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EU Ban, HACCP Compliance and Shrimp Exports from Bangladesh

by

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The paper evaluates the impact of the European Union import ban in 1997 and HACCP compliance on Bangladesh's shrimp exports by using an augmented gravity model. Panel estimation method was applied to capture the import country effect. The dynamic gravity model was found more suitable than the static one to explain shrimp exports from Bangladesh due to the presence of persistence. The results of the dynamic model show that the EU ban hurt Bangladesh shrimp exports by US$ 25 million in the short run along with a long run cost of about US$ 5 billion. However, through HACCP compliance, Bangladesh succeeded in exporting an additional US$ 18 million worth of shrimp in the short run. In the long run, HACCP compliance helped Bangladesh export an additional US$ 35 million annually. The results bring out significant role of policy incentives in increasing shrimp exports. Bangladesh needs to continue quality assurance system based on the HACCP to comply with SPS measures in order to boost its shrimp exports.

I. INTRODUCTION

The member countries of the World Trade Organization (WTO) may protect their interests in health and hygiene by taking necessary actions through the Agreement on the Sanitary and Phytosanitary (SPS) measures without making any discriminatory trade restrictions. However, exporting countries, especially the least developed countries (LDCs), often allege that certain provisions in the Agreement act as border protection instruments and as such may not necessarily safeguard the interests of the domestic residents but protect interests of favoured trading partners. It, thus, creates a continual tension between the exporting and importing countries over the legitimacy of the ban. However, one thing is clear in this debate. The

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exporting country is hurt once a ban is imposed; it loses exports almost immediately and has to incur additional costs to comply with the standards of the importing countries.

The case of European Union (EU) ban on imports of shrimp from Bangladesh in the fiscal year 1998 on the SPS grounds may be viewed from such a perspective. In July 30, 1997 the European Commission (EC) imposed a ban on imports of shrimp from Bangladesh into the EU on the ground that exports of this commodity did not meet the provisions of her HACCP (*Hazard Analysis Critical Control Point*) regulations.[1] The ban remained effective for five months, between August and December 1997. As a result, exports of frozen shrimp from Bangladesh to the EU reduced to *zero* during this period. The Government of Bangladesh (GOB) and the shrimp entrepreneurs invested substantially to ensure HACCP compliance in the export-oriented shrimp sector. Special credit programmes were designed and supports of a number of global organisations were sought. Cato and Santos (2000) estimated that the total cost of upgrading facilities and equipment, and training staff and workers for achieving acceptable SPS standards was about US$ 18.0 million and the annual cost of maintaining HACCP standards was estimated to be US$ 2.4 million.

Cato and Santos (1998) analysed the short term financial impact of the EU ban on import of shrimp from Bangladesh. The authors conducted simulation exercises under *with* and *without ban* scenarios and arrived at an estimate of about US$ 65.1 million as the cost of the EU ban for Bangladesh. Insofar as some of the farms/exporters succeeded in diverting a large part of their intended shipment to Japan and the USA, the net loss was reduced to about US$ 14.7 million. However, Cato and Santos' estimate may not provide the accurate impact of the ban unless two types of factors are controlled for. The first type of factors is dictated by trade theory, especially the gravity model type of analysis. From this perspective factors such as the level of income of the origin and destination countries, distance between them and other proximate determinants are important. The second type of factor is an outcome of the nature of trade relations between importers and exporters. Trade relations between importers and exporters are slow and difficult to build. Exporters have to earn trust and confidence of the importers apart from financial issues in the transactions. As exporters make one successful shipment, it makes a positive impression into the importers' mind and hence may propel further shipment(s) in

[1] HACCP is a process control system that identifies where hazards might occur in the food production process and puts into place stringent actions to take to prevent the hazards from occurring. By strictly monitoring and controlling each step of the process, there is less chance for hazards to occur.

the next period with possibly higher volume(s). The converse is also true. Thus, intuitively one can expect that current exports are also determined by the past exports.

This paper, thus, attempts to analyse both the short- and long-term impacts of the ban and the adoption of the HACCP, *albeit partially*, on the export performance of shrimp in Bangladesh. Evidently, there were short term losses as Cato and Santos (1998) estimated, albeit not accurately. The medium to long term impacts would depend on how the GOB and the shrimp entrepreneurs responded to the ban. The role of shrimp exports in the economy and growth performance of shrimp exports in terms of value before and after the EU ban are briefly examined in section II. Section III deals with methodological issues, including the method employed in the empirical work, while section IV is devoted to estimation techniques and issues related to static and dynamic models and dealing with zero shrimp exports to a particular country in a particular year. Estimation results first without persistence and then with persistence are presented in section V. The final section summarises the findings and discusses their implications.

