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IFPRI Discussion Paper 00978

May 2010

Emergence of Sri Lanka in European Fish Trade

Is There Cause for Concern in the Lake Victoria Region (East Africa)?

Andrew Muhammad

Guyslain Ngeleza

Development Strategy and Governance Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, South Africa, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

AUTHORS

Andrew Muhammad, U.S. Department of Agriculture
Senior Research Economist, Economic Research Service
AMUHAMMAD@ers.usda.gov

Guyslain K. Ngeleza, International Food Policy Research Institute
Postdoctoral Fellow, Development Strategy and Governance Division
G.Ngeleza@cgiar.org

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ABSTRACT

This paper examines European Union (E.U.) demand for chilled fish fillets assuming product heterogeneity due to country of origin and assesses the structural adjustment in demand as indicated by the increase in imports from Sri Lanka since the tsunami in December 2004. The primary objective of this research is to assess how Sri Lanka's fish exports affected fish exports from Kenya, Tanzania, and Uganda (Lake Victoria region). Although the results show no significant price competition between the Lake Victoria region and Sri Lanka, the Lake Victoria countries are clearly worse off now that Sri Lanka is a major supplier of chilled fish to the E.U. A comparison of the two periods 2001–2004 and 2007–2009 finds that in the former period, past imports of Lake Victoria fish had a positive impact on present imports, indicating that importers developed a preference for Lake Victoria fish during this time; in the latter period, this effect no longer existed. Most important is the change in the responsiveness of imports from Lake Victoria to real aggregate expenditures on imported fish in the E.U. The results show that a lesser share of aggregate expenditures is allocated to the Lake Victoria region and that the region now benefits less from an increase in aggregate expenditures.

Keywords: Lake Victoria, Tanzania, Uganda, Kenya, fish, imports, Sri Lanka, E.U.

1. INTRODUCTION

Fish processing and exporting in the countries surrounding Lake Victoria (Kenya, Tanzania, and Uganda) is an important source of foreign exchange for local economies. [1] In 2007, total fish exports for the region were valued at US$344.5 million. Exports were valued at US$61.2, $165.6, and $117.7 million for Kenya, Tanzania and Uganda, respectively. This represents a decrease of 11 percent when compared with the previous year, but an overall increase of 57 percent since 2001 (UNCOMTRADE 2008). The growth in fish exports has particularly impacted Uganda, where the fisheries sector is currently the highest foreign exchange earner next to coffee, employs approximately 300,000 people, and is the main source of household income for more than a million people (Abila 2000; Nunan 2007).

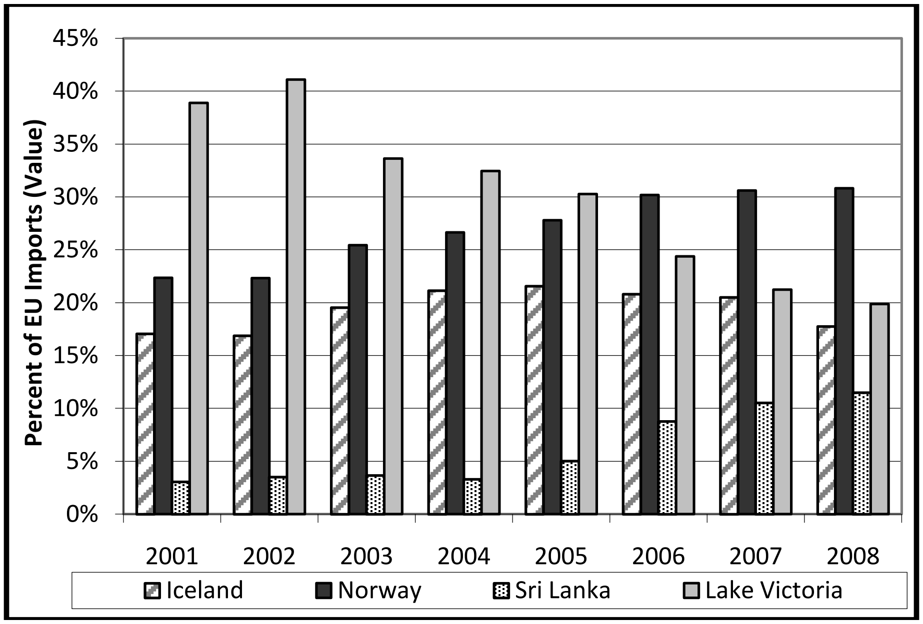
The Nile perch were introduced to Lake Victoria in 1954, which was a blessing for communities surrounding the Lake. The Nile perch processing chain created business opportunities and increased income for industry participants. The boomtowns that grew along the shore of Lake Victoria, often with populations of several thousand, supported industries and activities specific to fisheries, such as net mending, boat and outboard engine repair, and bait supplies as well as restaurants, bars, boarding, and so forth. These complementary industries depend heavily on spending that flows from the fisheries sector. Labor in the fisheries sector has risen considerably given the high demand for Nile perch in international markets. In 1983, an estimated 12,041 boats were on the lake. By 2004, this number increased to 51,712 boats, with 153,066 fishermen. The fisheries sector also generated indirect employment in other sectors such as processing and transportation (Geheb et al. 2008).

The fisheries sector is of particular importance to East Africa because it is considered a nontraditional sector, different from traditional agricultural sectors such as coffee, cotton, and tea. Unlike traditional agricultural exports, which are mostly raw commodities, a significant amount of domestic value added occurs in the nontraditional sectors creating employment for poor rural households. Nontraditional exports are also considered to be instrumental in restoring balance of payments, increasing export earnings, and reducing export revenue variability in the region, and are important to overall economic growth (Dijkstra 2001).

