A Demand System Analysis of the U.S. Trout Market

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Faced with a dynamic change in U.S. trout imports, this study tried to identify how trout imports affect the domestic trout industry in the United States. In doing so, this study analyzed the quantity effect and exchange rate effect on domestic trout price using a modified LDI-AIDS model. According to the results of this study, we found five important facts related to trout imports during this sample period of time. First, a low farm price of domestic trout might be due to reasons other than trout imports because empirical results show that the net effects of imported trout products are complementary rather than substitutionary in effect. Second, domestic trout price decreases with an increase in total trout supply into domestic market. Third, imported frozen products are gross-substitutes for domestic product, while imported fresh products are gross-complements for domestic product. Fourth, for domestic trout, the intensity of substitutable interaction of imported products is as follows: frozen fillets > frozen whole trout > fresh whole trout > rainbow trout. Finally, depreciation of the U.S. Dollar relative to the Chilean Peso reduces the negative impact of Chilean imported trout on domestic trout price.

Although the domestic nominal price of trout has increased at an annual rate of 2.01% from 1991 to 2008, the real price for domestic trout has decreased because inflation for that time period was 3.26%. The decrease in the real price of domestic trout might be one of the reasons for the decrease in domestic production of trout during this period of time. In contrast, along with an increase in demand for value added trout products, trout imports have increased from 1,754 to 4,165 tons, which, in turn, caused the market share of imported trout to increase from 6.5% in 1991 to 17.5% in 2008. In addition to an increase in imports, there is a dynamic change in trout imports in terms of types of value added trout products, origins, and prices. According to trade codes for U.S. imports, representative products of imported trout are: 1) frozen fillets (HS: 0304206005), 2) fresh or chilled whole trout (HS: 0302110090), 3) frozen whole trout (HS: 0303210000), and 4) farmed fresh rainbow trout (HS: 0302110010).[1]

Frozen fillets represent the largest share of imported trout, accounting for 57% of total imports in 2008. However, the import share of the frozen fillets has decreased from a high of

74% in 1991. The major exporting country of frozen fillet changed from Argentina to Chile. In 2008, Chilean frozen fillet takes 64.7% of total frozen fillet imports. Argentina exports 72.1% of total frozen fillet in 1991 but only 27.6% in 2008. From 1991 to 2008, the price of frozen fillet has the most highly increased from $2.03 per kilogram to $5.29 per kilogram. One reason of this increase of price comes from the devaluation of the U.S. currency against the currencies of exporting countries in recent years. For example, the value of one U.S. dollar was 691 Chilean Pesos in 2003 but only 462 Chilean Pesos in 2008.

Import share for fresh whole trout has increased from 12.7% in 1991 to 18.4% in 2008. This increase may be related to the recent wider culinary adoption of trout in the general cuisine, e.g., the increased popularity of trout steaks.[2] The major exporting country of fresh whole trout is Canada which has a geographical advantage for the export of perishable products into the United States as compared to other exporting countries. Canadian share of fresh whole trout imports into the U.S. has increased from 62.8% in 1991 to 70.2% in 2008. Chilean fresh whole trout commanded a 21.1% share of fresh whole trout imports in 1991 but only a 2.6% share in 2008. The imported fresh trout price is higher than those for frozen fillets and frozen whole trout. From 1991 to 2008, the prices of imported fresh whole trout have increased from $4.15 per kilogram to $6.20 per kilogram. The recent U.S. currency value against the Canadian dollar also decreased from Canadian dollar 1.57/$ in 2002 to Canadian dollar 0.87/$ in 2008.

Import share of frozen whole trout has decreased from 12.1% in 1991 to 6.4% in 2008. The major exporting country of frozen whole trout is Chile. The Chilean share of U.S. imported frozen whole trout has increased slightly from 50.1% in 1991 to 54.7% in 2008. Canadian share has expanded from 4.5% in 1991 to 22.2% in 2008. The price of imports of frozen whole trout is lower than for those of either imported trout fillets or fresh trout. The prices of imported frozen whole trout have increased from \$3.77 per kilogram in 1991 to \$4.19 per kilogram in 2008.