II. BANGLADESH'S SHRIMP EXPORTS

This section analyses the importance of shrimp exports in the economy of Bangladesh. Table I presents the values of total, primary products, and shrimp exports over the period of 1990 to 2007 fiscal years. The value of shrimp exports shows increasing trends over the period under consideration except in 1998 and 1999. During these two years absolute exports were below that of the immediate preceding and succeeding years. It increased from about US$ 127 million in 1990 to about US$ 279 million in 1997 and from about US$ 322 million in 2000 to about US$ 457 million in 2007. In contrast, during 1998 and 1999 exports of shrimp declined to about US$ 250 million. It may be noted that the trend in fish exports followed closely that of shrimp exports. Between 1990 and 1997, it increased from US$ 139 million to US$ 332 million and showed a depressing trend during 1998 and 1999 before bouncing back with a vengeance since 2000. Even though exports of primary products show the same cyclical pattern, total exports did not show any discernible sign of the impact of the EU import ban on shrimp.

The value of shrimp exports has been expressed as per cent share of (i) total fish exports, (ii) exports of primary products, and (iii) total exports (Table I). The share of shrimp exports in total exports was around 6-7 per cent in the early 1990s; the trend continued till the EU ban. After the ban its share declined to 4.6 per cent and showed a secular declining trend since then. It may be noted that exports of readymade garments (RMGs) have been increased dramatically since the mid-1980s. The value added of the RMGs is considered to be only 25 per cent, whereas

the same is about 100 per cent in the case of fish exports in general and shrimp exports in particular. In this respect, the contribution of shrimp exports would be much higher in total exports, if one compares the value added of shrimp exports with that of the RMGs. The share of shrimp exports in the exports of primary products increased remarkably over time. In the early 1990s it was less than 50 per cent but it increased to more that 60 per cent in the early 2000s before showing a declining trend (Table I). This implies that shrimp contributes to more than half of the earnings from the exports of primary products in Bangladesh. Unsurprisingly, shrimp exports constitute more than 90 per cent of fish exports in Bangladesh. Thus, whatever happens to the exports of shrimp invariably leaves behind its mark on the exports of fish.

TABLE I

ROLE OF SHRIMP EXPORTS IN THE ECONOMY OF BANGLADESH

(value in US$ million)

Year	Exports of				Shrimp Exports as per cent of		
	Shrimp	Fish	P. Products	Total	Fish	P. Products	Total
1990	126.86	138.49	322.96	1776.74	91.60	39.28	7.14
1991	127.97	143.89	306.13	2011.86	88.94	41.80	6.36
1992	119.71	134.62	267.26	2328.52	88.92	44.79	5.14
1993	155.48	176.97	313.91	2856.96	87.85	49.53	5.44
1994	197.67	229.04	346.80	3031.34	86.31	57.00	6.52
1995	260.70	324.46	452.20	4113.95	80.35	57.65	6.34
1996	270.51	320.88	475.84	4411.58	84.30	56.85	6.13
1997	279.22	332.06	526.43	4937.80	84.09	53.04	5.65
1998	**260.41**	**295.85**	**501.93**	**5687.70**	**88.02**	**51.88**	**4.58**
1999	242.23	280.99	422.33	5904.66	86.21	57.35	4.10
2000	322.43	347.44	469.14	6356.92	92.80	68.73	5.07
2001	349.75	364.23	484.62	6987.99	96.03	72.17	5.01
2002	252.18	282.80	390.30	6737.26	89.17	64.61	3.74
2003	297.04	333.89	462.59	7347.21	88.96	64.21	4.04
2004	362.87	397.16	553.36	8653.00	91.37	65.58	4.19
2005	365.82	399.77	648.29	8805.07	91.51	56.43	4.15
2006	403.58	439.55	772.70	9082.84	91.82	52.23	4.44
2007	456.98	486.84	832.27	11458.98	93.87	54.91	3.99

Sources: Export Promotion Bureau (EPB), *Export Statistics*, different issues.
Department of Fisheries, *Fisheries Statistical Yearbook of Bangladesh*, different issues

Bangladesh is a food deficit country and hence spends significant amount of foreign currency to import food grains every year. It might be of interest to see what proportion of food import bill that could be met from exports of shrimp. As imports of food grains do not show any systematic pattern, any sweeping generalisation is fraught with danger. Despite this caveat, it was found that shrimp exports could cover from as low 34 per cent of food grains imports in 1999 to as high as 156 per cent in 1997. On average shrimp exports were able to meet more than 80 per cent of the import bill of food grains. Thus, fish exports show an increasing role in the economy in many respects.