Since 2005, Sri Lanka has emerged as a major supplier of chilled fish to the European Union (E.U.). In 2001, the major suppliers were Norway, Tanzania, Iceland, and Uganda. These countries represented 21.51 percent, 20.94 percent, 16.52 percent, and 13.62 percent of the E.U. import market, respectively. Sri Lanka at that time accounted for less than 3 percent of total E.U. imports. This changed in 2006, however, when Sri Lanka's exports increased to 9 percent, and then increased even further to 11percent in 2007 and 12 percent in 2008. Sri Lanka is now one of the top exporters of chilled fish to the E.U., and the data suggest that this increase has come at the expense of fish exports from Kenya, Tanzania, and Uganda. For instance, the Lake Victoria region accounted for 21 percent of the E.U. import market in 2007, significantly less than in 2002 when the region accounted for 41 percent (Figure 1).

[1] The views expressed in this paper are those of the authors and may not be attributed to the Economic Research Service or the U.S. Department of Agriculture.

Figure 1. Percent of E.U. imports of chilled fish fillets by country, 2001–2008



Source: Eurostat.

The primary objective of this research is to assess the impact of E.U. fish imports from Sri Lanka on imports from Kenya, Tanzania, and Uganda. It is particularly important to determine the price competition between Sri Lanka and Lake Victoria fish and to determine if E.U. import demand has changed structurally as a result of the tsunami rehabilitation efforts to rebuild the Sri Lankan fisheries sector in 2005. While E.U. fish imports vary by degree of processing (whole, fillets.) and product form (chilled or frozen), this study is limited to chilled fish fillets, which account for the majority of fish exports from the Lake Victoria region. Issues to be addressed include the impact of Sri Lanka's fish exports on E.U. imports from competing countries, the change in responsiveness of E.U. imports to prices across competing countries, and the change in responsiveness of Lake Victoria's fish exports to changes in E.U. fish expenditures.

The dynamic nature of fish trade is also considered in this study. It is likely that the speed of adjustment in imports to changes in prices and aggregate expenditures also changed with the increase in imports from Sri Lanka. Additionally, given that Sri Lanka fish enters the E.U. duty-free through the Generalized System of Preferences incentive scheme to encourage good governance in developing countries (GSP+), the policy implications of the emergence of Sri Lanka in this E.U. market are also considered.

This paper examines E.U. demand for chilled fish fillets assuming product heterogeneity due to the country of origin and assesses the structural adjustment in demand as indicated by the increase in imports from Sri Lanka since 2005. The generalized dynamic Rotterdam model (Bushehri 2003) is used in estimating E.U. fish demand, and the pattern of structural change is determined by applying a gradual switching regression method as specified by Moschini and Meilke (1989) and Ohtani, Kakimoto, and Abe (1990). Estimation results are used to determine the competition between Sri Lanka and East Africa in the E.U. chilled fillet market.

2. BACKGROUND

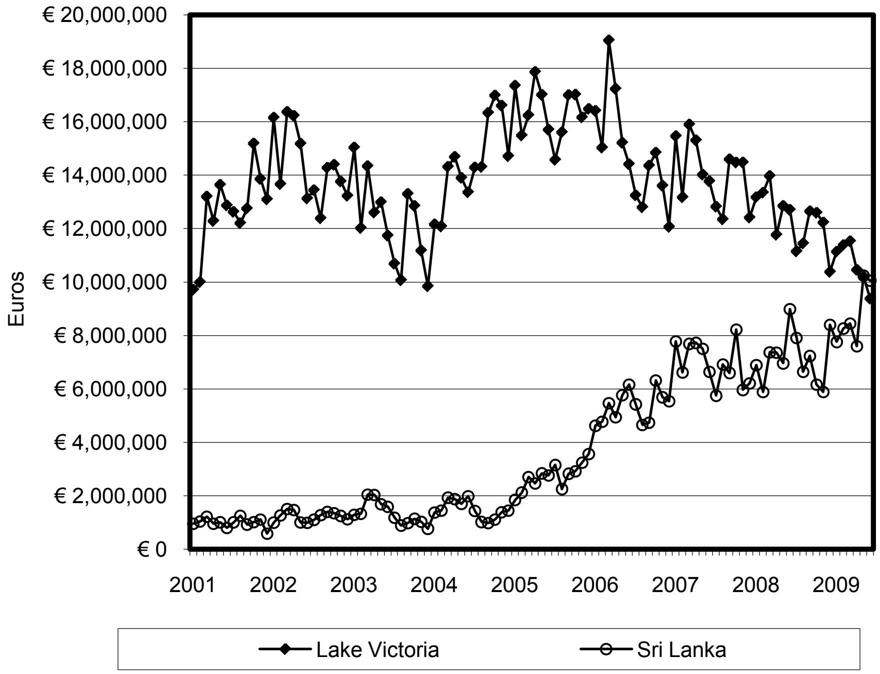
Processed Nile perch (fillets) is the primary fish export for the Lake Victoria region. In 1982, Nile perch landings were approximately 25,000 metric tons; by 2000 the total catches for Kenya, Tanzania, and Uganda combined were estimated at 220,000 metric tons and valued at US$280–$400 million annually (Thorpe and Bennett 2004). As mentioned, this study focuses solely on chilled fillets, which, for the Lake Victoria region, are the most important export to European markets. In 2008 for instance, total E.U. fish imports (live or dead; fresh, chilled, or frozen) from Lake Victoria were valued at €205.5 million, with chilled fillets accounting for 72 percent. Josupeit (2005) notes that the E.U. imports 600–800 metric tons of chilled Nile perch fillets per week. Overall, the E.U. has accounted for more than 90 percent of all chilled fillet exports from the Lake Victoria region (UNCOMTRADE 2008).

According to a United Nations assessment, the fishing and aquaculture industry in Sri Lanka was devastated by the tsunami in December 2004. This was compounded because of the importance of fishing as a major food source and export commodity. More than 7,500 fishers were killed by the tsunami; 5,000 fishing families were displaced; and 80 percent of coastal fishing vessels were completely destroyed or very seriously damaged, including around 19,000 boats. Ten out of the 12 main fishing harbors in the country were devastated.

