

Food safety regulations and trade effects: The Case of Indian Seafood Industry with special reference to *Kerala*, South India

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Abstract

This study represents an attempt to estimate the effects of SPS measures in terms of trade elasticity of regulations and competitiveness of exports. In spite of the generalized acknowledgment of growing liberalization of trade between countries, there are still numerous obstacles to trade, more of the non-tariff type. This study aims to contribute to the literature on quantifying the economic impact of health and environmental regulations expressed in the form of SPS measures on international trade in agro-food products, by taking Indian seafood exports case study. The gravity analysis, complemented with the CMS model, helped to obtain an insight into the overall dynamics of the export markets, trade flows and competitiveness of *fish and fishery products* (aggregate level), *shrimp* and *cephalopods*. For the regulatory variable, the maximum residue limit (MRL) on *cadmium* in the model is used as an independent variable. Thus, it was made much insightful in understanding the relationship between trade restrictiveness of regulatory stringency and export competitiveness of the commodities. A detailed study on micro level dynamics of *Kerala* seafood export sector has been carried out, particularly to understand what the industry level changes are experienced during the food safety regime. The results indicate that regulations on *cadmium* appear to be moderately trade restrictive. At the same time results are divergent at the disaggregate level, which is significant from the point of view of policy. The most important aspect of the existing chain in *Kerala's* seafood sector is the gradual disappearance of the independent pre processing sector which has been an important stake holder of the seafood value chain of Kerala. The pre processing node of the value chain is getting integrated to the processing sector causing a major restructuring of the existing value chain.

1. INTRODUCTION

The proliferation and increased stringency of food safety and agricultural health standards¹ is a source of concern among many developed countries either because

¹ A broad definition of standard includes mandatory technical regulations as well as voluntary agreements on the quality characteristics of goods and services.

these countries lack the technical and administrative capacities needed for the compliance or because these standards can be applied in a discriminatory or protectionist manner. It is very important to understand the impact of such standards on various agricultural export sectors in developing countries. Here we are attempting to capture the impact of food safety standards on seafood export² from India. To understand the minute details I am taking up a case study of seafood sector in *Kerala*. Any change in international food safety standard would immediately affect the export firms as they have to face the consignment bans. The contentious debate on the balance between environmental and public health concerns, and multilateral trade obligations necessitates empirical analysis on the various effects of regulations on trade. Indian seafood sector have been facing increased scrutiny by buyers and regulators especially for product quality and microbiological or chemical contaminations, mainly in the developed countries.

Mandatory standards³ fall within the purview of the World Trade Organization (WTO), specifically the Sanitary and Phytosanitary (SPS)⁴ and Technical Barriers to Trade (TBT) Agreements. These agreements have established international rules that aim to prevent mandatory standards impeding trade unless they are required to achieve a legitimate objective and, in such circumstances, to ensure that the measures applied are least trade distortive. Quantifying the trade impact of SPS measures is essential to resolve trade disputes and to provide a basis for calculating compensation claims. As Otsuki *et al.* (2001) pointed out; one major issue in trade policy is to compare the compliance costs of exporters with possible gains from complying. In the survey of the methodologies for quantifying the effects of SPS measures on trade, Beghin and Bureau (2001); Ferrantino (2003) note that estimating the trade forgone as a result of stringent SPS measures is an

² In this article the terms Seafood, marine products and fishery products are used as synonyms

³ Mandatory standards are also termed as technical regulations, are standards set by public institutions (in particular regulatory agencies) with which compliance is obligatory.

⁴ The Agreement on the application of Sanitary and Phytosanitary measures entered into force with establishment of WTO on January 1st 1995. The SPS Agreement establishes international rules on how to apply SPS measures. The purpose of the Agreement is to allow the legitimate protection of life and health to take place, while avoiding giving rise to illegitimate protectionism. Protectionism in this regard is defined as trade barriers over and above what is required to meet desired protection levels.

important step. They mentioned that a comprehensive impact of assessment of SPS measures is necessary for the following reasons; 1) to address the role to be given to non-tariff instruments and barriers in a future trade agreement and 2) to inform governments the costs of their SPS policies and provide the tools necessary to define more efficient solutions and regulations. Without quantification of the trade effect of SPS and TBT, it is unclear as to how significant they are as trade barriers. The direction and magnitude of the impact of SPS measures are essentially an empirical issue.

Unnevehr (2003) documents four cases from developing countries whose access to export markets was denied due to sanitary or phytosanitary issues, resulting in substantial costs in terms of lost sales, market share, and investments required to re-enter export trade. They included fish from Kenya, raspberries from Guatemala, shrimp from Bangladesh and horticultural crops from Guatemala, Jamaica and Mali. Otsuki *et al.* (2001) investigated the effect of *aflatoxin*⁵ standards in the EU on Africa-EU trade flows and health risks. They examine three regulatory scenarios: standards set at pre-EU harmonized levels, the standard set by Codex Alimentarius Commission (CAC)⁶, and the new harmonized EU standards. The human health implications of strengthening *aflatoxin* standards come from risk assessments conducted by the Joint FAO-WHO Expert Committee on Food Additives (JECFA). Using a gravity model, which includes *aflatoxin* standards as one of the explanatory variables, they predicted the effect of changes in the *aflatoxin* standard on trade flows between Africa and Europe. They conclude that compared to Codex standards, the implementation of the new harmonized *aflatoxin* standard in the EU would reduce health risk by approximately 1.4 deaths per billion a year, but would simultaneously decrease African exports to the EU by about US \$670 million.

⁵ *Aflatoxins* are a group of toxic substances that contaminate certain foods and have been associated with acute liver carcinogens in humans and animals.

⁶ The Codex Alimentarius Commission was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme.

A different picture is provided by Jaffee and Henson (2005) who argue that standards are not necessarily barriers for developing countries. They estimate the value of agro-food exports from developing countries rejected at the border due to SPS measures at about US \$1.8 billion, 74 per cent of which is accounted for by middle-income countries. The estimated value of low-income country agricultural and food product trade rejected at the border of importing country is US \$275 million, representing just less than 1 per cent of the agricultural and food exports of these countries. Other recent work on quantifying the impact of SPS regulations are (Bakshi, 2003) and (Gebrehiwet, 2004). Bakshi (2003) looked at the markets for Mexican avocados and examined the effect of demand, supply, imports and prices of partial easing of SPS barriers to trade in the US markets. Gebrehiwet (2004) quantifies the trade effects of SPS regulations on South African exports to the markets of Organization for Economic Cooperation and Development (OECD) countries by employing a gravity model, focusing only on a single regulation.

Marine products have long been the most buoyant among Indian export lines, following the imposition of stringent quality controls for marine products after the SPS regulations came into force. The demand for stringent and high hygienic standards in the production and processing facilities greatly increased, after the stipulation of Hazard Analysis Critical Control Point (HACCP) by United States Food and Drug Authority (USFDA), European Community (EC) directives (especially EC91/493⁷), and the EC ban on Indian marine products in 1997. The Government of India responded to these developments by taking important steps to maintain the highest quality standards based on the health safety regulation requirements of the importing countries. The Seafood Exporters Association of India claims to have spent US\$25 million on upgrading their facilities to meet the food safety regulations of the importing countries. The resultant impact on the structure of supply chains can have significant economic and social consequences for developing countries. In many cases, this impact reflects the fact that

⁷ EC Directives (91/493/EEC) For Fish and Shellfish Quality

investment in upgrading supplies chains and/or regulatory systems has not been correlated with the expansion of exports. On the other hand, there can be very positive returns in terms of continued and expanded access to high-value markets for those exporters that are able to comply. The case of seafood exports from *Kerala* provides a manageable case study that throws light on the challenges faced by exporters in India as a whole. At the same time, it highlights the particular challenges faced by the *Kerala* seafood sector that reflect the distinct manner in which it has evolved. In the present study we put forth two hypothesis, 1)The evolving stringent food safety standards imposed by the developing country export markets are trade restrictive to the Indian seafood export, 2) such a rise in standard will not only affect the export firms alone but also the entire supply chain will have to adjust accordingly. In other words there would be a possible re-shuffling and re-structuring of the entire supply chain.