TABLE II
EXPORTS OF SHRIMP TO THE EU, JAPAN, AND THE USA
(value in US $ million)

Year	EU	Japan	USA	Total
1990	44.03	27.66	52.47	126.86
1991	65.68	18.32	42.40	127.97
1992	56.74	11.83	45.88	119.71
1993	68.07	19.65	62.51	155.48
1994	98.56	22.30	68.35	197.67
1995	109.54	56.01	79.32	260.70
1996	117.69	68.27	74.88	270.51
1997	130.16	50.98	88.73	279.22
1998	**48.92**	**36.54**	**142.51**	**260.41**
1999	91.19	32.16	95.27	242.23
2000	129.48	36.24	125.94	322.43
2001	186.94	28.01	119.07	349.75
2002	134.02	11.43	97.41	252.18
2003	196.23	14.86	77.13	297.04
2004	209.71	19.62	127.36	362.87
2005	195.72	17.01	150.83	365.82
2006	220.17	17.07	159.39	403.58
2007	242.72	13.52	175.21	456.98
Growth (%)	8.89	-2.98	7.14	7.01

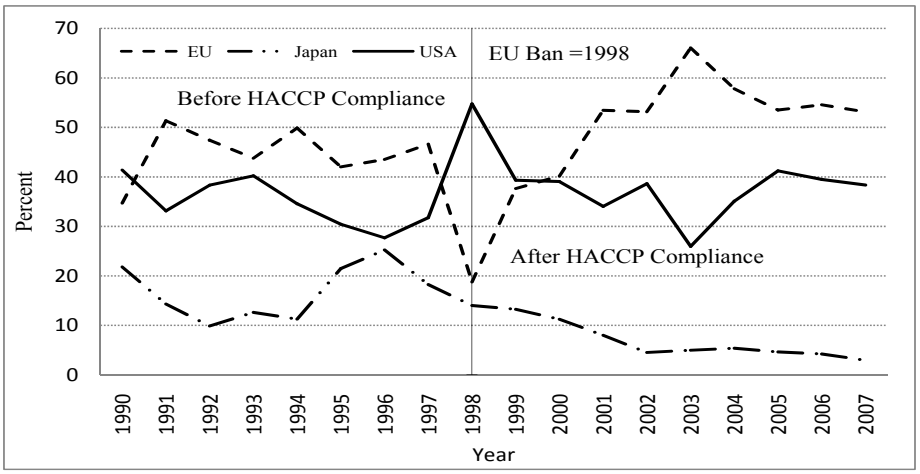
Source: Export Promotion Bureau (EPB), *Export Statistics*, different issues.

Table II presents the total exports of shrimps to the EU, Japan, and the USA. It may be noted that shrimp export to the EU countries was about US$ 44 million at the beginning of the 1990s; it increased to US$ 130 million in 1997. However, the value of exports plummeted to the 1990 level when the ban was imposed. It then picked up when the ban was lifted and Bangladesh started to comply with the HACCP regulations. Exports to Japan show an inverted U-shaped trend; before the

EU ban exports to Japan increased from US$ 28 million to US$ 51 million but after ban was lifted it showed a declining trend. Shrimp exports to the USA were about US$ 53 million at the beginning of the 1990s. It increased to US$ 143 million in 1998 when Bangladeshi shrimp exporters had to bear the brunt of the EU ban. Since then it showed an upward trend except in 2002 and 2003 presumably as a staggering effect of the 9/11 event in the USA.

Annual compound growth rates have been estimated for total shrimp exports as well as that for the above three destination countries for the period 1990 to 2007 (Table II). The annual growth of fish exports has been registered at 7.01 per cent. Among the three destinations, the EU shows the highest annual growth rate, despite smarting the impact of ban followed by the USA (7.14 per cent). In contrast, exports to Japan show negative growth rate (-2.98 per cent). In any case these three markets constitute more than 95 per cent of total shrimp exports from Bangladesh and the EU and the USA maintain more than 90 per cent of the market share. So, any disruption in the EU or the US market will leave shrimp exports in utter disarray.