Although the relative size of import volumes of farmed fresh rainbow trout is small, the import share of farmed fresh rainbow trout has markedly increased from 1.2% in 1991 to 17.8% in 2008. It might be related to the recent increasing preference for value added trout products. The major exporting country of farmed fresh rainbow trout is Canada. However, the Canadian share of farmed fresh rainbow trout imports has decreased from 82.3% in 1991 to 67.4% in 2008. This lost Canadian market share has been absorbed by growth in the Latin American export market to the United States. From 1991 to 2008, the price of imported farmed fresh rainbow trout has increased from \$4.56 per kilogram to \$6.24 per kilogram.

As previously mentioned, trout imports have changed dynamically since 1991. The objective of this study is to describe how imported trout affects the domestic U.S. trout industry. Also, this study examines the effect of the exchange rate on the domestic U.S. trout price using trade theory to explain the fundamental relationship between currency value and prices for both the importer and exporter.[3] In doing so, this study uses the Differential Inverse Almost Ideal Demand System (DIAIDS) which will be modified according to the objective of this study.

This study proceeds as follows. The next section discusses model development. In section three, we discuss data and estimation. Section four discusses the estimated results. Finally, the paper will conclude by providing the major findings of this study.

Duality and the Linear Inverse Demand System

To derive an inverse demand system, one can start either from the direct utility function and exploit Wald's identity which yields uncompensated inverse demands, or start from the distance (transformation) function and exploit Shephard's theorem which yields compensated inverse demand functions (Weymark, 1980 and Kim, 2001).

If $U(q)$ is a direct utility function, where q denotes the vector of quantities, the transformation or distance function $D(u,q)$ is implicitly defined by $U[q/D(u,q)] \equiv u$, where u is the reference utility level. The distance function is continuous, increasing, linearly homogeneous, and concave with respect to q, and decreasing in u. These properties establish a useful parallel between the distance function and the expenditure function, $E(u,p)$, derived from the utility-constrained expenditure minimization problem (where p is the price vector corresponding to q).

The parallel features of expenditure and distance functions are useful because, as emphasized by Hanoch (1978), they imply that any standard functional form for the expenditure function can be applied also to the distance function. The derivation of the linear inverse almost ideal demand system(LIAIDS) model starts with an expenditure function, exchanging the role of the variables (u,p) in the PIGLOG expenditure function of the AIDS model with the variables $(-u,q)$ with that of the distance function, where the negative sign on u emphasizes the opposite monotonic direction of $D(u,q)$ and $E(u,p)$ relative to the utility index. Then, the expenditure function given reference utility u is:

$$(1) \qquad \ln(D) = a(q) - ub(q),$$

where $a(q)$ and $b(q)$ are quantity aggregator functions defined as:

$$(2) \qquad a(q) = \alpha_0 + \sum_i \alpha_i \ln(q_i) + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln(q_i)\ln(q_j),$$

and

$$(3) \qquad b(q) = \beta_0 \prod_i q_i^{\beta_i} \ .$$

Because at $D=1$, the distance function is an implicit form of the direct utility function, then (1) implies the utility function $U(q)=a(q)/b(q)$. This, together with the derivative property, implies that the uncompensated inverse demand functions associated with (1)-(3) can be written in share form as:

(4) $$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(q_j) - \beta_i \ln(Q^*),$$

where $w_i \equiv \pi_i q_i$ is the *i*th budget share, and $\ln(Q^*)$ is a quantity index defined as $\ln(Q^*) \equiv a(q)$.

