Habit Formations in the U.S. Import Demand for Smoked Herring

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Abstract

Different variable specification techiniques representing habit formation are incorporated into an aggregate import demand function to examine potential habit formation in the US smoked herring import market. The results confirm that habit formation is an integral part of the US smoked herring import demand. Habit formation encourages continued consumption levels of smoked herring, and hence increases the inelasticity of the US smoked herring demand in the long-run. In the short-run, the characteristics of smoked herring, such as durability and import delays, stimulate the inventory adjustment effects dominance over the habit formation effects.

Key words Habit formation, import demand, herring

JEL Classification Codes Q17 Q22

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Introduction

The US currently produces about 110 thousand tons of herring per year. A major proportion of US herring production, about 45 thousand tons/year, is exported and generated revenue of $77.5 million per year during the period 1981-2006. The US imported about 20 thousand tons of herring at a cost of about $20 million per year during the same time period (NMFS, 2012). The US imports herring in forms of frozen products, fish oil and meal, salted and smoked products at an average price of $1/kg; in the meanwhile, the US exports herring in forms of fresh and frozen products at an average unit value of $1.7/kg.

The US current importation of herring, while the country exports significant quantities of the same product, may encourage the question 'Why is the US importing herrings while she is searching for export markets for its own product?' A possible hypothesis is that the US herring producers target high-valued markets in other countries, e.g. Japan. At the same time, the US imports herring to satisfy preferences by certain consumer groups who have specific and long-term habit of consuming herring. Therefore, there is a need to look at disaggregated data to understand the market. For example, smoked herring is primarily served during breakfast, as an apetizer, and as a snack food during the intake of alcoholic beverages, and during social events among immigrant groups from northern Europe, Russian, Jewish, and Islands. Hence, consumption of smoked herring may be significantly influenced by habit formation.

Habit formation plays a role in studies of food demand and consumption. Habit formation means that past consumption pattern is an important determinant of current consumption pattern (Pollak, 1970). Previous studies of food consumption with habit formation include US coffee demand (Okunade, 1992), US meat demand (Pope et al. 1980, Holt and Goddwin 1997, Zhen and Wohlgenant, 2006), and US sugar-sweeten beverage demand (Zhen et al. 2011). Studies of habit formation in seafood demand are however not common and this may be due to the high perishability of the products. This study examines different habit formation applications in a single-equation import demand model for smoked herring in the US market. The result of this study will help in strategy development for future marketing of seafood, especially traditional seafood specialties, e.g. fish sauce, smoked fish, etc., that are potentially habit-forming products in export markets

The overall objective of this study is to estimate the import demand function, and examine the effects of habit formation on the import demand of smoked herring in the US market. The specific objectives are (1) to understand factors affecting the US import demand for smoked herring, and (2) investigate alternative habit formation specifications in the import demand for smoked herring in the US market. The rest of the paper is organized as follows: Review of Literature, Import Demand Model, Data and Empirical Results, and Conclusions.

Literature Review

Countries trade because they face different opportunity costs for similar goods and services. If a country produces a good at a lower (higher) relative price, it will export (import) that good to increase the total welfare. Differences in technological levels and factor endowments are the causes of differences in relative prices of the same goods from one to another country (Vernon, 1966). From the demand side, if a country has a special preference for goods, the relative price of those goods tends to be higher compared to that of other countries; Hence countries also trade because of differences in preferences of goods (Linder, 1961).

Thursby and Thursby (1984) claimed that the simplest procedure to estimate aggregate import demand, which is consistent with economic theory, is to assume the importing country as a price taker, or facing an infinitely elastic supply of imports. The key assumption in the aggregate import demand model is that imports are not perfect substitutes for domestic goods. Thursby and Thursby (1984) examined different functional forms, and found that the static model and finite distributed lag model are not appropriate for the aggregate import demand. Actually, lagged values of the dependent variable are often working well for the aggregate import demand estimation. Erkel-Rousse and Mirza (2002) suggest that most import price elasticities are underestimated due to misspecification and measurement error when using import unit value for import price. Sawyer and Sprinkle (1996) showed that import demand models with a ratio of import price over domestic price in the predictors could avoid multicollinearity problem.

