Impact of Depreciating Exchange Rate on U.S. Produce Trade

Ram N. Acharya and Paul M. Patterson

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island

July 24-27, 2005

Assistant Research Professor and Associate Professor, Morrison School of Agribusiness and Resource Management, Arizona State University, 7001 E. Williams Field Rd, Mesa, AZ 85212.

Impact of Depreciating Exchange Rate on U.S. Produce Trade

This study examines the impact of depreciating exchange rate on U.S. fresh produce trade. The short run analysis does not support J-curve hypothesis but the overall results are consistent with the modified version of the hypothesis that devaluation would initially deteriorate the trade balance but improve it in the long run.

Key words: exchange rate, j-curve, fruit and vegetable, produce trade balance

Introduction

This study assesses the impact of changes in exchange rate on U.S. fresh produce trade balance. Economic theory postulates that an appreciation of a country's currency would raise the relative price of her exports but reduce the relative price of imports causing the demand for her products to fall in both domestic as well as export markets. However, the overall impact of changes in exchange rate would depend on the nature of export and import demand functions. In particular, the Marshall-Lerner condition states that if the absolute sum of export and import demand elasticities is greater than one, an appreciation of a nation's currency would deteriorate the trade balance situation.

Exchange rate is one of the important factors in determining the farm value because the produce industry relies heavily on export markets for its sales. For instance, a significant portion of domestic production of almonds (61%), apricots (35%), grapefruit (38%), hazelnuts (37%), and walnuts (36%) went to export markets during 2000-2002. For most of these trade dependent commodities, even a small decrease in export demand would result oversupply in the domestic market, which would lead to lower farm prices and dwindling profits. Thus, it is important to understand the role of exchange rates on produce trade. This study uses a relatively new approach to analyze the impact of changes in exchange rate on fresh produce trade balance.

A currency depreciation may initially deteriorate the trade balance before it starts to improve. This phenomenon, which was first observed by Magee (1973), is referred as J-curve effect in trade literature. Since the J-curve effect pertains to the relationship between currency depreciation and the balance of trade, most of the earlier studies were based on aggregate trade data. Carter and Pick (1989) focused on U.S. agricultural trade and observed that the agricultural trade balance does in fact worsen initially as the dollar depreciates. They found that a ten percent depreciation of the U.S. dollar would lead to a deterioration of agricultural trade that would last for nine months. However, they were not able to observe the second part of the J-curve. In a more recent study, Cho, Sheldon, and McCorriston (2002) examined the impact of exchange rate uncertainty on agricultural trade. They found that uncertainty in exchange rate is negatively affecting growth in agricultural trade.

Kristinek and Anderson provide a comprehensive review of studies that analyzed the role of exchange rate on agricultural trade. Most of the studies reviewed in their paper reported that exchange rate plays an important role in determining agricultural trade. However, none of these studies have examined the role of exchange rate on fresh fruit and vegetable trade. Since most of the fresh produce commodities are perishable in nature and a significant portion of their production goes to the export markets, exchange rate might play much more central role in shaping the trade balance. This issue is much more important at a time when the overall agricultural trade surplus is expected to disappear for the first time since 1959, while the value of U.S. dollar against its major trading partners continues to fall.

In this light, this study uses a relatively new approach developed by Pesaran, Shin, and Smith (2001) to test whether exchange rate and produce trade are cointegrated and estimates short-run and long-run relationships using an error correction method.

The Trade Balance Model

The long run U.S. fresh produce trade balance (TB_t) for time period t can be defined as a function of U.S.GDP ($Y_{us,t}$), the trade weighted GDP for major produce trading partner countries (Y_w), and the trade weighted real exchange rate (*REX*), i.e.,

(1) $$\ln TB_t = a + b \ln Y_{US,t} + c \ln Y_{w,t} + d \ln REX_t + \varepsilon_t ,$$

where TB_t is defined as the ratio ($I_{m\,t} / X_{m,t}$) of total U.S. fresh produce imports ($I_{m\,t}$) over total exports (X_t) making it a unit free measure of trade balance (Bahmani-Oskooee and Ratha). The trade weighted real exchange rate between U.S. dollar and the currency of its major produce trading partner countries is defined such that a decrease in the index reflects a real depreciation of the dollar. In this unit free trade balance relationship, we expect *a priori* for the coefficient *d* to hold a positive sign. However, the sign of the coefficients, *b* and *c*, depends on whether the increase (decrease) in income is due to increased (decreased) production of import substitutes.