Equation (2) and (4) together entail a nonlinear structure for the inverse demand model. In practice, however, $\ln(Q^*)$ can be replaced by an index $\ln(Q) = \sum_i w_i \ln(q_i)$ constructed prior to estimation of the share system to yield LIAIDS as:

(5) $$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(q_j) - \beta_i \ln(Q).$$

Fortunately, an alternative exists, the first-difference LIAIDS, that is,

(6) $$dw_i = \sum_j c_{ij} d\ln(q_j) + c_i d\ln(Q).$$

The resulting set of (6) is a linear differential inverse almost ideal demand system (LDIAIDS).

In (6), the adding up, homogeneity, and symmetry conditions of c_{ij} and c_i can be defined as follows:

Adding up: $\sum_i c_{ij} = 0$ and $\sum_i c_i = 0$;

Homogeneity: $\sum_j c_{ij} = 0$;

Symmetry: $c_{ij} = c_{ji}$.

The quantity and scale elasticities can be derived from (6) as follows:

(7.1) $f_{ij}^* = c_{ij} / w_i - \delta_{ij} + w_j$: compensated quantity elasticity

(7.2) $f_i = c_i / w_i - 1$: scale elasticity

(7.3) $f_{ij} = f_{ij}^* + w_j f_i$: uncompensated quantity elasticity.

Data and Estimation

Data Description

Our analyses include domestic food-size trout, imported frozen trout fillets, fresh whole trout, frozen whole trout, and farm raised rainbow trout. We obtained annual price and quantity data of these products for the period beginning in January 1991 to 2008 from various sources. Price and quantity data for domestic food-size trout were obtained from the National Agricultural Statistics Service (NASS). Quantity and value data for imported trout were obtained from the National Marine Fisheries Service (NMFS). The unit prices of imported trout were obtained by dividing the total value by volume of imports.

The obtained quantity and price data represent an actual quantity like pounds or kilograms and an actual price like dollars per pound or kilogram. Before using these actual data in an estimating procedure, we manipulated these data without sacrificing their original properties in the following manner. At first, we calculate the weighted average of quantity of these products during the sample period of time as follows:

(8) $$\overline{Q} = \frac{\sum_i \sum_t Q_{it}}{N \times T},$$

where Q_{it} is the actual quantity of product *i* at time *t*, N represents the number of commodities (N = 5 in this study) and T represents the number of months in the study period (T = 18 in this study). Then, the normalized quantity of seafood product *i* at each time *t* is obtained as follows:

(9) $$q_i = \frac{Q_i}{\overline{Q}},$$

where q_i is the normalized quantity of product *i*. q_i is greater than one if $Q_i > \overline{Q}$. q_i is less than one if $Q_i < \overline{Q}$. And q_i is equal to one if $Q_i = \overline{Q}$. Furthermore, the normalized quantity, q_i, has the same property of actual quantity, Q_i, in terms of their relative size.

Now, we normalize the actual price, p, as follows. We first recalculate expenditure using normalized quantity and is expressed as follows:

(10) $x = \sum_i p_i q_i$.

Using (3), we normalize product *i* price as follows:

(11) $\pi_i = \frac{p_i}{x}$.

Using (4), we then obtain normalized budget share of product *i* as follows:

(12) $w_i = \pi_i q_i$.

And the normalized expenditure, the sum of the normalized budget share, will be one:

(13) $\sum_i w_i = 1$.

Normalized quantity, price, and budget share will be directly (as itself) or indirectly (as logarithmic or differencing logarithmic number) used in the estimating procedure. The descriptive statistics of normalized budget share and quantity is summarized in Table 1.

[Place Table 1 Approximately Here]

Estimation

As discussed earlier, this study is intended to identify the effects of quantity and currency value on U.S. domestic trout price. In order to do this, the original LDIAIDS is modified as follows:

(14) $\Delta w_i = \sum_j c_{ij} \Delta \ln(q_j) + c_i \Delta \ln(Q) + \sum_k \theta_{ik} E_k$,

where E_k is the exchange rate between the U.S. dollar and exporting country's currency, *k*. Further, adding up implies the following parametric restrictions:

$\sum_i \theta_{ik} = 0$.