As far as hypothesis 1 is concerned, for quantifying the effects of stringent food safety standards on Indian seafood export, a gravity analysis is performed and to measure export competitiveness in the overall ambience of regulations, a constant market share analysis is also done. To test the hypothesis 2, a case study of seafood export sector in *Kerala* to study the implications of standards-related compliance for market structures and for the participation of small-scale farmers, laborers and firms in export-oriented supply chains.

1.1 SOURCES OF DATA

Data on international trade are sourced from the Commodity Trade Database (COMTRADE) of the United Nations Statistics Division. The data used are for the period 1995 to 2006 (12 years). Select bilateral trade data are also taken from the Statistical bulletin of the Marine Products Export Development Authority, Cochin. The study focused on member countries of the European Union (EU), Organization for Economic Co-operation and Development (OECD) and select countries in Asia. As CMS analysis covers a longer period, especially base and current years, the composition of countries varies when compared to that of

gravity analysis. The selection of countries in each analysis is also based on the value of trade (with regard to relevant years in the analysis) with India. The commodities covered are (*Fish and fishery products, frozen shrimp, squids and cuttle fish*)⁸. The variables like gross national product (GNP) and population are taken from the UN Statistical Division's database. They are taken in constant US dollars of 1995. Data on *cadmium* regulations are sourced from a range of sources which include USFDA, Codex reports and Commission Regulations (EC) No 466/2001.

2. QUANTIFYING THE TRADE EFFECTS USING GRAVITY MODEL

Quantifying the elasticity of regulation is much complex since regulations affect market supply and demand in various ways. Some studies (Otsuki *et al.*, 2001; Wilson and Otsuki, 2004, and Roberts and Unnevehr, 2004) assume a hypothetical relationship between food safety, and the forces of demand for and supply of safe food. Information on regulations (such as maximum permissible levels⁹ of contaminants as numerical values) could be used in the model as explanatory variables. Among the regulations on food safety issues, the ones on the maximum permissible level of *aflatoxin* and pesticide residue are unique in a way that can be expressed in terms of numerical values, making them ready to be used in econometric models as independent variables. A positive coefficient indicates that the regulation is trade restrictive. The coefficient is expected to be positive if this standard limits trade. This implies that the coefficient for the regulation (maximum permissible level) implies that the change in the value of trade for an incremental change in the regulation (numerical value of maximum permissible level).

⁸ The Harmonized Commodity Description and Coding System (Harmonized System, or HS), are adopted for fish and fishery products, frozen shrimp, squids and cuttle fish respectively.). Fish and fishery products (HS 92 Code: 03) Frozen shrimp (HS 92 Code 030613), Squids (HS92) Code 30741 and Cuttle fish (HS 92 Code 30749).Squids and cuttle fish added/grouped together and hereafter referred to cephalopods. Fish and fishery products form the aggregate of all marine products while shrimp and cephalopods are disaggregated level marine products. The Harmonized Commodity Description and Coding System (HS) is an internationally standardized system of names and numbers for classifying traded products developed and maintained by the World Customs Organization (WCO). HS is a six-digit nomenclature.

⁹ Maximum permissible level can also be mentioned as maximum residue level(MRL)

Two models are considered from the strand of literature which employed gravity model to arrive at the elasticity of the trade effects of regulations. Otsuki *et al.* (2001) estimated the impact of changes in the standard for the presence of *aflatoxin* levels in the EU on bilateral trade flows using trade and regulatory survey data for 15 European countries and 9 African countries between 1989 and 1998. The study concluded that a 1 percent reduction in the maximum permissible level of *aflatoxin* in cereals and dried fruits and nuts would reduce trade flow by 1.1 percent for cereals and 0.43 percent for dried fruits and nuts. In another study, Wilson and Otsuki (2004) have examined the trade restrictiveness of pesticide residue standard on banana exports from 19 developing countries. The study examined the trade impact of the proposed and more stringent standard of the OECD on pesticide *chlorpyrifos*. An expanded gravity equation was used to estimate the trade elasticity of the proposed regulation. The results indicated a negative effect of *chlorpyrifos* standard imposed by the OECD countries on banana exports from the select exporting countries. A 10 percent increase in regulatory stringency - tighter restrictions on pesticide residues - leads to a decline of banana imports by 14.8 percent, suggesting that the restrictiveness of higher food safety regulations imposed by importing countries can be considerable.

Otsuki *et al.* (2001); Wilson and Otsuki (2001) have provided valuable inputs to the debate allowing conclusions to be drawn on the effective impact food safety measures which had significantly reduced international trade for certain sensitive products especially agro-food products. Having reviewed the limited existing literature on the quantification of the effects of public health regulations on commodity trade, it is proposed to employ a similar model to estimate the effect of a similar regulation in the context of Indian seafood exports. This analysis addresses the specific question which, how much trade restrictive (trade effect or elasticity of regulation) are the Maximum Residue Limit (MRL) on *cadmium*¹⁰ for Indian seafood export in the export markets in the OECD and Asia. The difficulties in quantifying a range of different types of regulatory standards and

¹⁰ Appendix 1

restrictions are widely acknowledged. While recognizing the difficulties and limitations of such exercises, it is useful to obtain at least some (admittedly crude) quantitative assessment of the effect of regulations on *cadmium*.

A gravity model of trade in international economics predicts bilateral trade flows based on the economic ‘mass’ (using GDP measurements) and ‘force’ (using distance) between two units. For long, the gravity equation has been used, with many studies successfully accounting for the variation and over time, in the volume of trade flow across country pairs. The later versions of gravity models have focused more on other variables like tariff lines and regional trading arrangements. Classical gravity models generally use cross-section data to estimate trade effects and trade relationships for a particular time period. But cross-section data observed over several time periods (panel data) result in more useful information than cross-section data alone. The advantages of this method are (1) Panel data can capture the relevant relationships among variables over time, (2) Panels can monitor unobservable trading partner’s individual effects, (3) If individual effects are correlated with the regressors, the Ordinary Least Squares (OLS) estimates will be biased. Therefore, it is more ideal to use the generalized Least Squares (GLS) estimation so that individual effects are captured. This also successfully tackles the problems of heteroscedasticity and autocorrelation. These are the prime considerations in employing panel data for estimations. Some additional terminology associated with panel data describes whether some observations are missing. A *balanced panel* has all its observations, and *unbalanced* otherwise.

Panel data can be estimated using various methods which include fixed effects, random effects and mixed models. Fixed effects ¹¹estimation is a method of estimating parameters from a panel data set. The fixed effects estimator is obtained by OLS on the deviations from the means of each unit or time period. This approach is relevant when one expects that the averages of the dependent variable will be different for each cross-section unit, or each time period, but the

¹¹ Appendix 2

variance of the errors will not. The essential difference between fixed and random effects is that the one associated with the error term. When the individual effects are important for the interpretation then binary variables are introduced to capture either the cross section or time effects, which otherwise simply accrue to the error term. Within effects fixed effects estimator estimates individual effects first which do vary across entities but do not vary across time periods. But time specific effects can be extracted by employing binary variables for time as well. Thus, the model will have $m - 1$ entity specific binary variables and $t - 1$ time specific binary variables.

2.1. MODEL SPECIFICATION AND ESTIMATION

Using the available data set, we estimate three gravity models of seafood trade from India: (1) for the total *fish and fishery products* (aggregate level) from India (2) For the *shrimp* exports from India (3) For the *cephalopod* exports from India. The *shrimp* and *cephalopods* contribute a major share in the value of seafood exports from India. More over, it is very important to look at the disaggregate level of seafood exports to get a better insight on the issue of food safety standards and the trade relations.

