A DYNAMIC IMPORT DEMAND ANALYSIS OF HONDURAN COFFEE

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Abstract

The responsiveness of import demand for Honduran coffee to changing economic environments in its main trading partners was studied. Estimation included Johansen cointegration analysis and VAR models with Monte Carlo simulated error bands. Results indicate a significant response of Honduran coffee sales to changes in importers' incomes and import prices.

International trade in primary commodities has dominated the export performance of developing countries (Lord). This is one reason why the performance of disaggregate commodity trade has been of important concern to producers and economic policy-makers in these countries.

Previous work in trade has revealed low price and income elasticities of demand for coffee in importing countries (Houthakker and Magee). One implication of this is that changes in economic activity in coffee markets will have little effect on coffee demand from producing countries.

In the context of Honduras, coffee has been one of the most important export products for the domestic economy. Revenues from coffee production contribute 5-8 percent of the total Honduran gross domestic product and about 30 percent of the agricultural gross domestic product (Canales).

Recently, the world coffee market has undergone important changes in the supply side, which have been reflected in decreased world coffee prices. These changes are severely affecting coffee producing countries, especially those whose economy relies on coffee exports (Inter-American Development Bank et al.).

In Honduras, despite of the general world coffee crisis, coffee continues to be an important source of jobs and revenues for the country. For this reason, the Honduran government is making efforts to reduce the impact of this crisis in the domestic economy.

A valuable contribution to this problem is the determination of the responsiveness of import demand of Honduran green coffee to changing economic environments in its main trading partners, Germany, Japan, and the United States (U.S.).

The principal objective of this study is to estimate import demand relationships for Honduran green coffee to evaluate the effects of changes in income and import prices on coffee trade flows between Honduras and its main trading partners, Germany, Japan, and the U.S.

Model and Econometric Tools

In estimating import demand schedules of agricultural products, most recent works have followed a two stage utility maximization approach, basically a static Armington specification (Davis and Kruse; Duffy et al.; de Gorter and Meilke; Haniotis). However, important concerns have risen about using this methodology. Alston et al., presented evidence of failure for several cotton and wheat U.S. import markets, to satisfy the homothetic and separability assumptions at the second stage. Additionally, Davis and Kruse, showed that traditional methods of empirically implementing Armington trade model result in theoretically and statistically inconsistent parameter estimates.

In this study, using consumer utility maximization and a double logarithm functional form, a theoretical specification of Honduran coffee import demand in country i^{th} is written as:

$$m_{i,t} = a_{10} + a_{11}p_{i,t} + a_{12}y_{i,t} + e_t \text{, where} \quad (1)$$

m_i is country i's volume of green coffee imports from Honduras, p_i is the real import price of Honduran green coffee into country i, y_i is country i's level of income and e_t ~ i.i.d. All variables are expressed in natural logarithm. According to demand theory, a negative relationship is expected for price and positive for the income variables.

The resulting model (1) is useful for direct empirical applications since coefficient estimates are directly interpreted to be elasticities.

The study incorporates dynamics by using vector autoregressive framework (VAR) (Sims), including the contribution of Johansen, maximum likelihood estimation, for error correction models (ECM).

Equation (1) at current period t can be represented as an unrestricted (3 x 3) VAR of k^{th} lag order:

$$z_t = A_1 z_{t-1} + ... + A_k z_{t-k} + e_t \text{ ,} \tag{2}$$

where z_t is a (3 x 1) vector of endogenous variables including *m*, *p*, and *y*. Each of the A_i is a (3 x 3) matrix of parameters of the endogenous variables, and e_t ~ i.i.d. This is a reduced form system in which each variable in z_t is regressed on only lagged values of both itself and all the other variables in the system (Sims).

First, the stationary properties of each variable are estimated. The test for unit roots is carried out using the Phillips-Perron procedure (PP) (Phillips and Perron). The optimal lag length for each system of equations is chosen by implementing Akaike Information Criteria (AIC). The Schwartz Criteria (SBC) and the Likelihood Ratio (LR) test are also conducted to corroborate results from AIC.