The rehabilitation efforts since 2005 have included funding and assistance from the Sri Lankan government, nongovernmental organizations, and foreign governments. The Sri Lankan government provided compensation for destroyed houses, boats, and equipment as well as provided low-interest loans. Foreign governments, as well as organizations such as the World Bank, UNICEF, Red Cross, and others, assisted in providing new fishing vessels and equipment and in repairing damage vessels (De Silva and Yamao 2007).

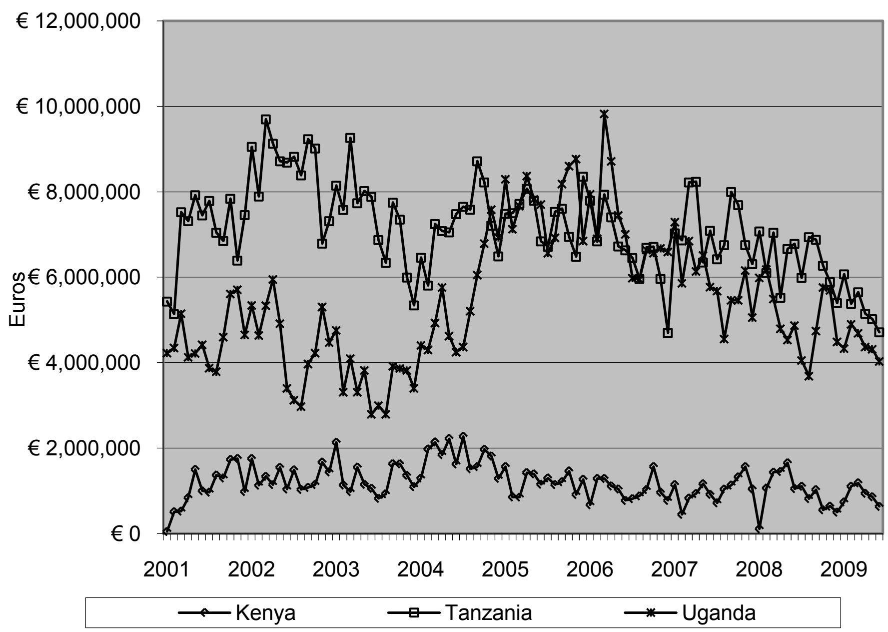
The rehabilitation efforts appear to have supported fish exporting, resulting in a significant increase in sales to the E.U. Before 2005, E.U. chilled fillet imports from the Lake Victoria region were significantly greater than imports from Sri Lanka. From 2001 to 2004, E.U. imports from Sri Lanka were consistently less than €2 million per month, while imports from Lake Victoria were as high as €18 million per month. Since 2005, imports from Sri Lanka have steadily increased to about €8–10 million per month, while imports from Lake Victoria have steadily decreased to about €10 million per month (Figure 2). The decline in imports from the Lake Victoria region is primarily due to declines in imports from Tanzania and Uganda. Imports from Kenya are relatively small in comparison and have not significantly changed since 2005 (Figure 3).

Figure 2. E.U. chilled fillet imports from Lake Victoria and Sri Lanka, January 2001–June 2009



Source: Eurostat.

Figure 3. E.U. chilled fillet imports from Lake Victoria by country, January 2001–June 2009



Source: Eurostat.

Table 1 shows the annual percentage changes in shares of the E.U. chilled fillet market by exporting country. In 2005 and 2006, Sri Lanka's share of the E.U. markets increased by 47 percent and 66 percent, respectively, in terms of quantity. In terms of expenditures, the respective annual increases were 53 percent and 74 percent. Since 2002, the share of the E.U. market accounted for by the Lake Victoria region has been steadily decreasing; however, the largest decreases occurred in 2005 and 2006, when output shares decreased by about 10 percent and 8 percent, respectively. In terms of expenditures, Lake Victoria's share decreased by about 7 percent and 20 percent, respectively.

Table 1. Percentage changes in output and expenditure shares, 2002–2008

Exporting Country	2002	2003	2004	2005	2006	2007	2008
	Percentage change in output shares						
Iceland	–13.49	5.58	6.52	6.39	5.63	–13.23	–2.52
Norway	10.10	7.21	3.98	–4.40	8.12	6.07	9.24
Sri Lanka	20.24	–5.58	–19.63	47.04	65.62	9.22	7.83
Kenya	19.36	10.41	18.78	–41.45	–12.06	–2.62	–6.96
Tanzania	7.80	–3.00	–13.93	–20.05	–8.18	6.86	–13.30
Uganda	–15.48	–14.18	22.46	17.73	–7.01	–18.09	–11.36
Lake Victoria	0.10	–5.28	–0.30	–9.63	–7.96	–5.22	–12.04
	Percentage change in expenditure shares						
Iceland	–1.01	15.74	8.18	1.99	–3.38	–1.56	–13.13
Norway	–0.13	14.00	4.76	4.35	8.60	1.40	0.66
Sri Lanka	15.42	4.02	–9.70	52.54	74.00	20.06	9.11
Kenya	17.18	–5.90	13.17	–44.18	–25.49	–7.54	–0.87
Tanzania	13.45	–17.46	–19.72	–15.53	–20.51	–1.11	–4.98
Uganda	–8.86	–23.22	23.84	17.55	–17.62	–24.73	–8.95
Lake Victoria	5.70	–18.19	–3.50	–6.67	–19.51	–12.98	–6.34

Source: Eurostat.

3. EMPIRICAL DEMAND MODEL

The generalized dynamic Rotterdam model is used in estimating E.U. demand for imported chilled fish by exporting country. The Rotterdam model is linear in coefficients, providing for easy estimation. Being a differential model, it can be estimated in first-difference form, which can make nonstationary variables stationary (Matsuda 2005).