In estimation, the adding up of the model causes the contemporaneous covariance matrix of residuals to be singular. Therefore, one equation was excluded from the system for estimation purposes. The coefficients of the dropped equation were then calculated from the adding up restriction. Then, the study added back the dropped equation and deleted another equation and re-estimated the system in order to determine the parameters and the standard errors of the former equation. The restricted SUR model, by both symmetry and homogeneity, was used to estimate quantity and scale elasticity parameters and exchange rate coefficient.

The main motivation for estimating an inverse demand system is that quantities are assumed to be predetermined naturally. However, fish consumption is assumed to respond to price incentives, and the actual quantity consumed annually is likely to be influenced by random perturbations in that year's price. As a result, the assumption of quantity pre-determinedness might be questioned. Accordingly, this study tested the pre-determinedness of annual quantities with the Wu-Hausman test (see Thurman, 1986 and Wu, 1973). The χ^2 statistic of the test was 1.25 with 11 degrees of freedom, less than the 10 percent critical value in the chi-square distribution of 17.2. In sum, the test for the pre-determinedness of quantities could not reject the null hypothesis, so the restricted SUR estimates reported in Table 2 are supported by this evidence.

Finally, this study estimates the Allais coefficients to measure the intensity of substitutable interaction among these five products by using following equations:

$$(30) \qquad a_{ij} = h_{ij} / w_{ij} - h_{rs} / w_r w_s + \left(h_i / w_i - h_r / w_r\right) + \left(h_j / w_j - h_s / w_s\right)$$

and

(31) $\alpha_{ij} = a_{ij} / \sqrt{(a_{ii} a_{ij})^2}$,

where the subscripts *r* and *s* refer to some standard pair of goods *r* and *s* with which it will be used to compare the relative strength of substitutability between any other pair, i and j , of goods. An α_{ij} greater than zero indicates that *i* and *j* are more complementary than *r* and *s*, while an α_{ij} less than zero signifies that *i* and *j* are stronger substitutes than are *r* and *s*. Clearly, $\alpha_{ij} = 0$ means that *i* and *j* have the same type of interaction as *r* and *s* (Lee and Kennedy, 2008).

Empirical Results

Table 2 summarizes quantity and scale elasticity coefficients estimated by the LDIAIDS procedure with exchange rate coefficients. The system R^2 is 0.70 for the LDIAIDS model. Thirteen (13) coefficients from the 30 coefficients estimated by the LDIAIDS procedure are significantly different from zero at least at the 10% level of significance. In particular, four of the five estimated own quantity elasticity coefficients are significantly different from zero at the 5% level of significance and two of the three cross quantity elasticity coefficients in the domestic trout budget equation are significantly different from zero at the 1% level of significance. However, all five scale quantity elasticity coefficients are not significantly different from zero at any conventional level.

Related to the exchange rate’s effect on prices, this study found results consistent with trade theory in the U.S. Dollar - Chilean Peso exchange rate. According to trade theory, devaluation of an importing country’s currency results in a decrease in the exporting country’s price and an increase in the importing country’s price. In this study, the exchange rate coefficients of Chilean currency are estimated as -0.158 for the domestic trout price and 0.174 for imported frozen trout fillets. Both coefficients are statistically significant at 5%. Furthermore, as seen in the previous section, most U.S. imported frozen trout fillets come from Chile. In terms of these facts, this study calculates the elasticities of exchange rate of Chilean currency on domestic price and imported frozen trout fillet price in order to quantify the effect of exchange rate of Chilean currency on domestic trout price and imported frozen trout fillet price (see Appendix I). According to the calculated elasticities, if the U.S. dollar depreciates 10% in value relative to the Chilean Peso by, then the U.S. domestic trout price increases by 6.61% and the imported frozen trout fillet price decreases by 5.84%. Accordingly, results show that a devaluation of the U.S. dollar against major exporting country currencies supports domestic trout price.