In the Johansen procedure maximum likelihood is applied to a differentiated process of the following form:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-k} + e_t \text{ ,} \tag{3}$$

where Γ_i = - (I-A_1-...-A_i), for all (i=1,..., k-1); Π = -(I-A_1-...-A_k); and Δ stands for the variables in first differences (e.g., $\Delta m_t = m_t - m_{t-1}$). Additionally, $\Pi = ab'$, where a represents the speed of adjustment to disequilibrium and b is a matrix of long run coefficients.

The Johansen test procedures rely upon the estimation of the rank r of the matrix of coefficients, Π, which is the number of cointegrating relationships. In order to determine r, the l_{trace} and l_{max} tests statistics are performed.

The goal in this procedure is to evaluate the long and short-run interrelationships among the variables. Long rung relationships are tested first (equation 3). For the short-run analysis VAR systems with variables in levels (equation 2) are estimated, and impulse response functions (IRF) are constructed. All data analysis were performed using Regression Analysis for Time Series (RATS), version 5. In future iterations of the research VAR models with variables in differences are estimated, and comparing and contrasting results are evaluated for robustness of the analysis.

Data and Sources

The data are annual and cover the period 1962-2001 for Germany and the U.S. and 1969-2001 for Japan. The volume and value of Honduran green coffee imports, from the three markets, were obtained from the United Nations trade flow database, COMTRADE. The category of coffee used was 071, described as "coffee and substitutes." This analysis estimated import prices by dividing value by volume. The national account data, Gross Domestic Product (GDP) and Consumer Price Index (CPI), came from the World Bank World Development Indicators database (2002). The CPI was required to deflate GDP and prices.

Dynamic Analysis Results

Unit Roots

A summary of results based on the PP test is presented in Table 1. For Germany, volume of imports and real import prices were found to be nonstationary, and real GDP was found to be nonstationary with the presence of a constant. For the case of Japan, the PP found nonstationarity only for real GDP, with the presence of a constant. For the U.S., the PP test found import price and real GDP to be nonstationary, and the latter variable with the presence of a constant.

Lag Order Model Selection

For Germany, the AIC minimized the model with two lags; in contrast, the SBC criteria and the LR test suggested the lag level of one (results not presented). Restricted data availability for Japan

(1969-2001), caused a limited maximum lag length evaluation of two. The AIC result indicated an optimal lag length of two, while the SBC and LR tests suggested a lag order of one. Finally for U.S., both tests, AIC and SBC, minimized the optimal lag length of one; additionally, the LR test suggested that lag levels higher than one are not significant.

Because of divergence of some of the previous results, plots of residuals and the Ljung-Box *Q* test were evaluated to detect the presence of residual autocorrelation, and then, adjust for any model specification problem. Results from these latter procedures indicate that the two lagged system performs better for the three countries, supporting the result from AIC in the case of Germany and Japan.

Cointegration Analysis

In the cointegration analysis, using the Johansen Maximum Likelihood method, one assumption is that at least two of the variables in z_t of equation (3) are nonstationary (Hansen and Juselious). For this reason the procedure was implemented only for Germany and the U.S.

In the case of Germany, both tests, the L-Max and Trace, fail to reject the null hypothesis of no cointegration (H_o: r = 0) at the ten percent level (results not presented). Therefore, it was concluded that there is no long run equilibrium relationship for Germany between volume of coffee imports from Honduras and real import price of Honduran coffee, and Germany’s real GDP.

Results of the cointegration analysis for the U.S. are presented in Table 2. Results include the rank test based on Lambda Max (L-Max) and Trace tests statistics. Critical values are those reported by Osterwald and Lenum.

Results of the cointegration analysis for the U.S. are inconclusive. The L-Max fails to reject the null hypothesis of no cointegration (H_o: r = 0); suggesting that there is no long-run equilibrium relationship among the variables. However, the Trace test indicates the presence of one cointegrating relationship (H_o: r = 1).