To determine the elasticity of food safety on Indian seafood exports (for the entire three scenario explained above) the following model is considered:

$$\ln(X_{ij})^t = b_0 + b_1 \ln(GNP_i)^t + b_2 \ln(GNP_j)^t + b_3 \ln(PCGNP_i)^t + b_4 \ln(PCGNP_j)^k + b_5 \ln(TGDP_i)^t + b_6 \ln(TGDP_j)^t + b_7 \ln(ER_{ij})^t + b_8 \ln(INF_i)^t + b_9 \ln(TIMP_j)^k + b_{10} \ln(CAD_j)^t + b_{11} \ln(DIST_{ij})^t + e_{ij} \quad (2.1)$$

where the dependent variable $\ln(X_{ij})^t$ denotes value of exports of seafood India (i) to countries (j) in year t . GNP_i , $PCGNP_i$, GNP_j , $PCGNP_j$ stand for the real GNP (expressed in 1995 US \$) and percapita GNP of exporting and importing countries respectively. $PCGNP_{ij}$ is the product of percapita GNP of exporting country and importing countries. $DIST_{ij}$ is the geographic distance between exporter and

importers. Initially the variables *ER* and *INF* are considered so as to capture the effects of changes in exchange rate between the exporting and importing countries and inflation in the ex-ported country. All these values are in natural logarithms. $TGDP_i$ and $TGDP_j$ are the trade-GDP ratio of the exporter and importer respectively to capture the effects of openness of the economies. A unidirectional gravity model is used where India's exports (value of exports sourced from the UN Comtrade) to 35 countries in case of total seafood exports and *shrimp* exports and 27 countries in case of *cephalopods* exports are modeled by taking food safety standard/sanitary regulation as the key independent variable, apart from the typical gravity variables such as size of the economy and geographic distance. For the regulatory variable, the maximum residue limit (MRL) on *cadmium* in the model is used as an independent variable, sourced from multiple resources which include USFDA, Codex reports, Commission Regulation (EC) No 466/2001 of European Union. National per capita income data are sourced from the National Accounts Statistics of the United Nations Statistics Division. The countries included in the analysis are listed in this section. All observations are annual for the period 2001-2006, making the total number of observations 210 in first two scenarios and 162 in the third scenario. Use of the gravity model is ideal to get the level of trade restrictiveness of the MRL of *cadmium*, which is a numerical value directly employable in the equation. Wherein $\ln(CAD)$ in equation is the variable for food safety, given as the maximum permissible level of cadmium in OECD and Asia.

The gravity model of India's seafood exports has been estimated taking all the explanatory variables in equation (2.1) for all the observations. There are many variables which are found to be either insignificant or having strong multicollinearity, which were dropped. The variable for ER (Exchange rate) and INF (inflation) were also found to be insignificant and having multicollinearity. Thus, dropping out a few variables, the final estimated gravity equation is the following:

SCENARIO 1

FISH AND FISHERY PRODUCT

$$\ln(X_{ij})^t = b_0 + b_1 \ln(TGDP_j)^t + b_2 \ln(PCGNP_j)^t + b_3 \ln(CAD_j)^t + b_4 \ln(DIST_{ij})^t + e_{ij} \quad (2.2)$$

In the equation, i denote the exporting country, j denotes the importing country and t denotes year $\ln(X_{ij})^t$ is the value of exports of total fishery products from India to various countries (35 countries in the OECD and Asia). $\ln(PCGNP_j)^t$ stands for the per capita GNP of the importing country. The proxy for transportation costs are captured by the variable $\ln(DIST_{ij})^t$ which stands for the geographical distance between exporters and importers. There are some limitations associated with the measure of distance, as they are taken from the Great Circle Distance, and represents the distances between country capitals, which may not represent the actual distances between commercial cities or centers. $\ln(CAD_j)^t$ is the variable to capture the trade effects of food safety stringency, given as the MRL on *cadmium* in OECD and select Asian countries. The model employs variable to capture the effects on trade as a consequence of trade liberalization. This is the openness variable represented by trade to GDP ratio, in the equation as $TGDP_j$ and e_{ij} is the error term assumed to be normally distributed.

In the estimation, individual effects are included. The estimation has followed fixed effects specification so as to get individual coefficients for all countries. So fixed effects is estimated after carrying out *Hausman test*¹² (the test to decide whether to adopt fixed effects or random effects specification) which favored the fixed effect model. Dummy variables for countries ($i - 1$, where $i = 1 \dots 35$) are employed as independent variables, so that the effects on heterogeneous intercepts (countries) are isolated. The generalized least square (GLS) regression is used which is corrected for heteroskedasticity and auto-correlation in the first step of the estimation. As one of the methods of estimating individual effects in the presence of time invariant regressors, transformation is used for estimations. The

¹² Appendix 2

first step of estimation is done using all variables except distance and regulatory variables for 210 observations. There is a problem with variables such as distance and regulation as the inherent transformation wipes them out if used along with other variables in the first estimation, because they do not vary across time. However, this problem is solved by estimating these variables in a second step, by running another regression with the individual effects as the dependent variable and distance and regulatory variables as independent variables as described in the model below:

$$IE_{ij} = b_0 + b_1 \ln(DIST_{ij}) + b_2 \ln(CAD_j) \quad (2.3)$$

Where, IE_{ij} are the individual effects, which are the individual country coefficients in the first step of estimation.

SCENARIO 2

SHRIMP EXPORTS

$$\ln(X_{ij})^t = b_0 + b_1 \ln(TIM P_j)^t + b_2 \ln(TGDP_j)^t + b_3 \ln(CAD_j)^t + b_4 \ln(DIST_{ij})^t + e_{ij} \quad (2.4)$$

Here the variable $TIMP_j$ is total import of fish and fishery product of importing country and the remaining variables are same as explained for equation 2.2.

SCENARIO 3

CEPHALOPOD EXPORTS

$$\ln(X_{ij})^t = b_0 + b_1 \ln(PCGNP_{ij})^t + b_2 \ln(TGDP_j)^t + b_3 \ln(CAD_j)^t + b_4 \ln(DIST_{ij})^t + e_{ij} \quad (2.5)$$

Here the variable $PCGNP_{ij}$ is product of percapita GNP of exporting and importing countries.

2.2. RESULTS AND INTERPRETATIONS

The estimated coefficients for the variables are described in table 2.1. Coefficients estimates can be interpreted as elasticities, as the model is estimated in the log

linear form. In the model, the coefficient of the GNP per capita is positive and highly significant. This implies that India tends to export more to high income economies. India's export to country j increases by .628 percent as the per capita GNP of importing increases by 1 per cent.

Table 2.1: gravity Analysis for fishery exports

Variables	Coefficients	Standard error
$\ln TGDP_j$.807	.402*
$\ln PCGNP_j$.628	.205**
$\ln CAD_j$.714	.328*
$\ln DIST_{ij}$	-1.048	.415**
<i>No of Observations</i>	210	
<i>Adjusted R²</i>	.92	
*, ** indicates significance at 5% and 1% level		

The regulation is found to be trade restrictive. The coefficient of the regulatory variable is positive and significant. The magnitude of the coefficient, which can be described as the elasticity of *cadmium* MRL, shows moderate response (in comparison with the coefficients of regulations which has been reviewed in this section) to regulations. The value of 0.714 means that a 10 percent tightening of regulatory stringency or a reduction in the maximum permissible level of *cadmium* will result in a reduction of exports by 7.14 percent.. The positive sign of the regulatory variable also has to suggest that total fishery imports are greater for a country that has less stringent regulation on *cadmium*. The trade-GDP ratio of importing country, the openness variable, has an expected positive and significant. The coefficient of this variable is .807 which means that India can further increase its exports by liberalizing exports. The distance variable is significant and has the anticipated negative sign, which indicates that India tends to trade more with its immediate neighboring countries during the period of food safety regulations. The co-efficient value is -1.048 which indicates that when distance between India and country j increases by 1 percent, the bilateral trade between the two countries declines by 1.048 percent.