Regarding seafood products, Ligeon et al. (1996) estimated the import demand for catfish in the US market, using a ratio of imports over domestic production as the dependent variable, and found that past imports have no effect on present imports. Kusumastanto and Jolly (1997) estimated an aggregate demand of fish consumption in Indonesia, using two dynamic specifications, Houthakker-Taylor state adjustment model and the partial adjustment model, for the fish demand function in Indonesia. They found that fish consumption depends on psychological buying habits of consumers. Nguyen and Jolly (2013) employed a cointegration and error correction model to estimate the aggregate import demand for seafood in selected Caribbean countries, and found that imports are not the causal reason for the decline of Caribbean fishery productions. Norman-López and Ashe (2008) estimated demand for imported tilapia in the US market, and concluded that imported tilapia and US catfish do not compete directly in the same market segment.

One of the practical problems in empirical analysis of demand is the representation of changing preference. Pope et al. (1980) discussed three specifications of habit formation in demand analysis: time trend variable, partial adjustment, and psychological stock of habits. Pope et al. (1980) found that with the passage of time, beef and pork demand became more inelastic; It means that habit formation increases demand inelasticity, encourages product consumption over time, and had positive effects on meat quantity demanded. Holt and Goodwin (1997) included different habit formation parameters in an inverse AIDS model for US meat expenditure. They employed the 'generalized linear habit formation specification' where habit parameters related to the own lagged consumption, as well as on the lagged consumption of all other goods. Holt and Goodwin (1997) employed a nonlinear, non-additive habit term with a distance function, and compared with it other habit specifications, such as static model, linear and additive habit, generalized habit formation model with short- and long-memory. They found that generalized habit formation with long-memory was most preferred, passed most of the model specification tests, and was statistically superior to all other specifications. Zhen and Wohlgenant (2006) studied meat demand with rational habit formation, and developed a model to shed light on how food safety concerns, as perceived by quality changes, affect consumers response, and found different effects between the models based on myopic vs. static consumer behavior. Zhen et al. (2011) incooperated habit formation in a demand system for sugar-sweetened beverages and tested for competing specifications of myopic vs. rational habit formation. Habit formation is myopic if the current consumption is influenced by past consumption, but consumers do not recognize the role of current consumption on future taste and utility (e.g. current consumption of alcohol reduced utility in the future due to health problem). Therefore, myopic consumers do not account for all costs of consuming a habit-forming good. Zhen et al. (2011) found evidence of myopic habit formation among low-income population, and rational habit formation among high-income population. The authors also found that consumers with myopic habit respond less to the taxes on habit-forming goods than those consumers with rational habit formation.

Import Demand with Habit

Habit formation is relevant when consumers maximize utility through delayed responses or partial adjustments of consumptions to changes in income and relative prices. The current consumption reflects accumulation of all past experiences; hence one-period lag of consumption is the most relevant variable for capturing past effects (Brown, 1952). Ryder and Heal (1973) introduced the concept of subsistence consumption, and argued that past consumption increases the current level of subsistence demand. Subsistence consumption does not affect current utility; utility gains are initiated from extra amounts of commodity on top of the subsistence consumption level. The higher level of past consumption is the lower utility gained from a certain current consumption quantity. Early studies modeled habit as 'myopic' or backward looking, in which consumers do not know the impacts of current consumption on future preference and utility. In the rational habit formation model, consumers look at both backward and forward when making a consumption decision (Ryder and Heal, 1973; Becker and Murphy, 1988). The life-cycle consumption model states that individuals, at time t, choose the level of consumption, C_t, to maximize the conditional expected utility at time t, $E(U_t)$. The utility function is given by

$$U_t = \sum_{j=0}^{\infty} \{ \beta_j \, U(C_{t+j}, V_{t+j}) \} \quad (1)$$

where V_{t+j} is a preference variable, and influenced by consumer's own consumption history. With habit formation, current utility depend not only on current consumption, but also on a "habit stock" formed by lagged consumptions. Habit formation causes consumers to adjust slowly to permanent shocks of income and price. The first-order condition for utility maximization problem yields a demand function:

$$D_t = D(P_t, Y_t, V_t) \qquad (2)$$

where, P_t is relative price at time t, Y_t is income at time t, and V_t is the habit variable. The import demand for a good is derived from the "excess demand" of that good in the domestic market:

$$M_t = D(P_t, Y_t, V_t) – S(P_t) = M(P_t, Y_t, V_t) \qquad (3)$$

where, M_t is the import demand at time t, D and S are domestic demand and domestic supply. The general import demand function is:

$$M_t = \alpha_0 + \alpha_1 P^*_t + \alpha_2 Y_t + \beta V_t + \varepsilon_t \qquad (4)$$

where, M_t is import quantity demanded, P^*_t is import price in the foreign currency, Y_t is domestic real income, and V_t is a preference variable, ε_t is a white noise error term. The US is a small importing country of smoked herring, and cannot affect the world price (P*). Import price should have a negative effect on import quantity, $\partial M/\partial P^* < 0$. The effect of domestic income (Y) on import quantity (M) should be positive, $\partial M/\partial Y = \partial D/\partial Y > 0$. Exchange rate is defined as EX = \$/\$*. Therefore, world price of smoked herring in the foreign currency can be exchanged for the domestic currency (US\$) as P* = P/EX, where P is smoked herring import price in US dollar. The import demand for smoked herring is:

$$M_t = \alpha_0 + \alpha_1(P_t/EX_t) + \alpha_2 Y_t + \beta V_t + \varepsilon_t \qquad (5)$$

Where, P is import price in US dollar, and $\partial M/\partial P < 0$. When exchange rate (EX) increases, the US dollar becomes stronger and can be exchanged for more of the foreign currency. In other words, imports become cheaper to US consumers. Therefore, the US will import more smoked herring when the exchange rate increases, or $\partial M/\partial EX > 0$.

International trade theory states that a country imports a good if its relative price is higher than that of other countries. The relative price of US smoked herring is P^{us}/CPI^{us}. The effect of CPI^{us} on import should be negative, $\partial M/\partial CPI^{us} < 0$, because when CPI^{us} increases the relative price of US herring (P^{us}/CPI^{us}) will decrease or the US has improved its herring competitiveness, and imports less smoked herring, or $\partial M/\partial CPI^{us} < 0$. We include the US consumer price indices in the import demand equation, and obtain:

$$M_t = \alpha_0 + \alpha_1 P_t + \alpha_2 Y_t + \alpha_3 CPI^{us}_t + \alpha_4 EX_t + \beta V_t + \varepsilon_t \qquad (6)$$

Expected sign of α_1 is negative; expected sign of α_2 is positive, expected signs of α_3 is negative, and α_4's is positive.

Variable V_t is a state preference or stock variable, which represents consumer's physical inventory or psychological habit associated with the good. Habit formation increases consumption quantities, therefore, if $\beta > 0$ the habit formation effect dominates. In contrast, $\beta < 0$ means that an inventory-adjustment effect dominates. Variable V_t is unobservable, and can be specified simply (1) as a time trend variable, and assuming that preference change is a smooth function of time; (2) as a partial adjustment variable, which takes lagged consumption (M_{t-1}) in the adjustment toward the equilibrium; (3) finally, Houthakker and Taylor (1970) use the concept of stock depreciation in the demand equation. They assumed that the rate of stock depreciation is constant and proportional to the amount of stocks, $w_t = \delta V_t$, where w_t is the 'average using up' of stocks at time t. From this assumption, Houthakker and Taylor (1970) derived an econometric demand equation:

$$M_t = A_0 + A_1 M_{t-1} + A_2 \Delta Y_t + A_3 Y_{t-1} + A_4 \Delta P_t + A_5 P_{t-1} + A_6 \Delta CPI_t + A_7 CPI_{t-1} + A_8 \Delta EX_t + A_9 EX_{t-1} + \varepsilon_t \quad (7)$$

Coefficient β is computed using the formula: $\beta = 2(A_1 – 1)/(A_1 + 1) + A_3/(A_2 – 0.5*A_3)$.