Following the results from the Trace test, when one cointegrating vector is normalized for volume of imports, the long run equilibrium model, including a constant in the cointegrating space, yielded:

$$m_{(U.S.)} = -3.12 + 0.27\, p + 0.79\, y \qquad (4)$$

where $m_{(U.S.)}$ is the volume of Honduran green coffee imports by U.S., *p* is the import price of Honduran coffee in U.S., and *y* represents the U.S. real GDP.

The speed of adjustment parameters (a_i) for the error correction term in the equations for volume of imports, import prices, and level of income were -1.11, 0.23, and 0.02, respectively. At the ten percent significance level, volume of imports (t = -4.89) and import prices (t = 1.35) adjust to a deviation from the long run equilibrium.

Since equation (4) is expressed in terms of natural logs of the variables, estimates for the parameters result in direct elasticities. The resulted sign for the price elasticity was not expected, and does not conform economic theory. The estimated long run equilibrium relationship suggests that the volume of Honduran coffee imports into the U.S. is income inelastic, 0.8. These results are similar to previous studies from (Houthakker and Magee; Huang et al.; Hughes; Islam and Subramanian; Okunade and McLean-Meyinsse; and Parikh). This result has been attributed to the fact that coffee consumption eventually reaches a saturation level for most individuals (Huang et al.), and at higher incomes this beverage is displaced by other beverages, such as alcoholic drinks (Parik).

Impulse Response Functions

The widely used descriptive methodology of dynamic multipliers, impulse response functions (IRF), was implemented in this study. This procedure is used to study the path reaction of variables to shocks in the VAR model.

Impulse responses may sometimes provide a misleading impression of results, for example a response whose sign is unexpected can arise. In order to characterize uncertainty about point estimates of IRF, Sims and Zha proposed the construction of error bands. These aim to characterize the shape of the likelihood function. This procedure was implemented using Monte Carlo simulation, and by application of antithetic acceleration, the variance of estimates was reduced (RATS).

The IRF, represented by solid lines, and estimates of one standard deviation error bands, short-dashed lines, are presented in Figures 1-3 for Germany, Japan, and the U.S., respectively. Both, the IRF and the error bands were corrected by the standard deviation of the forecast errors of each series. If error bands widen in a way that positive and negative reaction values are possible, including the original steady-state, the result is assumed to be null. In the figures, the vertical axis denotes the dynamic responses to specific shocks, while the horizontal axis represents time in years.

For Germany, a positive shock of one standard deviation on the level of income caused an increase in coffee import prices (plot A). The error bands suggest that this reaction is different from original equilibrium levels only during the first period (contemporaneously). The same shock to income produced a positive reaction in Honduran green coffee imports (plot B). The effect is different from steady-state levels during the second and third periods after the shock.

The effect of a positive shock on coffee import prices slowly decays toward the original equilibrium at period five (Plot C). The shock to prices causes a reduction in volume of coffee (plot D). The effect accumulates, and reaches the lowest point at period five (-0.65 standard deviation); thereafter, import volumes slowly return to equilibrium.

A shock in the volume of coffee imports slowly decreases and reaches equilibrium at period five (plot E). The effect of the shock on imports produces a positive reaction in prices, but the reaction is not different from steady-state levels (plot F).

Results of the dynamic reactions for Japan are presented in Figure 2. A positive shock of one standard deviation on Japan’s income does not have any effect on coffee import prices, as suggested by estimated error bands (plot A). The positive shock to Japan's income causes coffee import volume to increase contemporaneously (plot B). The reaction remains above original steady-state only during the third period after the shock.

A positive shock to coffee import prices lasted two periods (plot C). The change in import prices is reflected on a decrease of coffee imports during the second period. This effect is reversed and volume of imports increased, above original equilibrium levels, during the next three periods. This result was unexpected and does not conform to economic theory. There is the possibility that reduced imports, as a reaction to increased prices, causes the use of accumulated stocks, and imports are latter increased to compensate for reduced reserves.

The effects of an increase in coffee imports lasted five periods after the shock (plot E). The same increase in import volume, is expected to increase import price only during the following period (plot F).