The quantity and scale elasticity coefficients have been transformed into elasticities using equations (7.1) through (7.3). Table 3 shows compensated quantity elasticities and scale elasticities. Compensated quantity elasticities represent the net effect of quantity on price, while scale elasticities represent the effect of expenditure on price in this system. The results found two interesting facts. First, the results show that the estimated quantity elasticities are very inelastic (including both own and cross quantity elasticities). Tomek and Robinson (1990) define the relationship between quantity and price elasticities as an inverse relationship. Thus, if own quantity elasticity is less than one in absolute value, demand for own good is elastic. If cross-quantity elasticity is less than one in absolute value, demand for good *j* is greatly influenced by a small change in the price of good *i*. According to the results, demand for domestic and imported trout are very elastic because the own quantity elasticities of these five products are very inelastic. Also, cross price effect on quantity will be greater than one because most of cross quantity elasticities are very inelastic except for the cross quantity elasticity of domestic trout for imported farm raised fresh whole trout. This result is consistent with those of Barten and Bettendorf (1989), Park, Thurman, and Easley (2004), and Lee and Kennedy (2008 and 2009).

Second, two goods, *i* and *j*, are net quantity complements if $f_{ij}^{*} > 0$ and two goods, *i* and *j* , are net quantity substitutes if $f_{ij}^{*} < 0$. Contrary to expectation, most cross effects show a net complementary pattern. In particular, four imported trout products are net complements for domestic trout. As a result, the low farm price of domestic trout might be due to other reasons than increased trout imports. One possible reason for this is that with enlargement of the U.S. seafood market, U.S. seafood consumers prefer other seafood species to trout. This implication suggests the need for the development for value-added trout products as a means of helping to strengthen/ensure the economic growth of the domestic trout industry.

Table 4 shows uncompensated quantity elasticities. The uncompensated quantity elasticity represents the effect of gross quantity on price, which is the sum of net quantity and scale effect. Therefore, uncompensated inverse demand of a normal good is more quantity elastic than is compensated inverse demand. As seen in Table 4, own uncompensated quantity elasticities of domestic trout and imported frozen trout fillets, frozen whole trout, and farm raised fresh rainbow trout are more elastic than those of the own compensated quantity elasticities. The own uncompensated quantity elasticity of imported fresh whole trout is less elastic than that of the own compensated quantity elasticity. Imported frozen trout products including both trout fillets and whole trout are gross quantity substitutes for domestic trout, while imported fresh trout products are gross quantity complements for domestic trout.

As seen in Tables 3 and 4, most of the cross effects are complementary rather than substitutionary, which is inconsistent with the notion that most types of fish are mutual substitutes. Barten and Bettendorf (1989) proposed Allais coefficients as a more adequate measure of commodity interaction. In order to calculate the Allais coefficients, this study selected domestic trout and imported fresh whole trout as the standard pair of goods *r* and *s*, respectively. This selection causes all other Allais interactions to become negative, implying stronger substitutes between two commodities *i* and *j* than the standard pair of domestic trout, *r*, and imported fresh whole trout, *s*. For example, the Allais coefficient between domestic trout and imported frozen fillet is -0.882. This result implies that the substitutionary relationship between domestic trout and imported frozen trout fillets is stronger than is the substitutionary relationship between domestic trout and imported fresh whole trout. Therefore, by comparing the magnitude of the coefficients, we can identify the intensity of substitutable interaction between these trout products. According to the results, the intensity of the substitutable interaction of imported trout products with domestic trout is ordered as follows: imported frozen trout fillets (-0.882), frozen whole trout (-0.838), farm raised fresh rainbow trout (-0.624), and fresh whole trout (0.000).

Conclusions

Facing a dynamic change in trout imports, this study tried to identify how imports affect the U.S. domestic trout industry. In doing so, this study analyzed the quantity effect and exchange rate effect on domestic trout price using a modified LDI-AIDS model. Over the past two decades, the nature of trout imports have changed from consisting of primarily frozen trout to fresh or chilled product. Also, the major exporter into the U.S. market has changed from Argentina to Chile for frozen products and Canada for fresh trout. According to the results of this study, we found five important facts related to trout imports during this sample period of time.