Data and Empirical Results

Data of US smoked herring import quantities (M) and unit values (P) are collected from FAO Fishstat. US disposable personal income (Y) is from the US Bureau of Labor Statistics (BLS). The US exchange rate (EX), consumer price index (CPI) are from IMF–IFS database. All data are annual and available from 1976 to 2007. Time series data's variability and trend are shown in **Figre 1**.

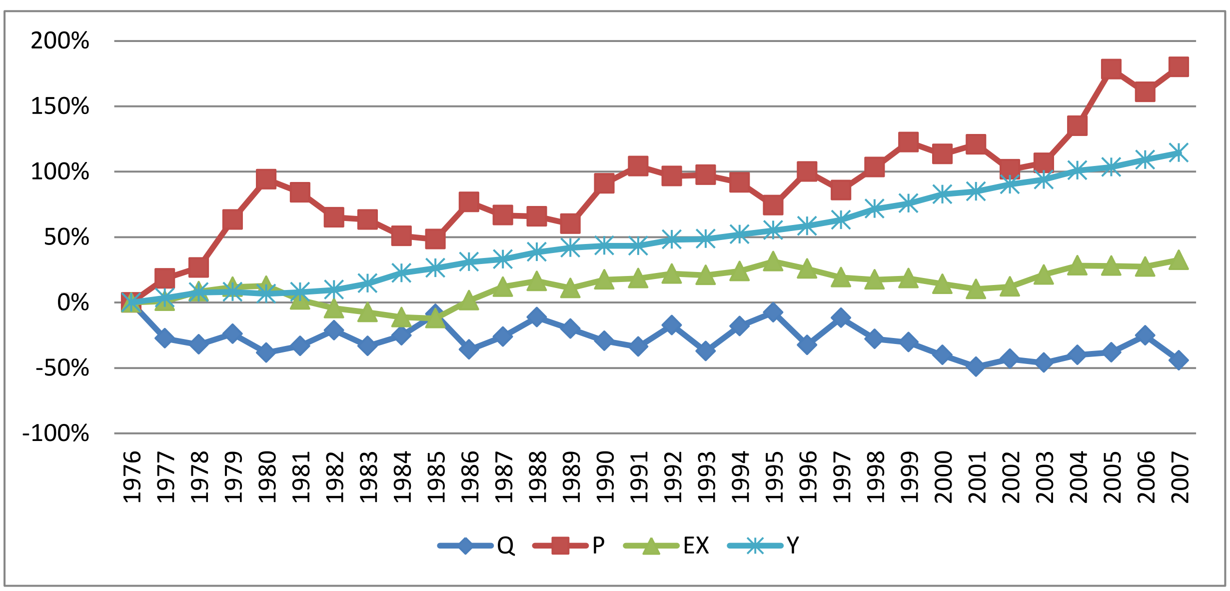

Figure 1. Changes of Import Quantity (Q), Price (P), Exchange rate (EX), and Real Income (Y).

The Box-Cox test shows that log-linear functional form is the best for the data used in this study. The purpose of Box-Cox power transformation is to ensure the basic assumption in the linear regression that the dependent variable is normally distributed around its predicted value with a scalar variance (Box and Cox, 1964). The transformation formulas are $y(\lambda) = (y^{\lambda} - 1)/\lambda$ if $\lambda \neq 0$; $y(\lambda) = \log(y)$ if $\lambda = 0$. Therefore, econometric models are linear if $\lambda = 1$, and log-linear if $\lambda = 0$. The Box-Cox test, transform data with λ from -3 to +3, uses loglikehood ratio test to compare the empirical models. The best value of λ gives the maximum log-likelihood ratio. For our data, Box-Cox test shows that $\lambda = - 0.25$ generates the largest log-likelihood value, -153.567, with a 95% confidential interval of [-2.25, 1.5]. Therefore, the most convenient λ is 0, or log-linear model is best fitted to the data.