Figure 1: Share of Shrimp Exports to the EU, Japan and the USA



The trends of the share of Bangladesh shrimp exports to the EU, Japan, and the USA are shown in Figure 1. The temporal movement of the shares evidently corroborates the analyses associated with Table II. It may be noted that the share of the EU maintained a mild upward trend until 1997 when it rose to 47 per cent of Bangladesh's shrimp exports. The 1998 ban dragged it down to 19 per cent and the

effect seems to have staggered up to the next year. Contrary to the claims by Cato and Santos (1998), Japan did not absorb any part of the displaced EU imports as its share decline from 18 per cent in 1997 to 14 per cent in 1998 and thereafter the Japanese share of the market showed a sharp decline. At present Japanese share stands at less than 5 per cent of Bangladesh's shrimp exports. In contrast, the share of the US imports surged from 32 per cent in 1997 to 55 per cent in 1998. Thus, the US importers seem to have attenuated much of the impact of the EU ban.

III. METHODOLOGICAL ISSUES

Analogous to Newton's law of motion in mechanics the gravity model for trade implies that trade flow between two countries is proportional to the product of each country's 'economic mass' (generally measured by GDP), raised to the power of quantities to be determined, divided by the distance between the countries' respective 'economic centres of gravity' (generally their capitals), raised to the power of another quantity to be determined. Following Matyas (1997) the correct gravity model specification with panel data may be viewed as a three-factor error components model. One dimension is time (reflecting the common business cycle or globalisation process over the whole sample of countries) and the other two dimensions of group variables are time invariant export and import country effects. Following Helpman and Krugman (1985) and Helpman (1987) an endowment based 2×2×2 model can be chosen, where one of the two goods is differentiated and the other is homogeneous. The two factors of production are the stock of capital and the labour force. In such a framework the total volume of trade of each country could be defined as the sum of inter-and intra-industry trade volumes. Most empirical analyses of gravity models add a certain number of dummy variables to test for specific effects, for example external shock such as ban on exports, imports and so on. The usual econometric representation of the gravity model takes the form of a triple-indexed model:

$$\ln X_{ijt} = \beta_0 + \eta_i + \eta_j + \lambda_t + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln D_{ij} + \sum_{k=4}^{p} \beta_k \ln A_{kijt} + U_{ijt} \quad (1)$$

where η_i are the export country effects, η_j are the import country effects, and λ_t are the time effects. Besides, Y_i (Y_j) indicates the GDP of the country i (j), D_{ij} measures the distance between the two countries' capitals (or economic centres), A_{kij} represents other control variables such as the real exchange rate, the EU ban[2] in

[2] The EU ban equals 1 if year equals 1998 and the countries are the EU member countries and zero otherwise.

1998, and HACCP compliance[3] since that year, U_{ijt} is the error term and β_s are parameters of the model. Since Bangladesh is only exporter and the data set to be used in the study is rather short, both γ_i and λ_t can be safely subsumed in the constant. So, a special case of the general gravity model in (1) becomes:

$$\ln X_{jt} = \beta_0 + \eta_j + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln D_{ij} + \sum_{k=4}^{p} \beta_k \ln A_{kjt} + U_{jt} \qquad (2)$$

where $i = 1, j = 1, \ldots, N;$ and $t = 1, \ldots, T$ and i now indicates Bangladesh.

Following the theoretical underpinnings of gravity model one expects positive signs for β_1 and β_2, and a negative sign for β_3. The signs of $\beta_{k's}$ cannot be assigned *a priori,* as these signs depend on the contextual relationship of exports and each of those particular variables.

IV. ESTIMATION TECHNIQUES AND ISSUES

The trade flow is usually handled econometrically in terms of a static gravity equation based on cross-section data. However, there has been a surge in interest in applying the model in the context of panel data without any agreement on the propriety of the type of model. While Baldwin (1994) used a random effects model (REM), Matyas (1997, 1998) does not give preference to the fixed effect model (FEM) over the REM or vice versa. But Egger (2000) argues both intuitively and based on Hausman (1978) test that FEM should be the preferred alternative. This paper follows Egger (2000) for estimating the static gravity model. Since the distance variable is time invariant, the FEM has been estimated in two steps following Coulibaly (2004). The first step regression includes only time varying variables along with country specific fixed effects. The second step regression on pooled data uses the estimated country specific effects as dependent variable and includes both time varying and time invariant variables. Regression coefficients at the first step measure the time dimension effect of the variables due to the historical causes and those of the second step measure cross section specification effects due to the structural causes. The two step regression is as follows:

First Step

$$\ln X_{jt} = \beta_0 + \eta_j + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \sum_{k=4}^{p} \beta_k \ln A_{kjt} + U_{jt} \qquad (3)$$

[3] The HACCP compliance equals 1 if year is greater than or equals 1998.