Table 2.2. Gravity analysis for *Shrimp* exports

Variables	Coefficients	Standard error
$\ln TIMP_j$	1.028	.254 ^{**}
$\ln TGDP_j$	-1.732	.681 ^{**}
$\ln CAD_j$	0.782	.424 [*]
$\ln DIST_{ij}$	-1.187	.690
<i>No of Observations</i>	210	
<i>Adjusted R²</i>	.90	
*, ** indicates significance at 5% and 1% level		

The variable $TIMP_j$ denotes the total import of *fish and fishery products* in the importing country j . The coefficient was found positive and highly significant which means as the total import of *fish and fishery product* of the importing country increases by 1 percent the *shrimp* import do increase by 1.028 percent reflects that the *shrimp* import of the importing country is directly proportional to the import propensity of *fish and fishery products* of the country. In tune with what we have already observed in case of total *fish and fishery products* here also the regulation is found to be trade restrictive. The coefficient of the regulatory variable is positive and significant. The magnitude of the coefficient, which can be described as the elasticity of *cadmium* MRL, shows moderate response to regulations. Here the value 0.782 means that a 10 percent tightening of regulatory stringency or a reduction in the maximum permissible level of *cadmium* will result in a reduction of exports by 7.82 percent. The positive sign of the regulatory variable also has to suggest that total fishery imports are greater for a country that has less stringent regulation on *cadmium*. Surprisingly on contrary to the result in scenario 1 the trade-GDP ratio of importing country, the openness variable, is negative and significant. The coefficient of this variable is 1.732. Considering this result with the coefficient of *cadmium*, it supports the hypothesis that regulation may have a trade diversion effect to economies not much liberated during the period under consideration. However, even among the OECD countries during the period the trade must have been diverted to countries which have experienced relatively low trade openness in comparison with other OECD countries. The distance variable is significant and has the anticipated negative sign.

Table 2.3. Results Gravity analysis for *cephalopods* exports

Variables	Coefficients	Standard error
$\ln PCGNP_{ij}$.442	.190 ^{**}
$\ln TGDP_j$	1.48	.507 [*]
$\ln CAD_j$	-.97	.525 [*]
$\ln DIST_{ij}$	1.9	.987 [*]
No of Observations	135	
Adjusted R ²	.86	
*, ** indicates significance at 5% and 1% level		

Differing from the earlier results we obtained in *scenario 1* and *2*, in case of *cephalopods* export model the coefficient of regulation has significant negative value, which indicates the trade augmentation aspects of stringent standards in case of *cephalopod* exports. The magnitude of the coefficient, which can be described as the elasticity of *cadmium* MRL, shows value of 0.97 means that a 10 percent tightening of regulatory stringency or a reduction in the maximum permissible level of *cadmium* will result in an increase of exports by 9.7 percent. The negative sign of the regulatory variable also has to suggest that total *cephalopod* exports from India has positively responded to countries with stringent regulation on *cadmium* during the period under consideration. The product of per capita GNP of India and the importing country was found positive and significant. This implies that India tends to export more to high income economies. India's export to country *j* increases by .442 percent as the product of per capita GNP of India and importing country increases by 1 per cent. The trade-GDP ratio of importing country, the openness variable, has an expected positive and significant. The coefficient of this variable is 1.9. The distance variable is significant and has the positive sign, which indicates that in case of *cephalopods* India tends to trade more with far of countries (mainly OECD Countries) where the food safety regulations are relatively stringent than the Asian countries. The co-efficient value is 1.9 which indicates that when distance between India and country *j* increases by 1 percent, the bilateral trade between the two countries escalates by 1.9 percent.

The individual country effects¹³ indicate the propensity to export which are also the intercepts of the regression. There are several countries which show a high propensity to import from India. The country specific effects are significant for 25 countries in case of total fishery exports and 20 countries in case of *shrimp* exports. In case of *cephalopod* export analysis 21 countries has shown significant individual effects. They are mostly from the OECD, exhibiting strong effects. Thus, OECD countries are major outlets for Indian fishery products. This reinforces that food safety regulations which these countries impose may have a significant impact on Indian exports as the value of the coefficient indicates, adequately reflecting the policies of the OECD with regard to food safety regulations on the imports of agro-food products from developing countries. On the whole, the evidences indicate that decisions on export destinations have to be made considering these major determinants such as GNP per capita, distance and trade policies of individual countries with regard to regulations.

Here we have analyzed three scenarios of seafood exports from India to OECD and Asian countries. The first two scenarios where total seafood export from India at an aggregate level and shrimp exports shows the trade restrictiveness of the maximum residue level of cadmium, while the scenario 3 where we considered cephalopod exports from India has shown trade augmenting aspect of the stringent food safety regulations. Thus the analyses exhibit the dual nature of the stringent quality measures at the disaggregate level of the seafood items. Another point worth emphasizing is that there can be other important variables which are not included in the model (mainly due to data and estimation problems). Here, the gravity analysis is used as a desirable exercise to indicate the direction and magnitude of the effect on exports and has to be seen in this critical viewpoint. Thus, one of the arguments of this section also include that dependence on one model alone may not reflect all the theoretically attributed border effects. Thus, the major concern is whether access to markets can be retained. This reflects upon whether any particular regulation is really detrimental for an exporting country.

¹³ Appendix 2

3. CONSTANT MARKET SHARE ANALYSIS

The extensive application of CMS norm belongs to two main categories. The simpler version statistically decomposes the source of export performance and distinguishes between changes in market penetration (market share) and changes in the size of these markets (market size). Thus, here CMS analysis uses aggregate export data to measure the difference between constant share norm and actual export performance. By this procedure, export performance is assumed to be invariant regarding commodity disaggregation.

The more comprehensive version of the CMS analysis takes into account the commodity composition effect along with market size effect and competitiveness effects. In this method, competitiveness is actually a residual term. First applied to export growth by Tyszynski in 1951, this approach has since then been employed by many authors. Richardson (1971) gives a critical treatise on the competitiveness term of the CMS analysis. Merkies and van der Meer (1988) provide further theoretical grounding for the CMS approach. It has also been employed by a few studies to analyse India's export performance in terms of general competitiveness. These studies try to explain a country's export performance in terms of general competitiveness.

CMS analysis has been frequently used to examine the various factors behind growth in exports. However, the approach has been subject to limitations that should be kept in mind when interpreting the results of its application. First, the approach is sensitive to the choice of beginning and end-points, and may produce volatile results if the years chosen happen to be exceptional. Here, a period that is long enough is chosen to lessen this possible problem. Further, they have been taken as annual arithmetic averages to further reduce any serious inter-year variations. Second, the competitiveness effect is only a catch-up component in export growth, so in addition to competitiveness *per se* it can possibly encompass other factors that may not be directly related to competitiveness (such as peculiar trade

policies in exporting and importing countries). In practice, it is rather difficult to separate the impact of pure competitiveness from other factors that may affect the growth in exports. At the same time, it provides valuable inputs and indications on the share of the market, size of the market and the retention of the overall share due to supply conditions and the policies of the exporting and importing countries.

3.1. CMS MODEL SPECIFICATION

The following analysis will throw light on India's export performance in the importing countries (OECD, and select Asian countries). The method of CMS analysis, modified for a single commodity case, is an ideal complement to the gravity analysis in previous section. The data requirement, however, remains more or less similar. It should be emphasized that the CMS analysis is merely a measurement technique for decomposing the growth of a variable, and should not be viewed as a behavioural relationship. This model decomposes the source of export performance and distinguishes between changes in market penetration (market share) and changes in the size of these markets (market size). $(x^1 - x^0)$ in equation 3.1 refers to the growth in exports i (individual destination countries), which is decomposed into three components of export performance on the right hand side of the equation. The method is applied to individual markets, so that the country composition effect term is dropped, producing the following decomposition of export growth:

$$x^1 - x^0 = S^0(X^1 - X^0) + \sum_i (S_i^0 - S^0) * X_i^1 + (x^1 - \sum_i S_i^0 X_i^1) \quad (3.1)$$

Where,

x = value of India's exports of seafood to major export markets.

S = India's market-share of total exports of seafood to major export markets

S_i = India's market-share of total exports of seafood to member countries i in major export markets.

X = total exports of seafood to major export markets

X_i = value of total exports to the member countries i in major export markets; the superscripts 0 and 1 refer to the base period and subsequent period respectively.

Size of the market effect refers to the change in quantity of total exports to i over the period, $(X^1 - X^0)$. If this increases / declines, then even with a constant market share (S^0), then exports will increase / decline by $S^0(X^1 - X^0)$. The size of the market effect results from a shift in the demand in major export markets. Market Composition Effect refers to the changes in the export shares in individual member countries i compared to its overall share in the group, in the base period $S_i^0 - S^0$. Competitiveness effect measures the difference between actual exports in the subsequent period, x^1 and the level of exports that would have occurred had the same base period market share in each country ($x^1 - \sum_i S_i^0 X_i^1$) been maintained. It indicates the extent to which a country is able to gain international market shares in spite of adverse world demand movements. It is often interpreted as an indication of the dynamic ability of a country to respond to changing environment and adapt its supply situations to world conditions. Thus, it decomposes the export growth into the size of the market and market composition effects thereby isolating competitiveness effect ($x^1 - \sum_i S_i^0 X_i^1$) which is a residual term in the equation.