Let q and p represent the quantity and price of fish imports, h denote a measure of dynamic behavior, i and j denote the product origin (exporting country), n denote the number of source countries, and x denote total import expenditures where $x = \sum_{i=1}^{n} p_i q_i$. Following Bushehri (2003), the dynamic Rotterdam model is specified as

$$w_i \frac{q_i}{q_i(t)} = \sum_{j=1}^{n} w_i \phi_{ij} \frac{h_j}{h_j(t)} + w_i \eta_i \left[\frac{x}{x(t)} - \sum_{j=1}^{n} w_j \frac{p_j}{p(t)} \right] + \sum_{j=1}^{n} w_i \eta_{ij}^{*} \frac{p_j}{p(t)} . \quad (1)$$

Note that for any variable y, $y = \mathrm{d}y(t)/\mathrm{d}t$. w_{it} is the share of total expenditure allocated to imports from the ith country ($w_i = p_i q_i / \sum_{i=1}^{n} p_i q_i$). ϕ_{ij} can be defined as the responsiveness of quantity demanded for good i to changes in past imports of good j where $\sum_j w_i \phi_{ij} (h_j / h_j(t))$ measures the dynamic adjustment in imports. η_i is the expenditure elasticity, and η_{ij}^{*} is the compensated price elasticity. Without the dynamic adjustment term, equation (1) is similar to the absolute price version of the Rotterdam model found in Theil (1980) and Theil and Clements (1987), where the term in brackets is the change in real aggregate expenditures and the last term denotes the impact of price changes on the quantity imported.

To put equation (1) in empirical form, we replace continuous changes with discrete time changes. Bushehri (2003) suggests the first-period log difference, which is typically used in most demand studies. Therefore, we approximate the changes in quantities and prices as follows:

$$\Delta q_t = \log q_t - \log q_{t-1} \approx q / q(t) \text{ and } \Delta p_t = \log p_t - \log p_{t-1} \approx p / p(t) .$$

The term in brackets in equation (1) is equal to the Divisia volume index, which is a measure of real aggregate expenditures (Theil 1980). We replace this term with a discrete measure of the Divisia volume index ΔQ_t , where

$$\Delta Q_t = \sum_{i=1}^{n} w_i \Delta q_{it} = \Delta x_t - \sum_{j=1}^{n} w_j \Delta p_j \approx x / x(t) - \sum_{j=1}^{n} w_j (p_j / p(t)) . \quad (2)$$

Specific to this study, ΔQ_t is a measure of change in real expenditures on chilled fillets from all supplying countries.

The following dynamic specification is used for discrete time periods:

$$\sum_{j=1}^{n} \phi_{ij} \frac{h_j}{h_j(t)} = \alpha_i + \sum_{k=1}^{p} \sum_{j=1}^{n} \alpha_{ijk} \Delta q_{jt-k} , \quad (3)$$

where $\sum_k \sum_j \alpha_{ijk} \Delta q_{jt-k}$ is a distributed lag of the quantities imported in log-difference form. Given equations (1)–(3), the empirical form of the dynamic Rotterdam model is expressed as

$$\bar{w}_{it}\Delta q_{it} = \gamma_i + \sum_{k=1}^{p}\sum_{j=1}^{n}\gamma_{ijk}\Delta q_{jt-k} + \theta_i \Delta Q_t + \sum_{j=1}^{n}\pi_{ij}\Delta p_{jt} + \varepsilon_{it} \quad , \tag{4}$$

where $\bar{w}_{it} = 0.5(w_{it} + w_{it-1})$; $\gamma_i = \bar{w}_{it}\alpha_i$; $\gamma_{ijk} = \bar{w}_{it}\alpha_{ijk}$; $\theta_i = \bar{w}_{it}\eta_i$; and $\pi_{ij} = \bar{w}_{it}\eta^*_{ij}$. γ_i, γ_{ijk}, θ_i, and π_{ij} are parameters to be estimated, and ε_{it} is a random disturbance term. Equation (4) states that the quantity imported from a particular country is a function of past imports from that country (and competing countries) q_{jt-k}, real expenditures on chilled fillet imports from all supplying countries ΔQ_t, and the export prices for each supplying country p_{jt}. Demand theory requires the following restriction on parameters:

$\sum_i \gamma_i = 0$, $\sum_i \gamma_{ijk} = 0$ for all *j* and *k*, $\sum_i \theta_i = 1$, $\sum_i \pi_{ij} = 0$ (Engel's aggregation);

$\sum_j \pi_{ij} = 0$ (homogeneity); $\pi_{ij} = \pi_{ji}$ (symmetry); and

$\mathbf{\Pi}_{n\times n} = \left[\pi_{ij}\right]$ is negative semidefinite.

Following the methodology of Moschini and Meilke (1989) and Ohtani, Kakimoto, and Abe (1990) and the empirical applications of Gil et al. (2004) and Peterson and Chen (2005), the structural change in import demand is modeled assuming a common time path for all parameters in the system. Denoting this time path as d_t, the Rotterdam model with structural change is parameterized as

$$\begin{aligned}\bar{w}_{it}\Delta q_{it} &= \gamma_i + \delta_i d_t + \sum_{k=1}^{p}\sum_{j=1}^{n}(\gamma_{ijk} + \omega_{ijk} d_t)\Delta q_{jt-k} + (\theta_i + \lambda_i d_t)\Delta Q_t \\ &\quad + \sum_{j=1}^{n}(\pi_{ij} + \nu_{ij} d_t)\Delta p_{jt} + \xi_{it} \quad .\end{aligned} \tag{5}$$

d_t is a dummy variable; and equation (5) has an added constant shifter δ, dynamic effect shifters ω, and slope shifters λ and ν. d_t can be defined such that it gradually changes from 0 to 1 during a transition period where

$$\begin{aligned} d_t &= 0 && \text{for } t = 1,\ldots,\tau_1 \\ d_t &= (t-\tau_1)/(\tau_2-\tau_1) && \text{for } t = \tau_1+1,\ldots,\tau_2-1 \\ d_t &= 1 && \text{for } t = \tau_2,\ldots,T \quad . \end{aligned} \tag{6}$$