Second Step

$$\hat{\eta}_j = \delta_0 + +\delta_1 \ln Y_{it} + \delta_2 \ln Y_{jt} + \delta_3 \ln D_{ij} + \sum_{k=4}^{p} \delta_k \ln A_{kjt} + \varepsilon_{jt} \quad (4)$$

However, this estimation process will not provide an unbiased assessment of the impact of the ban and HACCP compliance because of its static nature and the associated bias in estimates. As it was argued earlier, there is persistence in export and import relationship. This is all the more true of exports of primary products such as shrimp. Due to the presence of persistence the static gravity model needs to be modified. Thus, a partial adjustment mechanism suggested by Houthakker and Taylor (1970) is adopted so that shrimp exports have the following form:

$$\left(\ln X_{jt} - \ln X_{jt-1}\right) = \theta\left(\ln X^*_{jt} - \ln X_{jt-1}\right) + U_{jt}\text{; with } 0 < \theta < 1 \quad (5)$$

where X^*_{jt} is the desired level of shrimp exports assumed to be determined by the deterministic part of equation (2). Manipulation of equations (2) and (5) and rearrangement result in the following dynamic model that would allow measuring both the short- and long-term impacts of the determining variables:

$$\ln X_{jt} = \alpha \ln X_{jt-1} + \eta_j + \ln Z'_{jt}\beta + U_{jt}\text{; j = 1, …, } N\text{; and } t = 1, \ldots, T \quad (6)$$

Here α is the coefficient of persistence in exports, Z'_{jt} is the vector of covariates dictated by the gravity model and other relevant theories mentioned earlier, and β is the corresponding vector of coefficients. The first element of Z'_{jt} is unity to allow for the intercept. The parameters α and β are assumed to be constant across time and space. Forming vectors of observations in *j*, the model becomes

$$\ln X_t = \alpha \ln X_{t-1} + \eta + \beta \ln Z_t + U_t\text{;} \qquad t = 1, \ldots, T \quad (7)$$

where $\mathbf{X}_t = (X_{1t}, \ldots, X_{Nt})'$ is the $(N \times 1)$ vector of Bangladesh shrimp exports for the cross-section of N countries at time t, and $\mathbf{Z}_t$ is an $N \times K$ matrix with rows given by the set of vectors Z'_{jt}; η is a $(N \times 1)$ vector of the unobserved country effects, and $\mathbf{U}_t$ is the corresponding $(N \times 1)$ error term vector.

In the context of persistent dependent variable the (two step) FEM technique does not give consistent estimates. For this reason, in addition to the above (two step) FEM, instrumental variable estimation following Anderson and Hsiao (1982), Arellano and Bond (1991), and Blundell and Bond (1998) was applied to obtain consistent estimates of shrimp export equation due to the presence of persistence in the dependent variable. Unlike the two step regression in the case of FEM, the total effects are estimated in a single step. Essentially, the approach involves taking first difference of (6) to get rid of the country effects as:

$$\ln X_{jt} - \ln X_{jt-1} = \alpha\left(\ln X_{jt-1} - \ln X_{jt-2}\right) + \left(\ln Z_{jt-1} - \ln Z_{jt-2}\right)'\beta + \left(U_{jt} - U_{jt-1}\right) \quad (8)$$

By construction the differenced lag of exports, $\left(X_{jt-1} - X_{jt-2}\right)$, in the above equation is endogenous. Hence, instruments are needed to consistently estimate the equation. The differenced right-hand-side variables are instrumented with appropriately lagged levels. On the assumption that the error terms in (7) are serially uncorrelated, i.e., $E\left(U_{jt}U_{js}\right) = 0$, the following moment conditions yield appropriate instruments for the differenced lagged dependent variable.

$$E\left(\ln X_{jt-s}\Delta U_{jt}\right) = 0 \text{ for } t = 3, \ldots, T \text{ and } s \geq 2 \quad (9)$$

$$E\left(\ln Z_{jt-s}\Delta u_{jt}\right) = 0 \text{ for } t = 3, \ldots, T \text{ and } s \geq 2 \quad (10)$$

When the moment conditions (9) and (10) hold, one can use the lagged levels as instruments for the first differenced variables. However, when the lagged levels are weakly correlated with subsequent first differences, the Arellano and Bond (1991) differenced GMM estimator suffers from small sample bias (Blundell and Bond 1998). To deal with the potential problem with the differenced GMM estimates, Arellano and Bover (1995) proposed an alternative estimator dubbed as the system GMM estimator that makes use of additional information in levels. This approach combines two sets of equations—one set in the first differences and another in levels—into a system of equations. This introduces additional T-2 moment restrictions given by:

$$E\left[\left(\eta_j + U_{jt}\right)\Delta \ln X_{jt-1}\right] = 0 \quad (11)$$

$$E\left[\left(\eta_j + U_{jt}\right)\Delta \ln Z_{jt-1}\right] = 0 \quad (12)$$

The system GMM estimator uses the moment conditions in (11)–(12) to consistently estimate the parameters of interest in equation (7). Consistency of the GMM estimation depends on whether errors in the levels equation are white noise. If they are not and are serially correlated, the GMM estimator loses its consistency. Thus, one needs to test for the first and second order autocorrelations in the differenced equation following Arellano and Bond (1991). By construction, one expects first order serial correlation in first differenced equation but not second (or higher) order autocorrelation.

