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Research Article

Food safety standards and their effects on Iran's fish exports

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Abstract

Food safety standards are one of the major non-tariff barriers of global trade. We investigate their effects on fish international trade patterns, especially for the developing countries. The main objective of this study is to investigate the role of mercury standards on Iran's fish exports. We utilize the gravity model analysis based on balanced panel data model, covering eight importing countries over the 2006-2015 period. The estimated coefficient of mercury standard supports the hypothesis that fish safety standards are one of the important factors affecting fish exports. Moreover, regulation similarity between countries could increase fish trade. Other explanatory variables of geographical distance between countries, trade agreement between countries and real exchange rates also have a significant effect on fishery product exports. The results indicate that Iran's fish exports are negatively correlated with mercury standards of importers. As a result, adapting fisheries product standards and producing with the methods to deal with mercury standard imposed by importing countries is crucial for increasing Iran's fish exports.

Keywords: Mercury Standard, Gravity model, Fish, Export

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Introduction

In recent years, barriers to international trade such as tariffs and quotas have declined in many countries. They have been increasingly turned into a variety of standards related to product characteristics and production methods, processing, and distribution procedures (Hoekman and Nicita, 2011). The main aim of imposing standards in agricultural products trade is to ensure food safety and health of animals and plants, and these standards have also developed to other food products in recent decades. Mandatory and voluntary standards for imports are different between countries despite international coordination and the development of multilateral regulations and common conformity assessments by international institutions (Ferro *et al*., 2015).

The World Trade Organization (2015) sets out international regulations under Sanitary and Phytosanitary (SPS) agreement for the appropriate use of standards in order to protect human, plant and animal health as well as environment. Sanitary and Phytosanitary agreements aim to prevent unnecessary barriers to trade, but many countries still use restrictive food safety standards (Henson and Jaffee, 2008).

International trade of seafood products have increased more than twice in the past two decades and more than half of the exports of these products came from developing countries (Mashura and Makochekanwa, 2016). Iran is one of the developing countries that experienced a growth in fish production over 2006-2018. The average annual production of fish increased from 575365.8 tons in the period 2006-2009 to 1155190.0 tons in the period 2016-2018 (Table 1). Average annual production growth rate increased from 3.5% between 2006 and 2009 to 11.8% between 2016 and 2018. Between 2006 to 2009 and 2016 to 2018, the average annual increase in fish exports was 85457.1 tons, which was more than 300 percent increase in the average annual exports during the 2006-2009 period. Nevertheless, Iran has faced with different food safety standards such as mercury standards when exporting its seafood products to other countries.

Mercury (Hg) is one of the heavy metals mainly made by human activities. Mercury in contaminated waters enters human bodies through the food chain, it accumulates causing hazardous effects to human health (Rice *et al*., 2014). Fish, from fresh or marine water, appears to be the primary reason of Hg poisoning in humans (Bernhoft, 2012). Through mechanisms that are not yet known, various species of fish have higher rates of Hg bioaccumulation (Rice *et al*., 2014), and several countries and international organizations have established different levels of daily or weekly mercury intakes, to limit the maximum concentrations in fish and mercury standards.

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Table 1: Average annual Iran's fish production and exports, 2006–2018.

Average annual	Production	Export volume
Actual (tons)		
2006-2009	575365.8	25515.9
2010-2012	743074.3	46284.0
2013-2015	898601.0	58831.8
2016-2018	1155190.0	110973.0
Annual growth rate (%)		
2006-2009	3.5	14.0
2010-2012	11.8	26.0
2013-2015	8.1	7.5
2016-2018	11.8	25.3

Source: Tehran chamber of commerce, industries, mines and agriculture and FAOSTAT.

As food safety standards are not the same among different countries, this makes the effects of food safety standards on fish and seafood exports differ widely with different results. Kareem (2016) concluded that fish standard regulations have different effects on the margins of trade. This occurs because of the significant differences in the costs of compliance, the size of firms or countries, access to development assistance and countries' specific commodity promotion interests (prioritized commodity). Damalie (2015) showed that food safety challenges are the key drivers of export implementation for Canadian agri-food exporting firms and it is negatively correlated with firms' export sales growth so that its impact is higher than the number of export markets. The results also showed that prior investments in internal food safety resources and the implementing food safety systems within the firm could influence food safety challenges. Li (2014) confirmed that stricter standards have significant negative effects on trade of shrimp between EU and trading partners with lower level of food safety standards.