τ_1 is the end point of the first regime (or period), τ_2 is the starting point of the second regime, and *T* is the end of the sample period. Note that the transition path is abrupt if $\tau_2 = \tau_1 + 1$, that is d_t changes from 0 to 1 at a particular observation. The transition path is gradual if $\tau_2 > \tau_1 + 1$, that is d_t gradually changes from 0 to 1 over a number of observations (Moschini and Meilke 1989). For instance, if a demand-altering event occurred in December 2004, d_t could be defined such that it is 0 for all observations before the event and 1 for all observations after the event (abrupt change). If, for instance, a year is required for the market to fully adjust to the event, d_t would be 0 for all observations before December 2004 and 1 for all observations from December 2005 onward. During the period December 2004–November 2005, d_t would gradually increase from 0 to 1. This would be defined as the period of transition because the parameter estimates would be changing from their initial state to their final state.

The hypothesis of no structural change is implied by δ = ω = λ = ν = 0. Additional restrictions are required for Engel's aggregation, homogeneity, and symmetry:

$\sum_i \delta_i = \sum_i \omega_{ijk} = \sum_i \lambda_i = \sum_i \nu_{ij} = 0$ (Engel's aggregation),

$\sum_j \nu_{ij} = 0$ (homogeneity), and $\nu_{ij} = \nu_{ji}$ (symmetry).

Of particular interest is the impact of structural change on the demand elasticities. The short-run expenditure elasticity with structural change is

$$\eta_i = \frac{(\theta_i + \lambda_i d)}{\overline{w}_i}, \tag{7}$$

and the own/cross-price elasticity with structural change is

$$\eta_{ij} = \frac{(\pi_{ij} + \nu_{ij} d)}{\overline{w}_i}. \tag{8}$$

The long-run expenditure and own/cross-price elasticity with structural change are

$$\eta_i^L = \frac{(\theta_i + \lambda_i d)}{\overline{w}_i - \sum_{k=1}^{p} (\gamma_{iik} - \omega_{iik} d)} \tag{9}$$

$$\eta_{ij}^L = \frac{(\pi_{ij} + \nu_{ij} d)}{\overline{w}_i - \sum_{k=1}^{p} (\gamma_{iik} - \omega_{iik} d)}. \tag{10}$$

Equations (7)–(10) are statistically compared when $d = 0$ and when $d = 1$ to determine whether structural change affected the demand elasticities.

4. EMPIRICAL RESULTS

Monthly data are used in estimating chilled fillet demand in the E.U. (January 2001–June 2009). The External Trade Section of the Statistical Office of the European Communities (Eurostat) provided the data, the 1995 Standard International Trade Classifications (SITC) 03451 (fish fillets and other fish meat, fresh or chilled). Imported quantities are measured in units of 100 kg, and values are in euros. Import values are on a cost, insurance, and freight basis. The source (exporting) countries are Iceland, Norway, Lake Victoria, Sri Lanka, and ROW (rest of the world), where Lake Victoria is an aggregation of Kenya, Tanzania, and Uganda. Research by Muhammad (2009) indicates that E.U. fish imports from Lake Victoria are not differentiated by country of origin, suggesting that Lake Victoria should be treated as a single country in analysis. ROW is an aggregation of the remaining exporting countries. Import prices were calculated by dividing the value of the commodity by the quantity.

Descriptive statistics for the model variables are reported in Table 2. Average export prices range from as high as €792.63/100 kg for Iceland to as low as €429.69/100 kg for Lake Victoria. At €751.39/100 kg, Sri Lanka's exports are relatively more expensive when compared with Lake Victoria's exports. This is due to the primary fish export from Sri Lanka being yellow fin tuna, which commands a higher price than Nile perch in international markets. Lake Victoria has been the leading supplier of chilled fish to the E.U., with average monthly exports of 3.24 million kg and an average monthly value of €13.726 million. Throughout the data period, Lake Victoria accounted for 29.51 percent of total E.U. expenditures on imported chilled fish, on average. In more recent years, the share of imports from Lake Victoria has been significantly less, accounting for a little as 14.6 percent.

Table 2. Descriptive statistics for model variables, January 2001–June 2009

Exporting Country	Mean	Standard Deviation	Minimum	Maximum
	Price (€ per 100 kg)			
Iceland	792.63	104.56	282.17	1064.16
Norway	559.45	78.28	424.26	762.48
Lake Victoria	429.69	57.72	293.68	569.49
Sri Lanka	751.39	199.61	498.07	1201.60
ROW	627.46	86.14	122.91	780.73
	Monthly quantity (million kg)			
Iceland	1.238	0.418	0.539	2.868
Norway	2.469	0.790	0.990	4.321
Lake Victoria	3.241	0.581	1.969	4.416
Sri Lanka	0.440	0.251	0.105	0.961
ROW	1.380	0.480	0.731	4.918
	Monthly expenditures (million €)			
Iceland	9.753	3.277	4.149	16.733
Norway	14.013	5.369	5.682	25.233
Lake Victoria	13.726	2.028	9.384	19.047
Sri Lanka	3.714	2.795	0.586	10.246
ROW	8.555	2.600	4.623	14.504
	Expenditure share (%)			
Iceland	19.32	2.67	13.02	24.06
Norway	27.29	4.14	16.97	35.27
Lake Victoria	29.51	8.21	14.60	46.08
Sri Lanka	6.65	3.85	1.78	15.71
ROW	17.23	2.41	12.66	23.36