First, empirical results show that net effects of imported trout products are complementary rather than substitutionary for domestic trout. As a result, the low farm price of domestic trout might be due to other reasons than just increased trout imports. One possible reason is that with enlargement of the U.S. seafood market, U.S. seafood consumers prefer other seafood species to trout. This implication suggests the need for the development of value-added trout products that broadly appeal to U.S. seafood consumers' taste as one means of strengthening the economic growth of the domestic trout industry.

Second, in light of the relationship between domestic trout price and consumer expenditure, domestic trout price decreases with an increase in total trout supply into the domestic market. When we consider imports of frozen trout fillets as a major import product, the increase in imports of Chilean trout products may have the greatest influence on domestic trout prices.

Third, imported frozen trout fillets and whole trout are gross-substitutes for domestic trout, while imported fresh whole trout is a gross-complement to domestic trout. In particular, the import price of frozen trout is much lower than for those of fresh trout. In 2008, the import prices of frozen trout fillets and whole trout are $5.29 and $4.19 per kilogram, respectively, while the import prices of fresh whole trout is $6.24 per kilogram. As a result, increase in low price imported frozen products are major concerns about domestic trout industry.

Fourth, the estimated Allais coefficients show that own product has strongest substitutability compared to those of cross products. For domestic trout, the intensity of substitutable interaction of imported products is frozen trout fillets > frozen whole trout > fresh whole trout > rainbow trout.

Finally, depreciation of U.S. currency against exporting country's currency reduces the negative impact of Chilean imported trout on domestic price.

Table 1. Shares and Variation in Expenditure and Quantity: 1991 - 2008

Type of Product	Sample Average Share in Expenditure			Sample Average Share in Quantity		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
q_1	0.849	0.746	0.929	3.446	3.056	4.168
q_2	0.072	0.020	0.159	0.226	0.086	0.449
q_3	0.033	0.005	0.067	0.072	0.013	0.143
q_4	0.027	0.012	0.054	0.074	0.028	0.144
q_5	0.019	0.002	0.049	0.042	0.003	0.099

q_1 : Food-Size domestic Trout
q_2 : Imported Frozen Fillet
q_3 : Imported Fresh or Chilled Whole Trout
q_4 : Imported Frozen Whole Trout
q_5 : Imported Farm Raised Fresh Rainbow Trout

Table 2. Quantity and Scale Elasticity Coefficients and Exchange Rate Coefficients

	$dlnq_1$	$dlnq_2$	$dlnq_3$	$dlnq_4$	$dlnq_5$	$dlnQ$	$dlnE_{ca}$	$dlnE_{ch}$
D1	0.048^{***}	-0.036^{***}	0.001	-0.015^{***}	0.003	0.050	0.109	-0.158^{**}
M2		0.040^{***}	-0.007	0.003	0.000	-0.062	-0.099	0.174^{**}
M3			0.013^{**}	-0.005^{*}	-0.001	0.045	-0.071^{*}	0.054^{*}
M4				0.018^{***}	-0.001	-0.018	0.078^{**}	-0.079^{**}
M5					0.000	-0.023	-0.007	-0.002

D1: Domestic Trout Budget Share

M2: Imported Frozen Fillet Budget Share

M3: Imported Fresh or Chilled Whole Trout Budget Share

M4: Imported Frozen Whole Trout Budget Share

M5: Imported Farm Raised Fresh Rainbow Trout Budget Share

E_{ca}: Exchange Rate between U.S. Dollar and Canadian Dollar, C$/US$

E_{ch}: Exchange Rate between U.S. Dollar and Chilean Peso, Peso/US$

Systme R^2: 0.7039

* represents statistically significant at 0.1 level

** represents statistical significant at 0.05 level

*** represents statistically significant at 0.01 level

Table 3. Compensated Quantity Elasticity and Scale Elasticity

	$dlnq_1$	$dlnq_2$	$dlnq_3$	$dlnq_4$	$dlnq_5$	$dlnQ$
D1	-0.094	0.029	0.034	0.009	0.022	-0.941
M2	0.342	-0.367	-0.068	0.074	0.019	-1.868
M3	0.867	-0.149	-0.575	-0.128	-0.015	0.376
M4	0.291	0.194	-0.153	-0.312	-0.019	-1.673
M5	1.004	0.074	-0.025	-0.028	-0.992	-2.203