Shepherd and Wilson (2013) showed that EU standards could reduce trade for all countries as well as many goods. Nevertheless, internationally harmonized standards have limited the effects on trade, and in some cases even tend to have an increasing effect. EU standards also restrict trade of lightly processed products more than highly processed products, and it may hurt developed countries more than developing countries, but this effect of the standards depends on the sector and country type.

Liu and Yue (2012) also pointed out that food safety standards could be either a barrier or a catalyst for trade. Drogué and DeMaria (2012) and Mangelsdorf *et al*., (2012) showed that food safety standard harmonization has a positive impact on agricultural trade, but the effects of the interaction between similarity of regulations and

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exporting countries are ambiguous. Anders and Caswell (2009) and Tran *et al*., (2012) found that stricter food safety standards for seafood have negative impacts on many developing countries exporters. Baylis *et al*., (2011) showed that stricter standards act as a barrier to exports from developing countries and it is conceptually reasoned that exports from developed countries should be less affected. Nguyen (2009) concluded that different food safety standards had different effects on seafood products. The enforcement of the Japanese laws, the US HACCP, the EU MRPL caused respective average loss of 91.1%, 81.2%, and 71.6% to fresh fish trade.

The mentioned studies are witnesses of an increasing number of studies, which examined the relationship between food safety standards and food products trade. While most existing studies had found negative relationships between tightened food safety standards and food exports, the other studies reported an insignificant or even a trade-creating effect of these standards. The current study contributes to the literature in two aspects. First, panel data of food safety standards and in particular mercury standards for 8 major fish importers from Iran are created and second, the effects of mercury standards on fish exports from Iran as a fish exporter examined through the stringency changes in these standards during 2006-2015. For this purpose, gravity model was used which is a common model in predicting trade flow.

Materials and methods

The gravity model of trade proposed by Tinbergen (1962), explains that trade flows between two trading countries depend on economic size and their distance. The gravity model has been widely used by many researchers (Shepherd and Wilson., 2013; Caporale *et al*., 2015; Ulengin *et al*., 2015). The main purpose of this paper is analyzing the effects of mercury standards on Iran's fish exports. According to this goal, Iran's exports for fisheries products have been modeled as a function of mercury standards, geographical distance, the real exchange rate, tariff rate, regional trade agreements, and dummy variables. The gravity equation used in this study is as following formula:

$$Export_{it} = \beta_0 + \beta_1 \ln(S_{jt}) + \beta_2 \ln(DisS_{ijt}) + \beta_3 \ln(Dis_{ij}) + \beta_4 \ln(RER_{it}) + \beta_5 \ln(100 + T_{jt}) + \beta_6 RTA_{ij} + \beta_7 D_j + u_{ij} + \varepsilon_{ij}$$

where, i denotes country i, j denotes country j and t denotes year. β s are coefficients that should be estimated and ε_{it} is a stochastic error term. Export is the amount of fisheries products export to other countries. S_{jt} denotes the mercury standards in importing countries, and $DisS_{ijt}$ is the distance index of mercury standard between Iran and importing countries, taking values in the range 10 (indicating perfect

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similarity) and $+\infty$ (indicating perfect dissimilarity or difference). Dis_{ij} is the geographical distance between the capitals of two countries. RER_{it} is real exchange rate of country I and T_{jt} is the average of import tariff rates (%) imposed by importers on fish from Iran. RTA_{ij} is a dummy variable for the regional trade agreement and it is equal to 1 when there is a bilateral agreement and 0 otherwise. D_j is a dummy variable that is equal to 1 if importing country is developed and 0 otherwise.

There are two different approaches in panel data regression, namely fixed effect and random effect models. It is obvious that fixed effect model should be used when identifying the characteristics of the trade flows between predetermined countries. Therefore, we estimate equation (1) using the Poisson pseudo maximum likelihood (PPML) estimator with fixed effects. PPML model has proposed by Silva and Tenreyro (2006) who argued that this model has a consistent estimation compared with the OLS estimator.