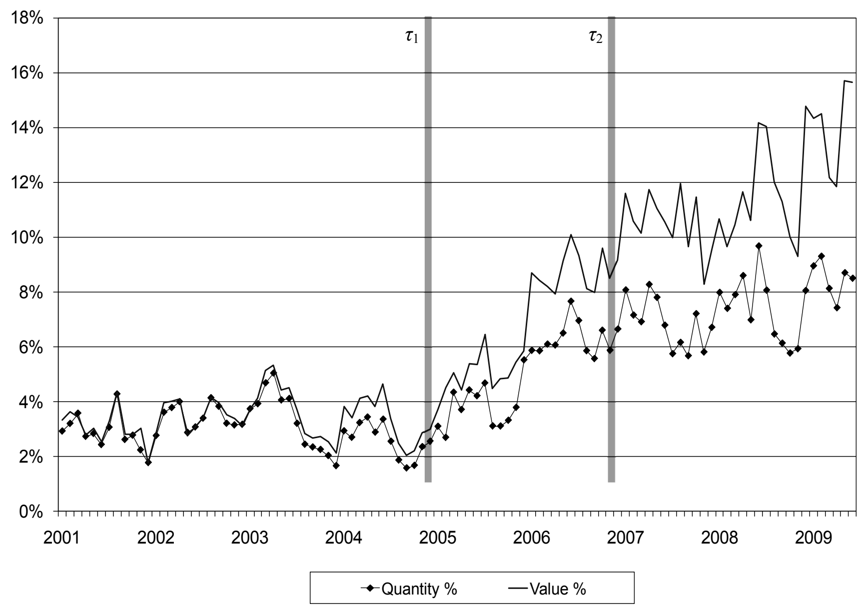
Source: Eurostat.

Note: ROW, rest of the world.

The import demand system represented by equation (5) is estimated using the LSQ procedure in TSP (Time Series Processor) (version 5.0), which uses the generalized Gauss-Newton method to estimate the parameters in the system. The structural break points (τ_1 and τ_2) are determined based on the pattern of fish imports from Sri Lanka after the 2004 tsunami. E.U. imports of chilled fish from Sri Lanka were relatively stagnant, averaging about 3 percent of total imports from 2001 to 2004. Since the tsunami in December 2004, Sri Lanka's share of E.U. imports started to trend upward. In terms of quantity, this continued until early 2007.

Given the pattern of E.U. imports from Sri Lanka, the following data points are selected to model the structural change in E.U. demand for imported chilled fish: τ_1 = December 2004, which marks the 2004 tsunami; and τ_2 = January 2007, which marks the period when the percent of total E.U. imports from Sri Lanka grew at a slower rate when compared with 2005–2006. January 2005–December 2006 is the period of transition, which is the time allowed for the E.U. market to fully reflect the changes in Sri Lanka (Figure 4).

Figure 4. Percent of E.U. imports from Sri Lanka (quantity and value) with regime ending and starting points



Source: Eurostat.

Likelihood ratio (LR) tests are conducted to determine if there was structural change in E.U. demand for imported chilled fish after the 2004 tsunami. The hypotheses of no structural change in the trend effects ($\delta = 0$), dynamic effects ($\omega = 0$), expenditure effects ($\lambda = 0$), and price effects ($\nu = 0$) were each considered separately as well as jointly. The log-likelihood values, LR statistics, and p-values are reported in Table 3. Test results rejected each null hypothesis of no structural change, and the joint structural change test ($\delta = \omega = \lambda = \nu = 0$) resulted in an LR test statistic of 111.765 and a p-value of 0.000, indicating that the joint hypothesis of no structural change should be rejected at any reasonable significance level. These findings suggest that structural change occurred in the E.U. import market after 2004.

Table 3. Likelihood ratio (LR) tests results

Structural Change Test	Log-likelihood Value	LR Statistic	P-value	Test Result
Unrestricted model	978.786			
No structural change in the following				
Trends	966.687	24.197	0.000(4)[a]	Reject
Dynamics	972.795	11.981	0.017(4)	Reject
Expenditures	965.598	26.376	0.000(4)	Reject
Prices	959.429	38.713	0.000(10)	Reject
All estimates	922.904	111.765	0.000(22)	Reject

Source: Author's calculations.

Notes: All models have homogeneity and symmetry imposed.
[a] The number of restrictions is in parentheses.

Estimates of E.U. demand for imported chilled fish prior to the structural adjustment (January 2001–December 2004) are reported in Table 4. All estimates are homogeneity and symmetry constrained. The trend estimates (γ_i) reflect the pattern of E.U. imports holding dynamics, prices, and expenditures constant.[2] The trend estimate for Lake Victoria (–0.009) is negative and significant and reflects the declining trend in chilled imports from Lake Victoria since 2002. Although the data do not suggest that Sri Lankan imports were trending upward prior to 2005, the trend estimate for Sri Lanka is significant and positive (0.006). The negative estimate for Lake Victoria suggests that exports to the E.U. were trending downward even before imports from Sri Lanka gained a significant share of the E.U. market.

Table 4. E.U. import demand estimates, January 2001–December 2004

Country	Trend γ_i	Dynamic γ_{ii}	Expenditure θ_i	Price π_{ij}				
				Iceland	Norway	Lake Victoria	Sri Lanka	ROW
Iceland	0.009 (.005)	–0.019 (.009)*	0.279 (.024)*	–0.191 (.018)*				
Norway	0.004 (.005)	–0.005 (.017)	0.277 (.032)*	0.115 (.017)*	–0.173 (.030)*			
Lake Victoria	–0.009 (.004)*	0.097 (.027)*	0.218 (.031)*	0.044 (.012)*	–0.012 (.018)	–0.032 (.016)*		
Sri Lanka	0.006 (.003)*	0.015 (.006)*	–0.015 (.016)	–0.008 (.009)	0.028 (.016)	–0.008 (.010)	–0.015 (.020)	
ROW[a]	–0.010 (.005)*	–0.088 (.033)*	0.241 (.034)*	0.041 (.011)*	0.043 (.013)*	0.010 (.010)	0.004 (.008)	–0.098 (.013)*
			R^2 =	.83	.73	.87	.62	

Source: Author's calculations.