Results for the U.S. are presented in Figure 3. A positive shock of one standard deviation in the U.S. income has no significant effect on import prices (plot A). The positive change in income does not have an immediate effect on volume of coffee imports; however, it caused an increase in imports during the fourth and fifth periods after the shock (plot B).

An increase in the U.S. import price of Honduran coffee slowly decreases and reaches equilibrium after five periods (plot C). The change in price caused a negative contemporaneous effect on the volume of imports (plot D). Additionally, the effect on coffee imports is reversed during the second period and extends to the third period. This unexpected result is similar to the one from Japan. It is believed that accumulated stocks in importing countries play an important role in explaining this result.

A positive shock in the volume of Honduran coffee imports declines immediately at the following period (plot E). The positive shock of coffee import volume has no effect on prices (plot F).

Conclusion

The responsiveness of the import demand of Honduran green coffee to changing economic environments of its main trading partners, Germany, Japan, and the U.S. was studied. Import demand relationships for each country were estimated. The stationary properties of the series were evaluated using PP test. Optimal lag length selection was done by evaluating results from AIC and SBC criteria and LR test. Additionally, plot of residuals and the Ljung-Box *Q* test were evaluated to detect the presence of residual autocorrelation. Estimation procedures included cointegration tests, using the Johansen maximum likelihood method, and the VAR systems with variables in levels.

The dynamic effects in each of the systems were evaluated using the common methodology of dynamic multipliers (IRF), and in order to characterize uncertainty about point estimates of IRF, error bands were constructed using a Monte Carlo simulation procedure described in RATS, User's manual.

For Germany, the three variables, import volume, real import price, and real GDP resulted nonstationary. For Japan, only real GDP was nonstationary. For the U.S., real import price and real GDP were found to be nonstationary. The lag length selection procedures found an optimal lag length of two for each of the three countries.

From the cointegration results, no steady-state relationship among Honduran coffee imports, import prices, and the level of income was found for Germany. For the U.S. the Trace test for cointegration found one cointegrating vector. The estimated long run equilibrium yielded an income elasticity of 0.8.

Results from IRF suggest that a positive change in Germany's income has a contemporaneous increase on import price. The shock in income caused increased imports of Honduran coffee two and three years after the shock. An increase in the Honduran coffee import price implies a reduction in the volume of imports from Germany. This effect accumulates below original equilibrium and reaches the lowest point after five periods.

For Japan, a positive change in income does not have an effect on Honduran coffee import prices. The shock in income induced a positive contemporaneous reaction on the volume of imports, and this response remained above the original steady-state during the third period after the shock. Following a shock on import prices, imports decreased during the second period. After the second period, imports increased above equilibrium and remained at this level during three consecutive periods.

For the U.S. results indicate that a positive shock in the U.S. income does not have a significant effect on coffee prices. The shock in income caused an increase in coffee imports four and five periods after the shock. Also, results suggest a negative contemporaneous effect on import volumes as a result of a positive shock in import prices. Moreover, the level of imports is expected to increase at the second period.

Results of this investigation provide evidence that imports of Honduran coffee from its three major importing partners react to changes in economic activity and import prices. These results contrast previous findings from Huang et al., Hughes, Islam and Subramanian, Okunade and McLean-Meyinsse, and Parikh. These studies found a negligible role of income and prices in determining coffee consumption in several countries. In contrast, Kutty reported that Indian coffee demand, from its principal trading partners, is significantly affected by changes in import price.

A very interesting result is the lagged positive reaction of imports to a positive change in prices, as evidenced by the IRF from Japan and the U.S. Accumulated stocks in importing countries may play an important role in explaining this effect. One way to provide better insight into this is to include a variable that accounts for the level of coffee stocks in importing countries.

Finally, the study suggests that the three evaluated markets for Honduran coffee have considerable growth potential due to significant response of buyers to incremental changes in their real income. However, strategies based on price reductions aimed to increase revenues from coffee exports must be carefully analyzed.

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Table 1. Results of Phillip Perron Test for Unit Root Analysis. Import Demand Analysis of Honduran Coffee.