The underlying assumption of the CMS approach is that base period export shares are maintained in other market periods. The three structural components of the market share are calculated under this assumption. The total growth effect ($x^1 - x^0$) is equal to what the country's growth in export would have been if it had just maintained its share of total world exports. The market composition effect accounts for any additional growth (positive or negative) which takes place because the focus country's exports has grown in pace with the total growth in export of the commodity to the importing region as a whole. These three effects all hypothesize constant export shares. The residual effect ($x^1 - \sum_i S_i^0 X_i^1$), which proves the identity, accounts for all the growth which arises from changes in export shares.

3.2. RESULTS AND INTERPRETATION

The constant market share analysis is performed for the exports (quantity) of *shrimp* and *cephalopods*¹⁴ to the major export markets in the world (OECD and selected Asian countries) for the period 1995-2006. The analysis covered the whole period as annual arithmetic averages for three consecutive years. For example, 1995-2006 implies that it has covered the period 1995, 1996, 1997 for the base period and 2004, 2005, 2006 for the current period. The results are summarized in table 3.1.

Table 3.1. Decomposition of Shrimp Exports 1995-2006

Indian exports of shrimp	Shrimp	Cephalopods
Size of the market effect	92.62	20.08
Market composition effect	-33.06	25.34
Competitiveness effect	40.43	54.56

In case of *shrimp* competitiveness effect explains only around 40 percent of the growth in exports during 1995-2006. The market composition effects indicate the loss of market share to other exporters. On the whole the increase in exports is well explained by the enhanced demand alone. On the other hand *cephalopod* export is relatively competitive in comparison with shrimp during the same period. The competitiveness effect dominates the increase in exports to major markets, which explains around 55 percent of growth in cephalopods export during 1995-06. Thus the food safety regulations in the Europe which is the major importer of *cephalopods* from India has in fact augmented the increase in competitiveness of the cephalopod exports, while in case of *shrimp* the competitiveness is less. However, the competitiveness factor cannot be attributed to single factor of export determinant like food safety regulations but these figures are the modest indicators of different export determinants. The structural components are calculated on the assumption that a base period market shares are

¹⁴ The analysis for fish and fishery product (aggregate level) was not carried out because of the unavailability of data on quantity of exports at aggregate level.

maintained. However, these components may as a result, encompass a number of residual and other factors that are not necessarily associated with competitiveness such as discriminatory non-tariff barriers. At best, these figures are the modest indicators of the different forces that are in action at the international markets for Indian seafood. However, the main purpose of conducting the CMS analysis was to observe any complimentary /supplementary relation to the gravity analysis conducted in previous section, where we have observed contrasting results at disaggregated commodity level of seafood exports. We found that gravity analysis of shrimp exports revealed trade restrictive nature of the stringent food safety regulations while, the analysis of *cephalopod* exports suggest the trade augmenting facet of food safety standards. In this light we can argue that the CMS analysis supplements the results of gravity analysis conducted in section. The dominant competitiveness effect of *cephalopods* revealed through CMS analysis goes in tune with the trade augmenting results of cephalopods we obtained through gravity analysis. On the other hand the gravity analysis of *shrimp* exports revealed trade restrictiveness due to the increased food safety stringency in export destinations which goes well with the results of CMS analysis of *shrimp* where the competitiveness effect explained very less in the overall increase in market share during 1995-2006.

The results obtained from the gravity model analysis and CMS analysis obviously triggered the curiosity on *cephalopods*, and has lead to the finding that *Kerala* is the major producer and exporter of *cephalopods* from India (Appendix 4). Subsequently, we looked for *Kerala's* sanitary and phytosanitary compliance records *viz a viz* other states of India to find that *Kerala* is far ahead than other states in complying with the food safety regulations. It was found that during the year 2006 *Cochin* (the major seafood export hub of *Kerala*) has received only two complaints regarding noncompliance of seafood exports which is the lowest number of complaints among the seafood exporting states (ports) in *India* (table 2, appendix 4). The number of complaints of noncompliance has been reduced drastically during 2002 -2007 (table 3, appendix 4).

These findings answers to a great extend the puzzle generated in section 2 and 3, where we found that in case of gravity analysis the maximum residue limit (stringency) of *cadmium* has a positive impact on cephalopod exports from India. More over the CMS analysis revealed the dominance of competitiveness in *cephalopod* market share. *Kerala* is the major exporter of *cephalopod* from India and food safety compliance ability of seafood exporters in *Kerala* is far better than other states in India. This would be the logical answer to the puzzle posed during gravity and CMS analysis.

While *Kerala* seafood export sector presents a positive case of efforts to comply with the stricter food safety requirements in export markets, challenges remain. Particularly to understand what are the industry level changes experienced during the food safety regime, there is a need to study the micro level dynamics of seafood sector Hence a detailed study on *Kerala* seafood export sector has been carried out in the next section in a case study mode.

4. MICRO LEVEL CASE STUDY: KERALA SEAFOOD EXPORT SECTOR

We found that from 1997, the European Union (EU) imposed and enforced a set of food safety regulations on India's fishery exports, leading to a conditional ban on seafood exports and a subsequent crisis within the fish processing and export industry when the required standards could not be met. The new EU standards were followed by the enforcement of the seafood HACCP law in the USA from December 1999. In response, the fish processing and exporting industry successfully engaged in learning and innovation activities with the support of government institutions. But the institutional finance commensurate with the need was not forthcoming. As a result, many processors had to divert their working capital resources for upgradation of their plants. This coupled with the uncertainty prevailed in the international markets had adversely affected the seafood industry. A large number of seafood units become sick and non-viable. With a large number of seafood exporters facing recovery actions by financial institutions, the industry was looking for an exit route for non viable units.

European Union has been the major export destination of Kerala's marine exports. EU holds around fifty percent value share of Kerala's export destination during the year 2005-06. Thus any policy shock from the EU can have significant impact on Kerala's seafood export. Japan and USA are other major markets with around 12 percentage shares in value of export (table 4.1).

Table 4.1: Market wise export share of marine products from Kerala
Export value (in percentage)

Country/Year	2001-02	2002-03	2003-04	2004-05	2005-06
Japan	18.75	13.1	18.74	15.40	11.76
USA	17.5	18.37	12.92	12.01	11.56
EU	42.37	48.35	47.77	49.50	50.32
China	6.7	7.14	7.01	6.41	7.98
S.E Asia	6.5	5.31	4.46	5.18	5.53
Middle East	2.84	3.22	3.28	5.04	4.86
Others	5.36	4.52	5.55	6.45	8.00

Source: Kerala planning board economic review 2007

EU is the predominant driver behind the food safety controls being implemented in Kerala. seemingly continuous flow of emerging issues, most of which originally come to light through border detentions. Currently, controls on residues of antibiotics in the EU are a major concern, not only for India but for its major competitors. Additional issues include limits on heavy metals (like *cadmium*) and other environmental contaminants. For all of these concerns, it is clear that the EU imposes significantly stricter controls than Japan and U.S. Kerala is more dependent on EU and U.S. markets than the rest of India, and the state is dominated by exports of *shrimp* and *cephalopods*. EU's food safety requirements related to general hygiene controls and limits on antibiotics, as well as biological and chemical contaminants, have emerged as the dominant challenge.

4.1. IMPACT ON SEAFOOD PROCESSING SECTOR

Sea food processing facilities in *Kerala* traditionally procure the raw material in pre processed form from the peeling sheds. Products have traditionally been frozen in block form, although an increasing number of plants have installed capacity to manufacture Individually Quick Frozen (IQF) products. However, in most cases the value addition is very less and the products exported to EU and USA is further processed in the importing countries before it reaches the final consumer. The evidence available from the survey as well as the MPEDA records points out that the majority export firms operates with one freezing, although there is a shift toward consolidated businesses that operate multiple plants. The seafood industry in *Kerala* is highly export oriented where a very little share finds its way to the domestic markets. The period from 1990s to 2006 has witnessed significant increase in processing plant capacity as may be seen from figure 4.1, but the availability of raw material for processing has not kept in pace with the capacity build up in processing sector which has ultimately resulted in less than 25% capacity utilization of the processing plants.