Notes: Homogeneity and symmetry are imposed. Asymptotic standard errors are in parentheses.
ROW = rest of the world.
[a] The adding up property is used to recover the ROW estimates; * Statistically significant at the 0.05 level.

[2] Since equation (5) is in differential form, the constant term γ_i accounts for trending variables and the term $\delta_i d_t$ is the structural adjustment in the trend effect. Note that $y_t = a + bt$ implies that $y_t - y_{t-1} = b$. Ignoring dynamics, if $\Delta p_j = 0 \forall j$ and $\Delta Q = 0$, then $\overline{w}_{ij} \Delta q_i = \gamma_i$, which indicates that the growth rate in an import holding the Divisia index and prices constant is approximated as $\gamma / \overline{w}_{ij} (100)$.

The dynamic or lag effects (γ_{ii}) measure the impact of past imports on present imports and indicate that the responsiveness of imports to changes in aggregate expenditures and prices may not be instantaneous but partially adjust over several periods. Positive lag effects reflect habit persistence, whereas negative effects reflect short-run adjustments in inventories. For the importing firm, a positive lag effect reflects the adjustment cost in responding to changes in prices and aggregate expenditures. The estimate for Iceland (–0.019) indicates that past imports had a negative impact on present imports, *ceteris paribus*, suggesting that fillets from Iceland are inventoried. The positive estimates for Lake Victoria (0.097) and Sri Lanka (0.015) indicate either habit-forming behavior, stickiness in the responsiveness of importers to changes in prices and aggregate expenditures, or both (Table 4).

Estimates of the expenditure effect (θ_i) in 2001–2004 indicated a positive and significant relationship between the Divisia index and fish imports from all countries except Sri Lanka. θ_i reflects how a one-euro increase in aggregate expenditures is allocated across the five exporting countries. The expenditure effects were relatively equal for Iceland (0.279) and Norway (0.277), but not significantly greater than the estimates for Lake Victoria (0.218) and ROW (0.241). The expenditure effect for Sri Lanka was not significant because E.U. imports from Sri Lanka were relatively small before 2005 (Table 4).

The conditional own-price effects (π_{ii}) before 2005 are presented along the diagonal in Table 4. All own-price estimates were negative, as expected, because an increase in price should decrease the quantity imported, and significant at the 0.05 level for all countries except Sri Lanka. These negative estimates sufficiently ensure that the Slutsky price matrix is negative semidefinite (at least at the point of estimation). The conditional own-price effects were largest (in absolute value) for Iceland and Norway (–0.191 and –0.173). The own-price effects for the remaining countries were significantly smaller: Lake Victoria (–0.032) and ROW (–0.098).

The cross-price estimates (π_{ij}) indicate that there was a significant competitive relationship (substitutes) between Iceland and Norway (0.115), Iceland and Lake Victoria (0.044), and Norway and ROW (0.043). These estimates indicate that an increase in fish prices in one country would lead to greater imports from the other country. There was no significant cross-price relationship between Sri Lanka and any exporting country.

The structural adjustment estimates are reported in Table 5. These estimates are the change in the estimates reported in Table 4 after the structural change in the E.U. market. There are a number of interesting findings for the Lake Victoria region. The adjustment in the trend effect for Lake Victoria (–0.015) indicates that although imports from Lake Victoria were trending downward during the 2001–2004 period, the trend was even more negative during the 2007–2009 period. The trend adjustment estimate for Sri Lanka (0.009) indicates that the positive trend in 2001–2004 became even more positive in 2007–2009. Recall that the 2001–2004 dynamic effect for Lake Victoria indicated that past imports from the region had a positive impact on present imports. The adjustment in the dynamic estimate (–0.078) indicates that in 2007–2009 the relationship between past and present imports was insignificant. Additionally, the adjustment in the expenditure effect for Lake Victoria (–0.136) indicates that less expenditures were allocated to Lake Victoria fish in the latter period. Interestingly, the adjustment in the expenditure effect for Sri Lanka (0.118) is relatively close in absolute value and suggests that the expenditures once allocated to Lake Victoria are now being allocated to Sri Lanka.

Table 5. Structural adjustment estimates

Country	Trend δ_i	Dynamic ω_{ii}	Expenditure λ_i	Price Effects ν_{ij}				
				Iceland	Norway	Lake Victoria	Sri Lanka	ROW
Iceland	–0.025 (.007)*	0.051 (.020)*	0.075 (.062)	0.074 (.033)*				
Norway	0.006 (.008)	–0.007 (.033)	0.090 (.065)	–0.166 (.032)*	0.127 (.054)*			
Lake Victoria	–0.015 (.007)*	–0.078 (.037)*	–0.136 (.055)*	0.064 (.023)*	–0.033 (.030)	–0.002 (.030)		
Sri Lanka	0.009 (.004)*	0.007 (.011)	0.118 (.032)*	–0.023 (.015)	0.070 (.024)*	–0.012 (.018)	–0.028 (.025)	
ROW[a]	0.024 (.008)*	0.027 (.052)	–0.146 (.063)*	0.051 (.027)	0.002 (.031)	–0.017 (.024)	–0.007 (.017)	–0.029 (.034)

Source: Author's calculations.

Notes: Homogeneity and symmetry are imposed. Asymptotic standard errors are in parentheses.
ROW = rest of the world.
[a] The adding up property is used to recover the ROW estimates.
* Statistically significant at the 0.05 level.

