is appropriate to the expectations in both models. While, relative increase in production decreases import by 5.66%, it increases export by 4.96%. Production affects import and export at the same rate, but in the opposite directions. The signs of consumption coefficient are appropriate to the expectations and while relative increase decreases export by 5.57%, it increases import by 5.99%.

Income positively affects import and its relative increase increases import at a rate of 152%. As analyzed by taking the log data sets, these values also give the elasticity of the variables. Thus, income elasticity of import is notably high. Income also, affects export positively. Its relative increase increases export at a rate of 48.90%. This situation is not appropriate to the expectations. But due to the fact that income elasticity of import is high and import elasticity of export is high, the sign of the income coefficient appears to be positive in export model.

The most important element in foreign trades of countries is the value of their own money. If a country's currency gains value against other countries' currencies, export becomes more difficult for that country, whereas import becomes easier for the importing country. For this reason, sign of parity variable is expected to be positive in import model and negative in export model. The signs of coefficients obtained in the model are also appropriate to the expectations. Moreover, while increase in the value of country currencies against dollar increases import at a rate of 7.08%, decrease in the currency value decreases export by 0.25%.

Parameters evaluated above are common for all countries as required by the assumptions of fixed effects model. But, for these countries different coefficients have been calculated. These coefficients show that the junction points of these countries is not the same. Constants calculated for each country also, show the differences between countries in terms of import and in terms of export. The countries with higher constants have larger effects on import and export.

Moreover, both models have high R^2 values and are significant at 1% level. There are various economic studies conducted on fishery products. Some of them are based on horizontal cross-section and some of them are based on time series. Some of them consist of studies aimed at determining the current situation. Although, there is no other study developed with the same method, or overlapping with this study, it will be useful to address here some studies conducted on the same subject. In the study dealing with Bangladesh, China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam, which have performed the highest fish production in Asia, disaggregated projections, impact analysis for fish supply, demand and trade were made, using the AsiaFish model. The results indicate that with rising population and income, fish demand will continue to grow. Supply will also rise, with the bulk of the increase coming from aquaculture (Dey *et al*., 2004).

A study, which was conducted in Nigeria aiming to determine the income generation potential and the efficiency of resource use in aquaculture farms, data gained from 120 businesses via questionnaires were used. Average gross margin is determined to be N 207,000 and technical efficiency is determined to be 81% in the above mentioned study. The result of sources of technical efficiency differential shows that extension; education, stocking density and credit significantly influenced technical efficiency of the farms. Also, result of simulated marginal effects of these variables on technical efficiency shows that extension has the highest marginal effects on the efficiency estimates, followed by credit, education and stocking density (Ogundari and Ojo, 2009).

CONCLUSION

In the study, two different models have been established for import and export, taking into consideration the import, export, production, income and parity parameters calculated according to national currencies of the countries, which have a voice in world aquaculture production and Turkey. It was determined that the results of the analyses with the variables used in the model are appropriate with the expected situation. This study was conducted in order to examine the situation of the foreign trade of aquaculture products after 1980; the date at which the liberalization of foreign trade started to accelerate. Thus, globalization has gained speed after 1980. During this period globalization had a large impact on the free circulation of goods. This impact requires the examination of the situation of many goods and groups of goods in the world market. With globalization, the competitive power of countries in terms of trade of goods came to fore. Decisions of the World Trade Organization (WTO) have extended the

liberalization of trade in line with globalization and competition has been reduced to sectoral level. Within this context, it is necessary to determine sectoral policy instruments necessary to increase competition in trade of goods in the international arena. For this purpose, the situation of aquaculture products in world markets has been examined.

According to the model estimated to explain foreign trade of aquaculture products, 94.29% of the changes observed in import and 97.09% of the changes observed in export is explained with production, consumption, income, parity and import/export. The results obtained from the model show that these variables can be used as policy instruments for foreign trade of aquaculture products.

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