Series	Germany	Japan	U.S.
Import Volume	I(1) [z]	I(0)	I(0)
Real Import Price	I(1)	I(0)	I(1)
Real GDP	I(1) C	I(1) C [y]	I(1) C

[z] I(0) indicates series is stationary; I(1) indicates series is nonstationary.

[y] C stands for the presence of a constant.

Table 2. Trace and Lambda Max (L-Max) Statistics for Cointegration analysis. Import Demand Analysis of Honduran Coffee for the U.S. (1962-2001).

	Estimated Statistics			Critical Values [z]	
H_o: r [y]	L-Max	Trace		L-Max 95%	Trace 95%
0	19.24	38.03		22.0	34.41 * [x]
1	12.85	18.79		15.67	19.96
2	5.95	5.95		9.24	9.24

[z] Critical values are those reported by Osterwald and Lenum.

[y] l_{max} estimates the statistic for the null hypothesis (H_o) that the number of cointegrating vectors is r against the alternative of $r + 1$ cointegrating vectors, where r is the rank of Π matrix in equation (3). The l_{trace} statistic test the same null hypothesis as the l_{max} test; however, the alternative hypothesis is the rank of Π is $n - r$, where n is the number of variables in the system.

[x] Starred values mean that the null hypothesis is rejected.

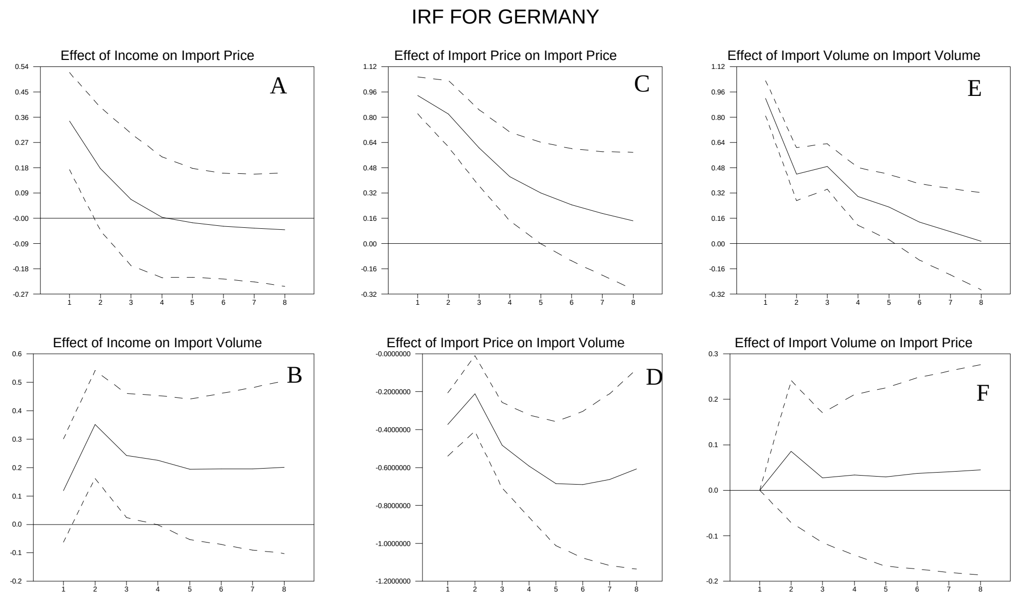

Figure 1. Impulse response functions (IRF) and error bands for import demand of Honduran coffee from Germany. Solid and short-dashed lines represent point estimate IRF and one standard deviation error bands, respectively. Model estimated with all variables in levels.