It is to be expected that for a product such as shrimp, exports to a country at some year(s) might be zero. These country-years with zero exports create a problem for estimation of the gravity model in log linear form. To address this problem the actual figures of shrimp exports X_{jt} are replaced by $(X_{jt}+1)$ so that logarithm can be taken even for zero exports. On the other hand, second step OLS regression was

estimated with sandwich variance covariance matrix a la White (1980) to ensure robustness. To arrive at the total effect for a time varying variable, the two estimated coefficients that are statistically significant, obtained from the two step regressions, are added, while estimate of the time invariant distant variable is obtained solely from the second step regression.

V. DATA AND EMPIRICAL FINDINGS

For purpose of econometric analysis the original 15 EU countries comprising Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and UK together with Japan and the USA are included. The data were collected for the period of 1990 to 2007. Annual data on GDP, total imports, nominal exchange rate,[4] CPI, and population are obtained from the *International Financial Statistics (IFS)*, CD-ROM database of International Monetary Fund (IMF). Data on Bangladesh's shrimp exports are taken from Export Statistics of the Export Promotion Bureau (EPB), Bangladesh. Data on the distance (in miles) between Dhaka (capital of Bangladesh) and the capital of country j (as the crow flies) are calculated from *www.indo.com/distance*. All the variables except CPI, population, and exchange rate are transformed into constant US dollars in millions. Population data of all countries are collected in millions. Data on the exchange rates are converted into Bangladesh's taka per unit of country j's currency assuming triangular arbitrage. Further, the real exchange rate was defined as the product of the nominal exchange rate and foreign CPI divided by the CPI of Bangladesh. Real exports, real GDP, real exchange rate, and distances are converted into natural logarithmic forms.

The definition and the descriptive statistics of the variables used in the paper are presented in Table III. The average real value of shrimp exports from Bangladesh was about US$ 74 (=exp(1.448)*17) million during pre-ban years. This reduced to US$ 60 million in 1998 when the EU ban was operative during first half of the year. However, shrimp exports bounced back to US$ 79 million during the post-ban years, a probable sign of the efficacy of the HACCP compliance measures. The average real GDP of Bangladesh was US$ 21 billion, while that of the importing country was about US$ 465 billion. However, there are substantial variations in the real GDP of the importing countries as it ranged between US$ 13 billion and over a trillion. The average real exchange rate was about 11 with a marked variation between 0.03 and 110. However, it must be reminded that exports of shrimps to the EU countries may be influenced by many other factors not included in the list of covariates.

[4] Nominal exchange rate was defined as home currency per unit of US dollar; for the EU countries it was defined as home currency per unit of US dollar until the adoption of the euro and euro per unit of US dollar thereafter.

TABLE III
DESCRIPTIVE STATISTICS OF THE VARIABLES USED: 1990-2007

Variables	Mean	Std.	Min	Max
Data in natural logarithmic form				
Real Exports of Shrimps (Pre-ban years)	1.448	1.601	0	4.611
Real Exports of Shrimps (Ban year, 1998)	**1.260**	**1.577**	**0**	**5.030**
Real Exports of Shrimps (Post-ban years)	1.533	1.612	0	4.875
Real Exports of Shrimps (All years)	1.480	1.602	0	5.030
Real GDP, Bangladesh	7.627	0.217	7.280	7.970
Real GDP, Importing Countries	13.049	1.514	9.483	16.260
Real Exchange Rate	2.390	2.204	-3.582	4.703
Distance	8.453	0.193	8.020	8.992
Data in level form				
EU Ban	0.049	0.216	0	1.000
HACCP Compliance	0.556	0.498	0	1.000

The results of the two step FEM estimates are succinctly discussed here with the caveat that these estimates, albeit appropriately taken care of country effects and ensuring robustness, are still biased in view of the fact that persistence effect is ignored. Both the first step and the second step estimations use heteroskedasticity-corrected covariance matrix estimator following White (1980). The results are reported in Table IV. It may be noted that the coefficient of Bangladesh GDP is imprecise and while that of the importing countries is positive and highly significant as expected. This implies that Bangladesh's exports of shrimp increases as these economies grow. The real exchange rate is also significant with a positive sign. It implies that Bangladesh shrimp exporters would benefit with the devaluation of her currency. However, the distance variable is not significant even at 10 per cent level and with 'wrong sign.'