It is well known that ordinary least squares (OLS) method using nonstationry time-series data produces spurious regressions (Granger and Newbold, 1974). A time series variable is stationary when its stochastic properties (e.g. mean, variance, and covariance) are invariant with respect to time (Kennedy, 2008). Granger (1981), Engle and Granger (1987) introduced the cointegration concept and method to estimate economic models using nonstationary time-series data. If a group of time series data have an equilibrium or economic relationship, they can not move independently from each other (Ender, 2004); in other words, they are cointegrated. Engle and Granger (1987) proved that time-series variables are cointegrated when (i) all variables are integrated to the same oder d; and (ii) there exists at least one linear combination of variables that is integrated to the order d-b, where b > 0.

Stationary Tests

A time-series variable is integrated to the order d when its d^{th} difference is stationary. In economics, most time series are integrated to the order 1. The Augmented Dickey-Fuller (ADF) test is employed to check for the first difference stationarity. The general form of ADF test is $\Delta y_t = a_0 + \gamma y_{t-1} + \sum_{i=2} \beta_i \Delta y_{t-i+1} + a_1 t + \varepsilon_t$. We test the null hypotheis of $\gamma = 0$, and the null hypothesis of $a_0 = \gamma = a_1 = 0$. If we fail to reject both null hypotheses, the series (y_t) has unit root, or integrated to the order 1 (Dickey and Fuller, 1981). The ADF tests are shown in Table 1.

Table 1. ADF Test for Stationary

Variables	τ	$Pr < \tau$	Φ	$Pr > \Phi$	Conclusion
lnM_t	-2.92	0.17	4.26	0.35	I(1)
lnP_t	-1.79	0.38	2.66	0.41	I(1)
$LnCPI_t$	-2.51	0.12	3.84	0.12	I(1)
$lnEX_t$	-3.03	0.14	4.63	0.28	I(1)
lnY_t	-3.46	0.06	5.99	0.08	I(1)

Notes: (i) Unit root tests were performed using Proc ARIMA in SAS 9.2; (ii) 95% critical of τ = - 3.60; (iii) 95% critical value of Φ = 7.24

The critical value for the null hypothesis of $\gamma = 0$ is τ_0 = - 3.60. If computed $\tau > \tau_0$, we fail to reject the null hypothesis of $\gamma = 0$. Similarly, if computed $\Phi < \Phi_0 = 7.24$, we fail to reject the null hypothesis of $a_0 = \gamma = a_1 = 0$. Table 1 shows that all variables have unit root. Therefore, we can test for the existence of cointegration among variables.

Cointegration Test and Error Correction Model

Engle and Granger (1987) proposed a two-step method to test for cointegration in a single-equation model. The basic of Engle-Granger method is to test for unit root in spurious regression residuals. However, OLS estimation of spurious regression requires us to choose a regressand among variables, and the estimates of parameters are sensitive to the choice of regressand. When there are more than two variables, the number of cointegration relationships can be greater than one, but OLS method is not be able to estimate all these relationships, and may produce inconsistent estimates of true cointegrating parameters (Kennedy, 2004). Johansen (1988) developed a method to test cointegration in a multiple-equation model. Johansen (1988) views all variables as endogenous, and forming a vector autoregressive (VAR) model to test for cointegration. Johansen test is developed from a vector autoregressive model: $Z_t = A_1Z_{t-1} + A_2Z_{t-2} + A_3Z_{t-3} + \ldots + A_mZ_{t-m} + \varepsilon_t$. Subtracting each side by Z_{t-1} and going through manipulations, we obtain: $\Delta Z_t = \Pi\, Z_{t-1} + \sum_{i=1}^{m-1} \Gamma_i\, \Delta Z_{t-i} + \varepsilon_t$, where, $\Pi = -\, I + A_1 + A_2 + \ldots + A_m$, and $\Gamma_i = -\sum_{j=i+1}^{m} A_j$. The rank of matrix Π is equal to the number of independent cointegrating vectors of Z variables. Johansen and Juselius (1990) developed a maximum likelihood method to test, and estimate those cointegrating vectors. Multiple cointegrating vectors make it difficult to identify the true equilibrium relationship among economic variables. Multiple cointegrating relationships do not imply multiple long-run equilibrium, but there are several sector equilibrias in a long-run equilibrium (Kennedy, 2004). At a certain time, there is a unique equilibrium in the market. Therefore, we select the cointegrating vector that has the best economic meaning. The cointegration rank test is presented in Table 2.