Structural Change and Demand Elasticities

The expenditure elasticities are derived and statistically compared across the two time periods (2001–2004 and 2007–2009). The elasticities are evaluated at the mean using the ANALYZ procedure in TSP, which uses the delta method to calculate the standard errors. Following Moschini and Meilke (1989) and Gil et al. (2004), the pre- and postadjustment elasticities are evaluated using regime-specific means. For the preadjustment elasticities, the expenditure shares are averaged for the period January 2001–December 2004 ($\bar{\bar{w}}_{it} = \sum_{t=1}^{\tau_1} \bar{w}_{it} / \tau_1$); and for the postadjustment elasticities, the expenditure shares are averaged for the period January 2007–June 2009 ($\bar{\bar{w}}_{it} = \sum_{t=\tau_2}^{T} \bar{w}_{it} / (T - \tau_2)$). The results are presented in Table 6.

Table 6. Expenditure elasticities pre- and poststructural adjustment

Country	Expenditure Share 2001–2004	Expenditure Share 2007–2009	2001–2004	2007–2009	Difference
			Short-run expenditure elasticities		
Iceland	0.184	0.196	1.514 [.000]	1.806 [.000]	0.291 [.361]
Norway	0.240	0.307	1.151 [.000]	1.194 [.000]	0.043 [.851]
Lake Victoria	0.368	0.211	0.592 [.000]	0.390 [.060]	–0.202 [.375]
Sri Lanka	0.035	0.108	–0.441 [.333]	0.947 [.000]	1.388 [.009]
ROW	0.172	0.178	1.401 [.000]	0.534 [.074]	–0.867 [.016]
			Long-run expenditure elasticities		
Iceland	0.184	0.196	1.370 [.000]	2.155 [.000]	0.785 [.022]
Norway	0.240	0.307	1.129 [.000]	1.149 [.000]	0.020 [.928]
Lake Victoria	0.368	0.211	0.804 [.000]	0.430 [.055]	–0.374 [.118]
Sri Lanka	0.035	0.108	–0.784 [.332]	1.186 [.000]	1.970 [.023]
ROW	0.172	0.178	0.927 [.000]	0.398 [.061]	–0.409 [.076]

Source: Author's calculations.

Notes: ROW, rest of the world.
P-values are in brackets.

The short-run expenditure elasticities for Lake Victoria in 2001–2004 and 2007–2009 are 0.592 and 0.390, respectively. These indicate that for every percentage increase in aggregate E.U. expenditures on imported chilled fish, imports from Lake Victoria increased by 0.592 percent in the former period but by only 0.390 percent in latter period. In the long run, imports from Lake Victoria increased by 0.804 percent in the former period and 0.430 percent in the latter period. However, the difference in these estimates is not significant. For Sri Lanka, a percentage increase aggregate expenditures would have no effect on imports in 2001–2004; but in 2007–2009, imports from Sri Lanka would increase by 0.947 percent in the short run and 1.186 percent in the long run. ROW is the region where the expenditure elasticities significantly decreased. No other county/region was negatively affected in the postadjustment period (percentage-wise). With rising (falling) expenditures, a significantly larger expenditure elasticity would be advantageous (disadvantageous) to an exporting country. From 2001 to 2007, chilled imports in the E.U. increased from 6 million kg per month (on average) to about 12 million kg per month. Since 2007, total imports have been relatively flat. If total imports are relatively constant, then these changes in the expenditure elasticities would be of no consequence to the exporting countries.

5. SUMMARY AND POLICY IMPLICATIONS

This paper examines E.U. demand for chilled fish fillets assuming product heterogeneity due to country of origin and assesses the structural adjustment in demand as indicated by the increase in imports from Sri Lanka since 2005. The generalized dynamic Rotterdam model was used in estimating E.U. fish demand, and the pattern of structural change was determined by applying a gradual switching regression method. The primary objective of this research was to assess the impact of Sri Lanka's fish exports on fish exports from Kenya, Tanzania, and Uganda. Although the results show no significant price competition between the Lake Victoria region and Sri Lanka, Lake Victoria countries are worse off now that Sri Lanka is a major supplier of chilled fish to the E.U. A comparison of the two periods 2001–2004 and 2007–2009 finds that in the former period, past imports of Lake Victoria fish had a positive impact on present imports, which suggests that E.U. consumers developed a preference for Nile perch; in the latter period, this effect no longer existed. Most important is the change in the responsiveness of imports from Lake Victoria to aggregate expenditures in the E.U. The results show that a lesser share of E.U. expenditures are allocated to Lake Victoria, and the region now benefits less from an increase in E.U. expenditures.

Sri Lanka's fish exports to the E.U. benefit from nonreciprocal tariff-free access to European markets under the Generalized System of Preferences incentive scheme to encourage sustainable development and good governance in developing countries (GSP+). Preferential access under the GSP+ scheme is not guaranteed. First, to be eligible, developing countries must implement key international conventions on human and labor rights, sustainable development, and good governance. Access to the E.U. could be denied if found in noncompliance. For instance, in June 2007, the E.U. withdrew trade preferences from Belarus over labor rights issues, and in February 2010, the E.U. temporarily suspended trade privileges for Sri Lanka after an investigation by the European Commission found that the country had violated the human rights provisions in GSP+.

Tariff elimination has two effects: (1) the substitution or trade diversion effect, which is the substitution of fish from one country for another given the resulting decrease in price due to the tariff reduction; and (2) the removal of the tariff could lead to greater trade overall and an increase in aggregate import expenditures. Given the insignificant price competition between Lake Victoria and Sri Lanka, there is likely no substitution occurring due to changes in the price of Sri Lanka fish. However, the results of this study show that the benefits of trade creation on Lake Victoria would have been significantly greater in 2001–2004 than in 2007–2009 since the expenditure effect was smaller in the latter period. If there is any benefit afforded to the Lake Victoria region as a result of Sri Lanka being approved for the GSP+ program, that benefit is now significantly less.

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P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6463215
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

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CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
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