Despite these issues, the impact of the EU ban is pronounced. The coefficient is statistically significant with a negative sign. However, the effort to comply with the EU standard through HACCP is not significant, implying that the effort might have ended in smoke. This is in clear contradiction with the findings of the other studies and casual observation of data. There is a clear upward trend in value of shrimp exports from Bangladesh to the EU and the other two countries during the subsequent years. This again testifies the issue of misspecification of the two step FEM model and warrants efforts to address this 'misspecification' problem. The next set of estimates attempts to deal with this issue.

TABLE IV

RESULTS OF THE FIXED EFFECTS ESTIMATES

Variables	First Step[5]	Second Step	Total Effect
GDP, Bangladesh	-0.239 (0.337)	0.821 (0.665)	Imprecise
GDP, Importing Countries	0.297* (0.178)	0.420*** (0.032)	0.717
Real Exchange Rate	-0.006 (0.020)	0.144*** (0.028)	0.144
Distance	-	0.352 (0.241)	Imprecise
EU Ban	-0.280** (0.140)	0.128 (0.316)	-0.280
HACCP Compliance	-0.042 (0.132)	-0.048 (0.286)	Imprecise
Constant	-0.517 (4.432)	-15.048*** (5.442)	-15.048
Within R^2/Adjusted R^2	0.06	0.32	-
Observations	306	306	-
Import Country Effects(16, 284) 110.78[0.000]		-	-

Notes: 1. Figures in parentheses are robust standard errors and those in brackets are p-values.
2. Figures with * imply significant at 10 per cent ; those with ** imply significant at 5 per cent ; and those with *** imply significant at 1 per cent .

The results of the Arellano-Bond GMM dynamic panel estimates are reported in Table V. The estimates reveal relevance of persistence effect. Based on the Sargan (1958) test statistic, the optimal lag is found to be two years. The exogenous variables and the difference of the lagged dependent variable are used as instruments in the level equation; the lagged dependent variable is the instrument in the first-difference equation. Thus, each explanatory variable appears in the instrument matrix. Moreover, the nominal exchange rate of the importing countries, population of both Bangladesh and the importing countries, and real imports of the importing countries are used as independent instruments for the level equation. Arellano-Bond GMM estimator tests for AR(1) and AR(2) in first differences. The model introduces first order serial correlation. The test for no second-order serial correlation of the disturbances of the first-differenced equation is important for the consistency of the GMM estimator. In addition, the Sargan (1958) test for the joint validity of the moment conditions (the presence of over-identification) is crucial to the validity of GMM estimates. As the results show, there is first order serial correlation, but no second order correlation. Further, as the Sargan (1958) test implies, the instruments used are orthogonal to the error term.

[5] Coulibaly (2004) uses marginal effects of the tobit model in the first step. The coefficient estimates used in this exercise are themselves marginal effects, as the model is linear in parameters in FEM and the second step regression.

TABLE V

ARELLANO-BOND GMM DYNAMIC PANEL ESTIMATES

Variables	Estimates
Lagged Exports of Shrimp	0.914***(0.006)
GDP, Bangladesh	0.413***(0.122)
GDP, Importing Countries	0.071***(0.009)
Real Exchange Rate	0.041***(0.009)
Distance	-0.184*(0.095)
EU Ban	-0.498***(0.102)
HACCP Compliance	0.062*(0.033)
Constant	-2.480*(1.266)
Observations	289
Sargan Test [$\chi^2_{(95)}$]	123.61**[0.026]
First Order Autocorrelation	-2.09**[0.036]
Second Order Autocorrelation	1.51[0.130]

Notes: 1. Figures in parentheses are standard errors and those in brackets are p-values.
2. Figures with * imply significant at 10 per cent; those with ** imply significant at 5 per cent; and those with *** imply significant at 1 per cent .
3. GMM type instruments for levels equations are second and third order lags of Bangladesh and importing country populations (in log form), total imports of the importing countries (in log form), and nominal exchange rate.