Table 2. Cointegration Rank Test

H_0: Rank = r	H_1: Rank > r	Eigen-value	λ_{Trace}	5% Critical Value
0	0	0.86	114.37	68.68
1	1	0.56	55.25	47.21
2	2	0.47	30.16	29.38
3	3	0.28	10.62	15.34
4	4	0.02	0.66	.084

Notes: Cointegration rank test were performed using Proc VARMAX in SAS 9.2

The cointegration rank test fails to reject null hypothesis of r = 3 since λ_{Trace} = 10.62 < critical value = 15.34. Three potential cointegrating vectors are estimated (Table 3).

Table 3. Cointegrating Vectors

Variables	Vector 1	Vector 2	Vector 3
lnM_t	1	1	1
lnP_t	0.32	-1.27	0.81
$lnCPI_t$	-5.43	-0.59	1.71
$lnEX_t$	-2.07	-0.60	-1.99
lnY_t	3.19	1.39	-0.68

The third vector conforms to demand theory; hence the long-run import demand of US smoked herring is: $\ln M_t = - 0.81*\ln P_t - 1.71*\ln CPI^{us}_t + 1.99 *\ln EX_t + 0.68*\ln Y_t$. The estimated equation follows the demand theory. Imported smoked herring is price inelastic (-0.81). A one percent increase in price will cause import quantities of smoked herring to decrease by 0.8 percent. Income has a positive effect on herring imports, and smoked herring is a normal good since income elasticity of $0.68 < 1$. Macroeconomic factors also affect herring imports. Exchange rate has a positive effect on herring imports, as anticipated. A one percent increase in exchange rate will result in a 2.0 percent increase in herring imports. The US consumer price index (CPI) has a negative impact as anticipated.

Error correction model (ECM) has been used widely in economics. The main idea is that a proportion of disequilibrium from one period is corrected in the next period. The error-correction models estimate short-run dynamics of variables that are influenced by deviations from the long-run equilibrium (Engle and Granger, 1987). The error correction term (ECT) is a short-run deviation from the long-run equilibrium. In the first step, the ECT term is computed from the long-run equilibrium relationship as the differences between predicted value and actual value of the dependent variable: $ECT_t = \ln M_t + 0.81*\ln P_t + 1.71*\ln CPI^{us}_t - 1.99 *\ln EX_t - 0.68*\ln Y_t$. In the second step, we include lag of ECT_t term in the estimation of smoked herring import demand equation using first differences in data, $\Delta \ln M_t = b_0 + b_1*\Delta \ln P_t + b_2*\Delta \ln CPI_t + b_3*\Delta \ln EX_t + b_4*\Delta \ln Y_t + \varphi \text{ lag}(ECT_t) + e_{t;}$ where, Δ is the difference operator. The expected sign of φ is negative, between -1 and 0. The parameters b_1-b_4 are short-run effects of interested variables on import quantities. The estimated results are in Table 4.

Table 4. Estimation of Error-correction Model

Parameter	Estimate	Standard error	t value
Constant	3.73	1.59	2.35
$\Delta \ln P_t$	-1.33**	0.33	-4.02
$\Delta \ln CPI_t$	-1.08	2.21	-0.49
$\Delta \ln EX_t$	0.46	0.61	0.76
$\Delta \ln Y_t$	-0.47	1.98	-0.24
$lag(ECT_t)$	-0.38*	0.16	-2.38
DW	2.11	-	-
White test	22.61	(0.31)	-
Shapiro-Wilk test	0.97	(0.49)	-

* significant at 95%; ** significant at 99%; P-values are in parentheses.

The ECT term has a negative sign (-0.38) as anticipated and statistically significant. It means that 38% of disequilibriums are corrected after each period. The short-run effect of import price on herring imports is negative as anticipated. There is evidence of habit formation effect on smoked herring imports. Theory predicts that habit formation make demand more inelastic in the long-run. The short-run elasticity of -1.3 is more elastic than the long-run elasticity of -0.8. The ECM has no problem of autocorrelation (DW = 2.1), no problem of heteroscedasticity (White test statistic = 22.61 and p-value = 0.31), and conforms to the normality assumption (Shapiro-Wilk p-value = 0.49).