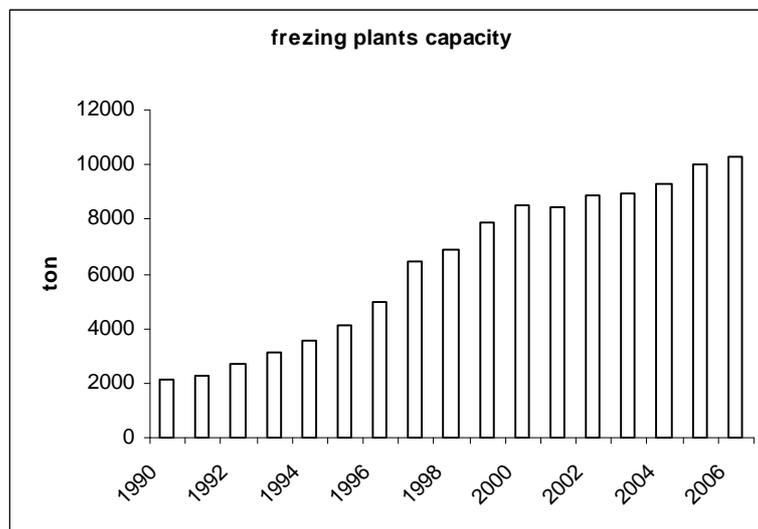


Figure 4.1 freezing plants capacity during 1990-2006

The rapid expansion of the processing sector during the 1990s, did not keep in pace with the emerging requests of the India's export market destinations,

especially EU. Even the new export processing facilities established during the period did not pay much attention for the importance of food safety standards and quality parameters. The standards of hygiene in the processing sector have shifted to an entirely different platform only after the EU bans of Indian exports in 1997. The compliance cost across the surveyed plants varied from US\$0.057 million to \$0.88 million. The average compliance cost across the seafood processing firms was found to be US\$0.40 million, which is at least a modest indicator of the investment cost spending per processing units for ensuring the market access to EU. The changes required to comply with the hygiene requirements varied significantly among fish processing plants. In extreme cases, plants had to be extended and/or the entire layout needed to be changed. According to the majority of the exporters the integrated pre processing facility was the major item among the compliance cost components. In fact the integrated pre processing facility is a mandatory requirement according to the Export Inspection Council (EIC).

More over the Processing plants also had to implement significant changes to their operational procedures. The majority had not implemented HACCP. These plants were required to establish the necessary plans, control procedures, and documentation systems. Furthermore, cleaning, maintenance, and rodent and pest control procedures had to be enhanced. In many cases, quite extensive programs of worker training had to be undertaken. The cost of implementing these new procedures has, in many cases, been considerable including laboratory analysis, record-keeping, ongoing staff training, and maintenance of worker medical records. To undertake these tasks, new technical and supervisory staff has had to be employed, and/or better qualified (and more expensive) personnel were needed. Monitoring fees paid to the Export Inspection Agency (EIA) have also increased significantly. In addition, the costs of preprocessing have had to be internalized within each processing plant. These costs are significantly greater than purchasing ready preprocessed raw material

LEVEL OF CONCENTRATION

The level of concentration of export share among the seafood exporters from *Kerala* has been presented in table 4.2. The presence of concentration in market share is very much evident, where few firms holding a large export share. Nevertheless, the pattern of change in concentration is very interesting. During the year 2002-03 there was only 1 firm holding more than INR50 Crores ¹⁵business turn over, while during 2006-07 there were 9 firms having a share of more than INR50 Crores business turn over. The number of firms over the years has declined, or more specifically a consolidation of export firms is happening.. The concentration ratio is found to be stable without any increase; rather the concentration ratio has declined during 2006-07 in comparison with the 2003-04 (table 4.3). It seems that the dominant trend over the next few years in fish processing node of the export value chain will be both consolidation and concentration.

Table 4.2: Distribution of seafood firms in *Kerala* according to their business turnover (Firm size measured in Indian rupee crores)

Firm size/year	2002-03	2003-04	2004-05	2005-06	2006-07
50 <	1	2	4	3	9
25-50	6	1	5	9	8
10-25	15	11	17	17	24
5-10	22	18	22	22	22
1-5	54	45	42	22	36
1>	118	101	71	73	52
No. of firms	216	178	161	146	151

Table 4.3: Concentration ratio seafood firms in *Kerala*

Year	Number of firms	Concentration ratio
2002-03	216	.021
2003-04	178	.034
2004-05	161	.023
2005-06	146	.021
2006-07	151	.021

¹⁵ INR is abbreviation used for Indian rupees

4.2. IMPACT ON PREPROCESSING SECTOR IN KERALA

Historically, in Kerala preprocessing of sea food has been undertaken by independent preprocessing facilities that supply preprocessed materials to processing plants. These are relatively less organized and lower capital based units generally called *peeling sheds*. Now many of the pre processing units are being integrated with the processing units. The *shrimp, squid, cuttle fish* etc. are brought by the *peeling shed* owners who employ large number of women and girls to peel them. Thus peeled products are graded and sold to the processing factories for further processing and export. The independent preprocessing sector has played an important role in the fishery economy of, absorbing much of the risk associated with fluctuations in raw material prices and carrying the significant fixed and variable costs associated with preprocessing. The stability of the export companies directly affects the depended peeling sheds. With the new regulations based on the EU stipulations more and more factories are needed to have their own pre processing facilities, however even now the pre processing is still done largely in the pre processing centers. It is found that today hardly 50% of the sheds operate regularly round the year.

During 2002 around 265 pre processing units deregistered from the business (MPEDA, 2003). While the number of preprocessing facilities declined during 1997-2006, installed capacity actually increased to around 100 percent per day during that period. Consequently, the average preprocessing plant capacity increased from 2.9 tons per day in 1997 to 9.2 tons per day in 2006. It could be inferred that the new preprocessing facilities registered has sufficiently large processing capacity.

A survey was covering 32 preprocessing establishments conducted across *Aroor - Chandiroor*¹⁶ belt to get an in depth information about the impact of international

¹⁶ *Aroor-Chandiroor* belt is the area where majority of pre processing units in Kerala are located

food safety regulations on sea food pre processing sector. Out of 32 preprocessing facilities surveyed 7 were functioning without MPEDA registration. About 72 percent of the labour force was women who worked on casual basis. The pre processing facilities procure the raw materials either directly from the landing sites or through agents. Most of the pre processing facilities supplied the processed material to one or two exporters on regular basis for so many years thus having a trust based relation ship between the exporters and pre processors. The average annual turnover of the surveyed facilities was US\$1.02 Million. The rough estimate of average capacity utilization was found to be 58 percent. Scarcity of raw materials and working capital was observed as the main reasons owing the low capacity utilization in these preprocessing facilities. More over it was observed that more than 95 percent of labour employed is on casual basis. In fact the casualization of the labour has increased over last four years. Thus the controlled workforce cultures in tune with the improvements in hygienic measures are found to be lacking in these facilities.

The pre processing facilities witnessed a very drastic change in the operational structure. For example even the way the workers used to do the pre processing activity has been changed. Earlier the workers used to sit on the floor to do the peeling operations, but due to the mandatory hygienic requirement the peeling operations has to be conducted on a table. Facilities like potable running water, change rooms, cold store, hand washing basins, toilets, staff uniforms and clothing and air conditioning has become mandatory for obtaining the MPEDA approval and subsequent registration. The respondents duly acknowledge the demand and requirements of the exporters in this regard. Thus the importance of international food safety and quality measures has been properly diffused to this particular node of the seafood value chain of *Kerala*.