The Arellano-Bond estimates show a clear sign of persistence of the exports of Bangladesh shrimp. The estimated persistence effect was 0.914, implying that last year's successful exports of shrimp will amplify current exports by more than 90 per cent, *ceteris paribus*. The coefficients of GDP both of Bangladesh and importing countries are positive and significant at 5 per cent level of significance. A one per cent increase in GDP of Bangladesh (importing country) would increase shrimp exports by 0.413 (0.071) per cent. This positive relationship between shrimp exports and size of the economies indicates that Bangladesh exporters would gain significantly if Bangladesh complies with the health and hygiene conditions of the importing countries. The coefficient of Bangladesh's real exchange rate is positive and statistically significant. However, the effect of the real exchange rate is low. Thus, it appears that devaluation of taka may not be an effective tool to increase exports of shrimp. Finally, distance, a proxy of transportation cost, shows negative sign and is statistically significant.

The central point of analysis of the paper is the quantification of the impact of the EU ban of Bangladesh shrimp, the immediate HACCP compliance. As mentioned earlier, Cato and Santos (1998) calculated that the ban really hurt Bangladesh shrimp exports. The authors also estimated the costs of HACCP compliance but did not provide the benefits of such measures. As one can find,

the EU ban hurt Bangladesh shrimp exports by US$ 25 million (=exp(0.498)*15) in the short run and would have cost about US$ 5 billion in the long run.[6] The short run estimate of this paper is higher than that by Cato and Santos (1998). One of the reasons for this apparent contradiction is the methodology involved and coverage of the data. Their analysis focused on the first half of 1998 when the ban was still effective. In contrast, data in this paper, for obvious reason, cover the whole fiscal year. Besides, their estimates were based on historical trends without conditioning of the proximate determinants of shrimp exports.

The estimates of this paper imply that the HACCP compliance of the Bangladesh shrimp exporters eventually paid off as the country succeeded in exporting an additional US$ 18 million (=exp (0.062)*17) worth of shrimp in the short run because of this compliance. The amount of benefits accrued in one year (the short run) was even enough for paying off the total capital costs of the HACCP compliance. From second year the accrued benefits far outweighed the annual costs of the compliance and hence, justify the annual costs incurred. In the long run HACCP compliance helped Bangladesh export additional US$ 35 million annually.

VI. CONCLUSIONS

The shrimp export sector suffered from the EU ban in 1998 fiscal year due to poor health and hygiene compliance in processing the product. The special case of gravity model was developed in this paper to quantify the impact of the EU ban and subsequent HACCP compliance. The panel data approach with import country effects was followed. Initially, the two-step FEM estimation method was pursued to capture the time dimension and cross-section specification of the data. However, many important variables came out as insignificant or with wrong signs. Even though the impact of the ban was negative, it seemed as if HACCP compliance measures ended in smoke. Besides, the static gravity model cannot estimate the long run effects of some covariates of special interest. These issues cast doubt on the propriety of static gravity model in presence of persistence in trade flows as noted in this paper. The dynamic gravity model was used to address these issues.

In the dynamic model, coefficients of all common gravity variables bear expected sign, and are statistically significant. Bangladesh's shrimp exports are significantly explained by the size of the economies, the real exchange rate, and the distance between Bangladesh and the importing countries. The positive relationship between shrimp exports and the size of the importing economy implies that growth

[6] As the dynamic panel model is akin to partial adjustment model, the long run coefficient estimates are retrieved by dividing the short run estimates by one minus the coefficient estimate of the lagged dependent variable.

of these countries would boost shrimp exports from Bangladesh. However, impact of devaluation of domestic currency on shrimp exports is found to be low. This indicates that devaluation of Bangladesh currency may not be an effective tool to increase exports of shrimp.

The paper also attempted to quantify the impact of the EU ban of Bangladesh shrimp and the immediate HACCP compliance. It was found that the EU ban hurt Bangladesh shrimp exports by US$ 25 million in the short run and would have cost about US$ 5 billion in the long run. Further, the HACCP compliance paid off as Bangladesh succeeded in exporting an additional US$ 18 million worth of shrimp in the short run and an additional US $35 million per year in the long run.

The policy implications of these findings are that precautionary measures even beyond HACCP compliance should be taken to assure buyers of product quality in order to enhance Bangladesh's shrimp exports. Proper quality of frozen shrimp must be maintained as well as the varieties of processed and semi-processed shrimp products must be increased as Bangladesh's shrimp exports largely depend on foreign demand. The importing countries' propensities to shrimp import must also be taken into account adequately when export target is set as Bangladesh's shrimp exports are not independent of importing country effects. Moreover, Bangladesh should carefully negotiate the safeguard clauses of the SPS agreement. Unless safeguard clauses of the SPS Agreements are brought into play, access of Bangladesh exports to the EU, Japan, and the US markets would be subjected to significant uncertainty and, thus, seriously constrained.

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