Habit Formation vs. Inventory Adjustment

We estimate the import demand equation of smoked herring with each of the three specifications of habit formation discussed previously. The results of empirical demand estimation with habit formation as time trend and partial adjustment are shown in Table 5.

Table 5. Habit Formation with Time Trend and Partial Adjustment Specification

Variables[a]	Time Trend Habit Formation			Partial Adjustment Habit Formation		
	Coint. vector[b]	ECM model	t value	Coint. vector[b]	ECM model	t value
$\ln M_t$ / lag(ECT_t)	1	-0.42*	-3.06	1	-0.94*	-3.56
$\ln P_t$ / $\Delta \ln P_t$	0.65	-1.14*	-3.61	0.74	-0.86*	-2.94
$\ln CPI_t$ / $\Delta \ln CPI_t$	1.47	-2.5	-1.12	-1.77	0.66	0.41
$\ln EX_t$ / $\Delta \ln EX_t$	-3	0.85	1.49	-0.58	0.49	0.96
$\ln Y_t$ / $\Delta \ln Y_t$	-0.62	2.67	1.26	1.01	0.76	0.45
Trend / ΔTrend	0.3	-1.02*	-2.94	-	-	-
lag($\ln M_t$) / Δlag($\ln M_t$)	-	-	-	-0.01	0.01	0.09
Constant	-8.97	0.15	1.28	-6.99	-0.07	-0.86

a) $\ln M_t$ / lag(ECT_t) are variables in cointegration vector / ECM model. Generally, X / ΔX are predictors in cointegration vector / ECM model; b) Cointegration vector; * significant at 99%;

In the time trend habit formation specification, the long-run empirical import demand equation is: $\ln M_t = -0.65{*}\ln P_t - 1.47{*}\ln CPI^{us}_t + 3.0{*}\ln EX_t + 0.62{*}\ln Y_t + 0.3{*}Trend$. The results show that when time passes, the long-run effect of habit formation will be positive on the consumption quantities. However, the change is relatively small. The ECM model with time trend variable gives the short-run price elasticity of -1.14, which is more elastic than the long-run import demand elasticity. Again the results show evidence of habit formation effect in the import demand for smoked herring in the US market.

In the partial adjustment specification of habit formation, the empirical results show that the short-run elasticity (-0.86) is larger than the long-run import demand elasticity (-74), in absolute value. The lag import quantities, (lag(lnM_t)), has a negative effect on the current import quantities; it means that there is an inventory adjustment in the US smoked herring imports. If imports of last year increased, imports of current year will decrease and vice versa.

The differences between short-run and long-run import demand elasticities imply that smoked herring importers should consider short and long-run effects in designing their marketing strategies. In the short-run, the US import demand is elastic; hence a decrease in import price will help exporters increase their revenue. However, the positive effect on revenue will die out soon and the revenue of exporters will decrease in the long-run if the price decreases . In the long-run the US import demand for smoked herring is inelastic. Therefore, the best long-run marketing strategies for smoked herring exporters in the US market should be price increasing, since consumption habit persistence will help exporters to earn more revenue with higher prices. However, building habit for a specialty food, e.g. smoked herring, require extra time and advertising efforts.

The state adjustment specification of habit formation proposed by Houthakker and Taylor (1970) considers commodity stocks, e.g. smoked herring, playing a role in the demand dynamics. The effect of commodity stocks on demand reflects the augmented effect of habit formation and inventory adjustment in the demand equation. Empirical demand with stock adjustments follows equation (7). The equation (7) may have an autocorrelation problem, since it contains lag of the dependent variable (M_{t-1}) among the predictors. However, we use OLS method to estimate equation (7) since Sexauer (1977) argued that alternative estimation procedures to correct autocorrelation of the Houthakker and Taylor model offer only little or no improvement over the OLS results. The results are shown in Table 6.