Average cost of sanitary improvements of the surveyed pre processing facilities was found to be INR95, 000. The amount spent was ranging between INR 16,000 to INR0.51million. A 6 percent rise in production costs has been reported by the surveyed respondents. It was also noted that seafood exporters are maintaining a

close relationship with the pre processing facilities and imparting training regarding hygienic standards of the workers and quality measures to be practiced in the pre processing facilities

Scarcity of adequate financial capital for modernizing the preprocessing facilities and problem of volatile working capital were the major constraints expressed by the respondents. Apart from this the scarcity of fresh water and good quality ice were also expressed. *Peeling shed* operators usually procure seafood from the landing centers from agents or directly from the boat owners on a payment on the spot mode. The raw material is transported to the pre processing facilities and processed in a day or two. Subsequently the raw material is transferred to the seafood processing units.. The payment usually takes 3 weeks to 2 months in many cases. On an average a pre processor requires INR0.4 million to 0.6 million per day. Thus to be in the business he has to borrow money from private money lenders at exorbitant interest rates. This ultimately resulted in acute financial instability in many cases.

Although most of the pre processing facilities in the business have achieved the required mandatory standards stipulated by MPEDA, the unhygienic house and hut peeling was still continued in the surveyed area. These practices lack good quality water and ice and has been carried out without proper supervision and quality checks. Though these facilities are not registered with MPEDA, the exporters do procure from these facilities at cheap rates. The co existence of few unhygienic pre processing operations along with the approved pre processing facilities may deteriorate the improvements made in the quality front.

5. SUMMARY AND CONCLUSIONS

The present study employs gravity analysis to find out the trade elasticity of a particular regulation (here the maximum residue level of *cadmium* on seafood export at aggregated and disaggregated commodity level). The main purpose of this exercise is to estimate the trade restrictiveness of regulations in the popular

econometric framework. In earlier literature, the studies which employed gravity model in the similar context yielded results which indicated a positive coefficient for the regulatory variable suggesting that the tighter regulations will be trade limiting. In the context of Indian seafood exports too, a typical gravity model is employed (choice of variables was mainly drawn from previous literature). Here we have analyzed three scenarios of seafood exports from India to OECD and Asian countries. The first two scenarios where total seafood export from India at an aggregate level and shrimp exports shows the trade restrictiveness of the maximum residue level of *cadmium*, while in scenario 3 in which, we considered *cephalopod* exports from India has shown trade augmenting effect of the stringent food safety regulations. Thus the analyses exhibit the dual nature of the stringent quality measures at the disaggregate level of the seafood items. Here, the gravity analysis is used as a desirable exercise to indicate the direction and magnitude of the effect on exports and has to be seen in this critical viewpoint. The constant market share analysis is performed for the exports (quantity) of *shrimp* and *cephalopods* to the major export markets in the world (OECD and selected Asian countries) for the period 1995-2006. The dominant competitiveness effect of cephalopods revealed through CMS analysis goes in tune with the trade augmenting results of *cephalopods* we obtained through gravity analysis. On the other hand the gravity analysis of shrimp exports revealed trade restrictiveness due to the increased food safety stringency in export destinations which goes well with the results of CMS analysis of *shrimp* where the competitiveness effect explained very less in the overall increase in market share. At best, these figures are the modest indicators of the different forces that are in action at the international markets for Indian seafood. As far as International food safety regulations are concerned, It was found that *Kerala* is far better than other states in India. Subsequently, a detailed study on micro level dynamics of *Kerala* seafood export sector particularly to understand what the industry level changes are experienced during the food safety regime.

We have seen that in *Kerala* at the processing node of the chain concentration and consolidation is taking place where the number of exporters has come down and professional players are upgrading their position in the value chain. The most important aspect of the existing chain is the gradual disappearance of the independent pre processing sector which has been an important stake holder of the seafood value chain of *Kerala*. The pre processing node of the value chain is getting integrated to the processing sector causing a major restructuring of the existing value chain.

The dominant response to the imposition of stricter food safety standards for seafood exports in *Kerala* has been reactive, loyal and defensive, both by the government and in the private sector. Thus hygiene and antibiotic controls have been upgraded largely in response to regulatory change in EU and US, or on demand from major customers. In *Kerala* substantive drive to upgrade hygiene controls occurred suddenly when market access to EU was threatened or curtailed. We have initiated the study by formulating two hypothesis, 1)The evolving stringent food safety standards imposed by the developing country export markets are trade restrictive to the Indian seafood export, 2) such a rise in standard will not only affect the export firms alone but also the entire supply chain will have to adjust accordingly, in other words there would be a possible re-shuffling and restructuring of the entire supply chain. As far as hypothesis 1 is concerned it was found that food safety regulations imposed by developing countries is trade restrictive for the Indian seafood sector. But at disaggregated commodity level, the stringent regulations can be trade augmenting as well. This emphasize the need to look at more disaggregated level analysis of commodities for better insights and interpretations, Regarding the hypothesis 2, the study reveals that the pre processing node of the seafood value chain is getting integrated to the processing sector causing a major restructuring of the existing value chain. India would have to upgrade the national system for testing, certification and laboratory accreditation so as to be at par with the prevailing international trade regulatory safety parameters. In this regard, it is also important to focus on capacity building

in the private sector. Identification of priority needs and provision of the most appropriate to the particular circumstances.

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APPENDIX 1

Use of *cadmium* standards as the proxy of stringency in food safety regulations

Cadmium (*Cd*) is a heavy metal which has no known essential function in human life and is toxic even at low concentration when ingested over a long period. Therefore many consumers regard any presence of these elements in fish as a hazard to health (Oehlenschlager 2005). Food products account for most of the human exposure to cadmium, except in the vicinity of cadmium emitting industries. Cadmium concentrations in most foods range from about 0.01 to 0.05 mg/kg. Sea food, such as mollusks and crustaceans can be a major source of cadmium. In fact most foods, including shell fish have trace elements of contaminants and heavy metals. For most species the level of these contaminants is well below the established standards at which adverse health effects might occur. Recently, there has been an increasing concern, mainly in the developed world about exposures, intake and absorption of *cadmium* (*Cd*) by humans, where increasingly affluent populations are demanding a cleaner environment in general, and reductions in the amounts of contaminants reaching people as a result of increasing human activities.

Table 1: Alerts relating to Exports of seafood to EU

Year	Bacterial inhibitors	Antibiotics	Cadmium	Others	Total
2003	12	10	6	17	45
2004	2	12	5	6	25
2005	3	12	7	10	35
2006	-	13	9	4	26

Source: Export Inspection Council (EIC)

Quantifying the elasticity of regulation is much complex since regulations affect market supply and demand in various ways. Information on regulations (such as maximum permissible levels of contaminants as numerical values) could be used in the model as explanatory variables. Among the regulations on food safety issues, the ones on the maximum permissible level of aflatoxin (one of the microbial contaminants) and pesticide residue are unique in a way that can be expressed in terms of numerical values, making them ready to be used in econometric models as independent variables. In our pursuit to select a regulatory variable as a proxy of the stringency of food safety standards, we found that at least in case of sea foods this is a difficult task. Because, mostly the prohibited contaminants of the seafoods are expressed in 'zero tolerance'. In such cases it is impossible to take the contaminant as an independent variable. But later, it was found that *cadmium* could be used as a proxy variable for two reasons, 1) the

emerging importance of *cadmium* standards (see table) and 2) *cadmium* is expressed as a numerical value and it varies across countries. The toughest part was to extract the maximum residual limits of *cadmium* across various countries. For this we have relied on multiple sources which include USFDA, Codex reports, Commission Regulation (EC) No 466/2001 EU, Country specific food safety and health related websites and published research articles on cadmium and food safety. The *cadmium* (MRLs) of important countries is presented in table 2.

Table 2: Maximum residue limits of Cadmium

Country	mg/kg
Switzerland	0.05
New Zealand	0.2
Australia	0.2
Spain	1
EU	0.5
Japan	1
USA	2
China	3
Pakistan	6
Codex	1

Source: USFDA, codex reports
Commission Regulation (EC) No 466/2001

APPENDIX 2

Model selection test- Fixed vs Random Effect Models

Fixed effects regression is the model to use when you want to control for omitted variables that differ between cases but are constant over time. It lets you use the changes in the variables over time to estimate the effects of the independent variables on your If you have reason to believe that some omitted variables may be constant over time but vary between cases, and others may be fixed between cases but vary over time, then you can include both types by using random effects The generally accepted way of choosing between fixed and random effects is running a *Hausman* test.

Statistically, fixed effects are always a reasonable thing to do with panel data (they always give consistent results) but they may not be the most efficient model to run. Random effects will give you better P-values as they are a more efficient estimator, so you should run random effects if it is statistically justifiable to do so. The *Hausman* test checks a more efficient model against a less efficient but consistent model to make sure that the more efficient model also gives consistent results.