Data

The analysis is based on balanced panel data and covers eight importing countries of Iranian fisheries' products during 2006-2015. The selected countries have imposed standards for fish exports from the other countries. The importing countries have been listed in Table 2. Iraq and Vietnam are the top two importers of Iran's fishery products among eight selected importing countries. It is accounted that more than half of Iran's fish exports between 2006 and 2015 were exported to Iraq. The average annual value of fish imports by Iraq accounted for 76% of Iran's total fish exports value between 2006 and 2015.

Table 2: Average annual value of fish export from Iran to major importers and average annual growth rates during 2006–2015.

Importers	Average annual export value from Iran ($)	Average annual growth rate of export value from Iran
Spain	317446.4	-28
Italy	568107.1	91
Germany	7900	55
China	4514438	40
Iraq	80218886	34
Taiwan	156896.7	1.1
Vietnam	18811281	120
Japan	23878.8	-99

Source: Tehran Chamber of Commerce, Lndustries, Mines and Agriculture.

The selected importing countries have implemented different mercury standards on fish imports (Table 3). Spain, Italy, Germany, China, and Taiwan issued mercury standards two times between 2006 and 2015. Iraq, Vietnam, and Japan did not change their mercury standards during 2006-2015.

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Table 3: Annual average mercury standards (ppm) regarding fisheries products export during 2006–2015.

Country	Mean	Min	Max
China	0.4	0.3	0.5
Germany	0.8	0.5	1
Iraq	1	1	1
Italy	0.8	0.5	1
Japan	0.4	0.4	0.4
Spain	0.8	0.5	1
Taiwan	1.1	0.5	2
Vietnam	0.5	0.5	0.5

Sources: Various Commission regulations, China Ministry of Health, Taiwan Department of Health and Welfare, Ministry of Agriculture and Rural Development of Vietnam, Hightower (2009).

Mercury standards indicate more stringent standards when their values are closer to zero and with farther away from zero, standards becomes more permissive. Among the countries studied, China has the most stringent mercury standard (0.3 ppm) and the most permissive standard adopted by Taiwan (2 ppm). Variations in mercury standards among countries and over time provide a useful database that can be used to estimate the impact of mercury standards on Iran's fish exports.Other variables data gathered from World Bank (2015), WTO, Central Bank of Islamic Republic of Iran and Tehran chamber of commerce, industries, mines, and agriculture.

Results

The descriptive statistical analysis of variables are reported in Table 4. For investigating stationary property of the variables, panel data unit root test (Levin *et al*., 2002) was used. The results of unit root test in Table 5 indicate that all variables are stationary at their levels.

Table 4: Descriptive statistics of the variables.

Variable	Mean	Min	Max	S.D.
Export	13077354.2	0	136925639.0	31680133.7
S; Mercury standard	0.7	0.3	2.0	0.4
DisS; Difference of standard	11.8	10.5	13.3	0.6
Dis; Distance	4811.2	940.1	7523.9	1895.7
RER; Real Exchange rate	21226.1	9538.0	39558.5	11499.3
T; Tariff (%)	(2.4) 102.4	(0) 100.0	(25) 125.0	6.9
RTA; Regional trade agreement	0.3	0	1	0.4
D; Developed country	0.5	0	1	0.5

Table 5: Panel unit root test (Levin, Lin, and Chu test).

Variable	Export	Ln (S)	Ln (DisS)	Ln (RER)	Ln(T)
With constant: Prob.	0.029	0.043	0.042	0.184	0.000
With constant and trend Prob.	0.015	0.000	0.000	0.000	0.000

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The empirical results using PPML fixed effect are presented in Table 6. According to the results, the right-hand side parameters explain 66-86% of the variation in Iran's fish exports to its partners. It can be seen that all estimated coefficients have the expected signs. It should be noted that in Table 6, we estimated six different regression models with different explanatory variables to investigate the effects of mercury standards and difference in mercury standards on fisheries export in different models.

Table 6: Impact of mercury standard on Iran's fish export by gravity model PPML.