Table 6. Habit Formation with State Adjustments

Variable	Estimate	Std Error	t value	p value
constant	7.000	2.43	2.88	0.0090
lag($\ln M_t$)	0.056	0.21	0.26	0.7949
$\Delta \ln P_t$	-0.777*	0.40	-1.9	0.0714
lag($\ln P_t$)	-0.521	0.40	-1.3	0.2087
$\Delta \ln CPI_t$	-0.352	2.95	-0.12	0.9061
lag($\ln CPI_t$)	1.726*	0.97	1.77	0.0910
$\Delta \ln EX_t$	0.719	0.59	1.21	0.2393
lag($\ln EX_t$)	0.809*	0.41	1.97	0.0624
$\Delta \ln Y_t$	1.679	2.06	0.81	0.4243
lag($\ln Y_t$)	-1.059*	0.54	-1.96	0.0633

Independent variable is $\ln M_t$; * significant at 90%;

The empirical model has no autocorrelation problem since Durbin-Watson is 2.1, and the Godfrey test fails to reject the null hypothesis of serial correlation in the regression residuals (p value = 0.15). The empirical model also has no problem of heteroscedasticity since White test fails to reject the null hypothesis of homoscedasticity (p value = 0.42). The model also passed the Shapiro-Wilk test for normality with p value of 0.26.

The Houthakker-Taylor model does not thoroughly explain the dynamics of smoked herring into the US market, only 51% of smoked herring import variations ($R^2 = 0.51$) are explained by the variations in the independent variables. Current changes of independent variables ($\Delta lnCPI_t$, $\Delta lnEX_t$, ΔlnY_t) do not statistically affect import quantities, except for import price (ΔlnP_t). The lags of independent variables statistically influence import quantities of smoked herring into the US, except for import price. The results imply that import quantities respond spontaneously to import price, but there are delays of import quantities response to other factors (e.g. income, exchange rate, and price of other goods). We use the empirical result in Table 6 to compute the stock adjustment coefficient, $\beta = 2(A_1 - 1)/(A_1 + 1) + A_3/(A_2 - 0.5*A_3) = 2(0.06 - 1)/(0.06 + 1) + (-1.06)/(1.68 - 0.5*(-1.06)) = -2.27$. The stock coefficient reflects the net effect, which reflects the dominance of habit formation or inventory adjustment over the other. The inventory adjustment or physical stock tends to dominate for durable goods, and in the short-run, or $\beta < 0$. Habit formation or psychological stock tends to dominate for nondurable goods, and in the long-run. In this study, we obtained the value of $\beta = -2.27 < 0$, implying that inventory adjustment dominates in the US smoked herring import market. Conventionally, people think that seafood is nondurable, and annual basis is considered as a long-run scope in market dynamics for seafood. However, conventional thinking may not be true for disaggregated data, e.g. the case of smoked herring imports in the US market. Quality of smoked herring lasts longer than other seafood products, and imports of smoke herring may take time to adjust. Therefore, the inventory adjustment effects dominate in the empirical results of our study. Any further marketing studies or activities in the US market should pay attention to these particular characteristics of smoked herring imports. For example, physical stocks of smoked herring imports play an important role in the demand for smoked herring in the US.

Conclusion

Different specifications of habit formation, such as time trend, partial adjustment, state adjustment, are incooperated into the aggregate import demand function. The empirical analysis is conducted for the US smoked herring imports which is a potential habit-forming product. The empirical results confirm that habit formation play a role in the demand dynamics of smoked herring imports in the US market. Habit formation increases the consumption quantity of smoked herring, when considering all other factors constant. In addition, habit formation turns the US demand for smoked herring more inelastic in the long-run. Finally, due to its specific characteristics, e.g. durability, import time delays, US smoked herring imports have an inventory or physical stock adjustment effects, and in fact, the physical stock adjustments dominate the psychological stock or habit formation effects in the short-run. The current study has some limitations, which can be addressed in future studies, such as identification of the scope of short-run vs. long-run for marketing strategy; employment of the demand system approach for groups of seafood products with different commodity characteristics to compare different effects of habit formations; and finally, rational habit formation can be considered in future studies.

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