To run a *Hausman* test comparing fixed with random effects in *Stata*, you need to first estimate the fixed effects model, save the coefficients so that you can compare them with the results of the next model, estimate the random effects model, and then do the comparison.

```
. xtreg dependentvar independentvar1 independentvar2 independentvar3 ... , fe
    . estimates store fixed
. xtreg dependentvar independentvar1 independentvar2 independentvar3 ... , re
    . estimates store random
    . hausman fixed random
```

The *hausman* test tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If they are (insignificant P-value, Prob>chi2 larger than .05) then it is safe to use random effects. If you get a significant P-value, however, you should use fixed effects.

The essential difference between fixed and random effects is that the one associated with the error term. When the individual effects are important for the interpretation then binary variables are introduced to capture either the cross section or time effects, which otherwise simply accrue to the error term. Within effects fixed effects estimator estimates individual effects first which do vary across entities but do not vary across time periods.

Scenario 1

Gravity analysis for fish and fishery products

Hausman fixed random

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
Intgdpj	.8077811	.5205203	.2872608	.1461312
lnpcgnpj	.6284183	.5580541	.0703642	.0890374

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 6.50
Prob>chi2 = **0.0389**

Since Prob>chi2 is larger than 0.05 the test favours fixed effects estimates.

Scenario 2

Gravity analysis for shrimp

Fixed-effects (within) regression

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnimpfish	1.028683	.2267385	4.54	0.000	.5811534	1.476213
Intgdpj	-1.732073	.6377353	-2.72	0.007	-2.990816	-.4733288
_cons	2.202044	4.514293	0.49	0.626	-6.708139	11.11223

Random-effects GLS regression

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lnimpfish	.8322155	.1132598	7.35	0.000	.6102303	1.054201
Intgdpj	-.709155	.3509689	-2.02	0.003	-1.397041	-.0212686
_cons	1.564108	2.794724	0.56	0.576	-3.913451	7.041668

-----+-----
 . Hausman fixed random

---- Coefficients ----				
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
lnimpfish	1.028683	.8322155	.1964678	.1964244
lntgdpj	-1.732073	-.709155	-1.022918	.5324727

b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\chi^2(2) = (b-B)'[(V_b-V_B)^{-1}](b-B) = 3.73$$

$$\text{Prob}>\chi^2 = 0.1550$$

In this case although $\text{Prob}>\chi^2 = 0.1550$ is larger than .05, since our p values are significant the test favours fixed effects estimation

Scenario 3

Gravity analysis for cephalopods

hausman fixedrandom

---- Coefficients ----				
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
lnexpgdpj	1.923659	-.1329876	2.056647	.658208
lnpcgnpjind	.4477754	.5948393	-.147064	.1014744

b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\chi^2(2) = (b-B)'[(V_b-V_B)^{-1}](b-B) = 9.82$$

$$\text{Prob}>\chi^2 = \mathbf{0.0074}$$

Since $\text{Prob}>\chi^2$ is larger than 0.05 the test favours fixed effects estimates

APPENDIX 3

Table 3.1: Estimated Country Specific Effects
Gravity analysis for Fish and fishery products exports

Country	Coefficient	Standard error
Australia	1.604	0.612*
Austria	-3.408	0.585*
Bahrain	-2.090	0.930*
Bangladesh	2.214	1.067*
Belgium	1.277	0.629*
Canada	1.496	1.780*
China	5.153	0.561*
Denmark	-1.662	0.572*
France	1.602	0.573*
Germany	1.063	0.980*
Greece	1.453	2.854
Hong	0.253	0.639*
Indonesia	1.622	0.486*
Italy	2.131	2.129
Japan	4.970	1.620
Lebanon	-0.719	0.650*
Malaysia	1.450	0.820*
Maldives	-1.758	0.517*
Mauritius	-0.031	2.990
Mexico	-1.482	2.795
Netherlands	0.399	1.763
New Zealand	-1.178	1.063*
Portugal	1.109	1.776
Rep. of Korea	1.049	0.782*
Saudi Arabia	-1.982	2.832*
Singapore	6.160	0.537*
South Africa	1.803	0.534*
Spain	2.902	2.329
Sri Lanka	1.758	2.015
Switzerland	-2.110	0.555*
Thailand	2.811	8.209
UAE	1.773	.435*
UK	2.523	.769*
USA	4.481	1.072*
Viet Nam	2.817	.717*

* Significant at 10 percent level.

Table 3.2: Country specific effects:
Gravity analysis for shrimp exports

Country	Coefficient	Standard error
Australia	-2.772	1.917
Austria	-5.156	1.212*
Bahrain	-2.61	.472*
Bangladesh	-6.058	1.727*
Belgium	-0.502	1.519
Canada	-2.893	1.884
China	-4.148	2.116*
Denmark	-5.2	1.758*
France	-4.821	2.254*
Germany	-3.811	2.007*
Greece	-4.935	1.834*
Hong	-3.761	1.393*
Indonesia	-2.699	1.34
Italy	-5.1	2.254
Japan	-4.792	2.992
Lebanon	-3.768	1.187*
Malaysia	-1.133	1.187*
Maldives	5.637	3.494
Mauritius	-2.683	1.038*
Mexico	-6.221	1.581*
Netherlands	-2.934	1.614
New Zealand	-2.779	1.138*
Portugal	-5.296	1.900*
Rep. of Korea	-5.79	1.960*
Saudi Arabia	-5.1	1.297*
Singapore	-1.823	1.144
South Africa	-1.303	1.255
Spain	-5.687	2.325*
Sri Lanka	-3.557	1.205*
Switzerland	-4.636	1.549*
Thailand	-2.59	1.647
UAE	0.9	0.964
UK	-2.67	2.078
USA	-4.23	2.921
Viet Nam	0.333	1.032

* Significant at 10 percent level.

Table 3.3: Country specific effects
Gravity analysis for Cephalopods exports

Country	Coefficient	Standard error
Australia	3.411	2.01*
Austria	0.006	1.269
Belgium	4.825	0.931*
Canada	5.812	1.567*
China	6.901	1.78*
France	7.312	1.482*
Germany	4.720	2.033*
Greece	8.401	0.515*
Hong	1.071	1.783*
Italy	7.725	2.326*
Japan	8.711	1.951*
Lebanon	4.942	0.731*
Malaysia	2.082	0.899
Maldives	0.321	1.144*
Mauritius	2.730	1.087*
Netherlands	4.300	1.681
New Zealand	2.851	1.678*
Portugal	7.016	1.422
Rep. of Korea	2.620	4.769
Singapore	-6.004	1.646*
South Africa	4.122	1.764*
Spain	9.390	1.56*
Sri Lanka	4.630	1.391
Switzerland	1.792	1.048*
Thailand	4.656	1.777*
UK	6.046	2.534*
USA	10.320	2.01*

* Significant at 10 percent level.

APPENDIX 4

Table.4.1: *Kerala's* share in cephalopod* exports from India (2005-06)
Value (US \$ in million)

Item	Value		Kerala's share(in percentage)
	India	Kerala	
Cuttle fish	124.48	57.38	46.1
Squid	130.49	43.32	33.2

Source: MPEDA (<http://www.mpeda.com>), Kerala planning board

*Cephalopod include cuttlefish and squid

Table 4.2: Region wise status of complaints related to seafood exports from *India*

Region/Reason	Antibiotic residues	Heavy metals(cadmium)	Others	Total
Cochin	1		1	2
Chennai	8	1	1	10
Mumbai		8	2	10
Kolkota	4			4
Total	13	9	3	26

Source: Export Inspection Agency, Cochin

Table 4.3: Status of complaints related to seafood exports from *Kerala*

Year/Reason	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Bacterial contamination	16	2	3	4	9	8	4	1		1	
Antibiotic residues	0	0	0	0	0	5	6	2	1		
Bacterial inhibitors	0	0	0	0	0	9	4				
Heavy metals	0	0	0	0	0	0	1	1	1		
others										1	1
Total	16	2	3	4	9	22	16	4	2	2	1

Source: Export Inspection Agency, Cochin