Variable	1	2	3	4	5	6
Ln (S)	1.244*** (0.324)	0.714* (0.406)	0.980*** (0.313)	-	-	-
Ln (DisS)	-	-	-	-8.222*** (1.765)	-3.330 (2.807)	-6.614*** (1.700)
Ln (Dis)	-	-0.521*** (0.184)	-0.517** (0.245)	-	-0.633*** (0.165)	-0.574** (0.231)
Ln (RER)	-	0.972*** (0.216)	-	-	0.971*** (0.218)	-
Ln (T)	-	-	-1.185 (0.802)	-	-	-0.914 (0.721)
RTA	-	1.483*** (0.282)	1.220*** (0.368)	-	1.512*** (0.291)	1.191*** (0.365)
D	-	-2.784*** (0.524)	-2.870*** (0.437)	-	-2.717*** (0.527)	-2.863*** (0.408)
Constant	16.393 (0.369)	10.605 (2.475)	25.951 (4.242)	36.017 (4.523)	19.339 (7.477)	40.978 (5.858)
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	80	80	72	80	80	72
R-squared	0.69	0.86	0.66	0.69	0.86	0.66

Dependent variable: Iran's annual fish exports to each partner.
Note: *, **, *** Statistical significance is indicated at10%, 5% and 1%, respectively, Robust standard errors are in parentheses.

Column 1 indicates that the sign on coefficient mercury standard is as expected, positive and statistically significant. The estimated coefficient of mercury standard (in all models) support the hypothesis that fish safety standards is an important factor affecting fish exports. These results suggest that export from Iran to importers is constrained by stricter food safety standard that imposed by importing countries. This finding reinforces the contributions of Wei *et al*. (2012) and Ferro *et al*. (2015) which confirmed that exports decrease when importers impose high food safety standard.

The results also show that geographical distance between Iran and importing countries as a proxy for transportation costs has negative and statistically significant impact on Iran's

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export. This result confirms the findings of Natale *et al*., (2015) which stated that distance between countries has negative and significant effect on fish exports. The results indicate that the sign of real exchange rate is as expected, positive, and statistically significant.

The coefficient of the regional trade agreement dummy variable is positive and statistically significant, suggesting that implementation of regional trade agreements lead to increase in Iran's export to other member countries. Iran can take advantage by joining a larger RTA to increase its export opportunities to potential markets. This finding is consistent with previous studies (Paudel and Burke, 2012; Natale *et al*., 2015), which state that the membership in RTA has a significant influence on export. According to the results, the dummy variables for developed country importers is negative and statistically significant on Iran's fish exports, indicating that Iran tends to export more to developing countries in comparison with developed countries. This result is consistent with that obtained by Shepherd and Wilson (2013) who confirmed that the developing countries tend to export less to developed countries.

Based on the results (specification 3), tariff rate has negative effects on export and its coefficient is statistically insignificant, which suggests that tariff imposed by importing countries does not play an important role in Iran's fish exports. Other variables in specification 3 are similar to specification 2.

In specifications 4-6, the role of mercury standard difference on Iran's fish exports was investigated. The results indicate, in line with expectations, that mercury difference is negatively signed and has a significant effect on exports. In other words, importing countries with lax standard – high similarity with Iran – have more imports from Iran compared to importing countries with strict standard. The result is consistent with the previous report (Drogué and DeMaria, 2012), which confirmed that regulations similarity between countries, increase trade between them.

Discussions

Product standards are one of the important non-tariff barriers of international trade. Food safety standards by countries affect export flows of products, especially for developing countries. A review of the literature indicates that food safety standards play an important role in exports for developing countries. Nevertheless, there is not any literature available regarding the impact of fishery products standards on Iran's exports of these products. This study seeks to fill the gap in the literature by analyzing the role of food safety standards (mercury standard) on Iran's fish exports. For this purpose, the gravity model was used, and the analysis was based on balanced panel data that covered eight countries over the period of 2006-2015. Based on the results, the usual determinants of

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exports (such as geographical distance, regional trade agreement and other variables) were statistically significant factors affecting Iran's fish exports. Mercury standard plays an important role in fish exports from Iran to other countries. The results of standard differences also revealed that fish exports from Iran to importing countries with high similarity are higher in comparison with importers with low similarity. From a policy point of view, adapting production methods of fish and upgrading standard to deal with the mercury standard is a crucial issue for exporting countries such as Iran. Therefore, this is an opportune time to invest more resources into production methods of fish in order to gain an advantage in competition.

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