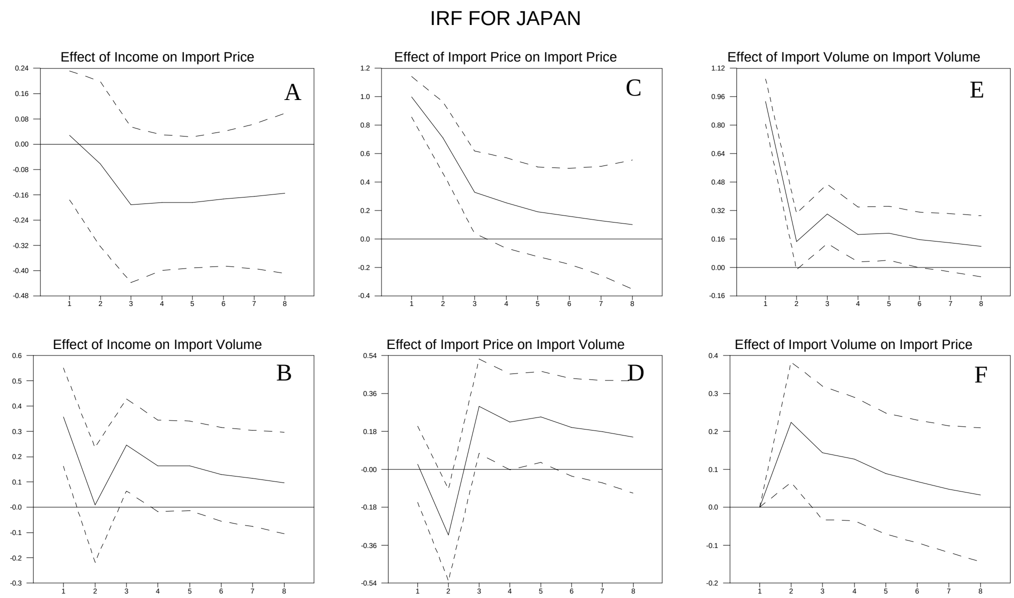

Figure 2. Impulse response functions (IRF) and error bands for import demand of Honduran coffee from Japan. Solid and short-dashed lines represent point estimate IRF and one standard deviation error bands, respectively. Model estimated with all variables in levels.

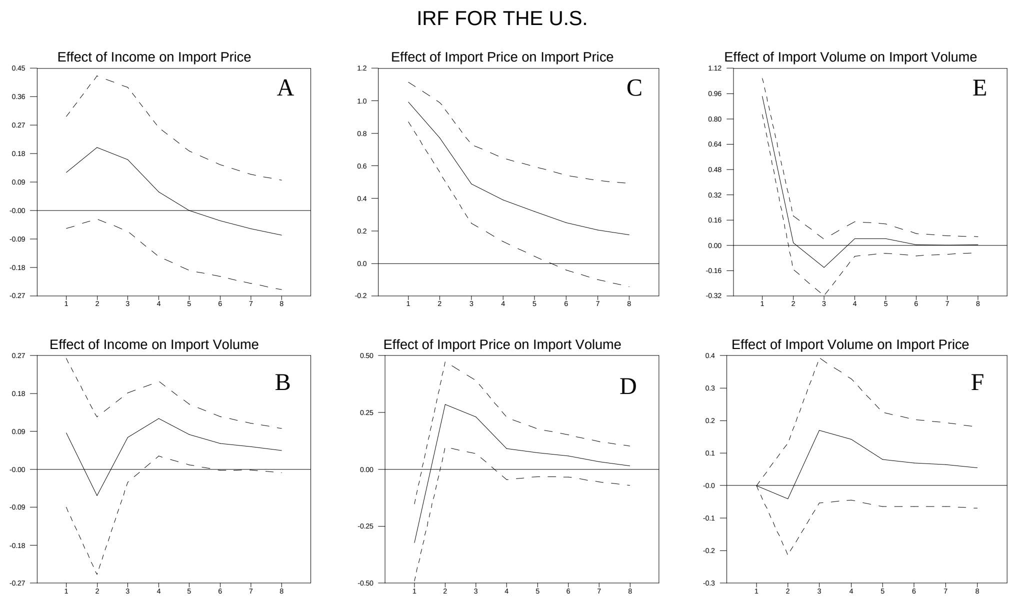

Figure 3. Impulse response functions (IRF) and error bands for import demand of Honduran coffee from the U.S. Solid and short-dashed lines represent point estimate IRF and one standard deviation error bands, respectively. Model estimated with all variables in levels.