Table 4. Uncompensated Quantity Elasticity

	$dlnq_1$	$dlnq_2$	$dlnq_3$	$dlnq_4$	$dlnq_5$
D1	-0.894	-0.039	0.003	-0.016	0.005
M2	-1.244	-0.501	-0.130	0.023	-0.016
M3	1.187	-0.122	-0.563	-0.118	-0.007
M4	-1.129	0.074	-0.208	-0.358	-0.051
M5	-0.867	-0.084	-0.097	-0.088	-1.034

Table 5. Allais Coefficients

	$dlnq_1$	$dlnq_2$	$dlnq_3$	$dlnq_4$	$dlnq_5$
D1	-1	-0.882	0.000	-0.838	-0.624
M2		-1	-0.208	-0.223	-0.219
M3			-1	-0.380	-0.111
M4				-1	-0.176
M5					-1

Appendix: Elasticity of Exchange Rate at Mean

Elasticity of exchange rate of Chilean currency on domestic price

$$\frac{dw_d}{d\ln E_{ch}} = \frac{dp_d \cdot q_d}{d\ln E_{ch}} + \frac{dq_d \cdot p_d^{'}}{d\ln E_{ch}},$$

where subscript $_d$ and $_{ch}$ represent “domestic” and “Chile”, respectively, and $p^{'}$ represent the initial price.

Since $q_d = 1$ at mean and $dq_d = 0$,

$$\frac{dw_d}{d\ln E_{ch}} = \frac{dp_d}{d\ln E_{ch}} = \frac{dp_d}{dE_{ch}} \cdot \frac{E}{p_d^{'}} = \frac{-0.158}{p_d^{'}},$$

where $p_d^{'} = 0.239$ is average normalized domestic trout price during the sample period of time.

$$\frac{dp_d}{dE_{ch}} \cdot \frac{E}{p_d^{'}} = \frac{-0.158}{0.239} = -0.661$$

Elasticity of exchange rate of Chilean currency on imported frozen fillet price

$$\frac{dw_f}{d\ln E_{ch}} = \frac{dp_f \cdot q_f}{d\ln E_{ch}} + \frac{dq_f \cdot p_f^{'}}{d\ln E_{ch}},$$

where subscript $_f$ represents “imported frozen fillets”.

Since $q_f = 1$ at mean and $dq_f = 0$,

$$\frac{dw_f}{d\ln E_{ch}} = \frac{dp_f}{d\ln E_{ch}} = \frac{dp_f}{dE_{ch}} \cdot \frac{E}{p_f^{'}} = \frac{0.174}{p_f^{'}},$$

where $p_f^{'} = 0.298$ is average normalized imported frozen fillet price during the sample period of time.

$$\frac{dp_f}{dE_{ch}} \cdot \frac{E}{p_f^{'}} = \frac{0.174}{0.298} = 0.584$$

Footnote 1.
Rates of duty are applied to each HS code. However, since the duty amount of each product is relatively small compared to imported price, this study ignores the duty amount in discussing the imported price. Rates of duty are 5.5¢/kg for HS 0304206005 and 2.2¢/kg for HS 0302110090, 0303210000, and 0302110010.

Footnote 2.
According to Foltz, Dasgupta, and Devadoss (1999), fresh trout steaks were found to be more popular than frozen trout steaks.

Footnote 3.
Koo and Kennedy (2005) graphically show that a devaluation in an importer’s currency increases importer’s price and decreases exporter’s price.

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