The J-curve phenomenon, however, is observed only in the short run. To analyze the short run dynamics, we employ an autoregressive distributed lag model (ARDL) recently proposed by Pesaran, Shin, and Smith and applied in many cointegration studies (Bahmani-Oskooee and Ratha). In its error correction version, the ARDL model can be expressed as

(2) $$\Delta \ln TB_t = a + \sum_{i=1}^{n} b_i \Delta \ln TB_{t-i} + \sum_{i=0}^{n} c_i \Delta \ln Y_{US,t-i} + \sum_{i=0}^{n} d_i \Delta \ln Y_{w,t-i} + \sum_{i=0}^{n} f_i \Delta \ln REX_{t-i}$$
$$+ \delta_1 \ln TB_{t-1} + \delta_2 \ln Y_{US,t} + \delta_3 \ln Y_{w,t} + \delta_4 \ln REX_t + \mu_t .$$

Following Pesaran, Shin, and Smith, a two steps procedure was used in estimating equation (2). In the first step, inclusion of lagged level variables is justified using a variable addition test (F-test). This involves testing a joint test that $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ against the alternate hypothesis $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$. In this case, the calculated F-statistics does not follow the standard distribution, therefore, the critical values tabulated by Pesaran, Shin, and Smith should be used. However, this test can be applied irrespective of the degree of integration among the variables (see Pesaran, Shin, Smith for details). A rejection of the null hypothesis, that all four coefficients associated with the lagged level variables are equal to zero, would imply that the variables included in the ARDL are mutually cointegrated and a level relationship exists. Once the cointegration relationship is established and the optimum lag length is determined (by using Akaike information criteria), the short run version of the error correction model can be estimated.

Data

The monthly fresh produce trade, real exchange rate, and gross domestic products for major trading partners (EU, Canada, Japan, Mexico, Hong Kong, Korea, Chile, Honduras, New Zealand, China, and Guatemala) and rest of the world were obtained from USDA's online trade database. The trade weighted exchange rate and the GDP in trading markets were calculated from these data using trade volume as weights.

Empirical Results

The descriptive statistics of the variables used in the model are reported in table 1. On the average, U.S. is a net importer of fresh fruits and vegetables. The average produce import to export ratio for the sample period is 1.5. While the trade balance on fresh fruits was mostly negative, vegetable trade balance was mostly positive until 1998. The demand for fresh produce has increased substantially in the recent years primarily because of the increased awareness about the health benefits of consuming fresh fruits and vegetables, changing socio-demographic composition of the population, and year-round supply of high quality produce commodities. As a result, there has been a substantial increase in fresh produce import from the countries in the southern hemisphere mainly during the winter months when domestic production is limited. A simple correlation analysis shows that exchange rate had relatively small but significantly positive relationship with produce trade balance (0.31) during the sample period.

The two step testing procedure adopted in this study started with the use of Akaike information criteria to determine the optimal lag length on differenced variables and testing for cointegration in the first step and estimation of error correction model with appropriate lag lengths in the second stage (Pesaran, Shin, and Smith).

The Akaike Information Criteria shows that a 7, 10, and 2 period lag lengths are optimal for fresh vegetable, fresh produce, and fresh fruit trade balance equations, respectively (Table 2). To ensure a sufficiently large lag structure, we used 12 period lags in all three equations (Pesaran, Shin, and Smith).

Consistent with the prior studies, cointegration test results (table 3) are sensitive to lag lengths (Bahmani-Oskooee and Ratha). In general, these results show that the four variables used in this study are mutually cointegrated and a level relationship can be used to examine their long run relationship.

The parameter estimates for the error correction model are reported in table 4. In the fresh fruit trade balance model, none of the coefficients of exchange rate are significant except for the coefficient associated with the 12-period lagged exchange rate. Although a significantly positive coefficient for the 12-period lagged exchange rate variable shows that a depreciation of U.S. dollar with respect to its trading partners will improve the trade balance after 12 months, it does not show J-curve effect. Moreover, none of the coefficients of the fresh vegetable model are significantly positive and does not show any J-curve effect.

However, in the fresh produce trade balance equation, lagged exchange rate coefficients are negatively significant at 1 and 5 lag lengths. None of the coefficients except for the 12th lag are positive. Although the exchange rate coefficients are negative initially and become positive after 12 months, as postulated by the J-curve hypothesis, the positive coefficient is not statistically significant. Thus, although there is some indication of J-curve type effect in the case of overall produce trade balance, these results are not conclusive.

However, in the long run, exchange rate has a significantly positive impact on all 3 equations analyzed in the study (table 5). In particular, a depreciation of dollar by one percent would improve trade balance in favor of U.S. by almost one percent for fresh fruits and more than one percent for fresh vegetables (1.55 percent) and total fresh produce (1.20 percent).

Concluding Remarks

A relatively new approach proposed by Pesaran, Shin, and Smith was used to examine the impact of changes in exchange rate on fresh produce trade. Since short run dynamics involved in produce trade are expected to be different from the long run effects, an autoregressive distributed lag (ARDL) model was developed to examine the short run effects. The short run analysis involved using Akaike information criteria to determine optimal lag length and a test to determine whether the variables of interest are mutually cointegrated. Then, based on the results from the first two tests, an error correction version of the ARDL model with appropriate lag lengths was developed to analyze the short run dynamics. On the other hand, an ordinary least square approach was used to examine the long run impact of changes in exchange rate on fresh produce trade balance.

Based on Akaike information criteria, an autoregressive distributed lag model with 12 lags was used to test for cointegration. Results showed that the four variables used in the model are mutually cointegrated implying that levels relationship can be used to analyze the long run relationships. Although a J-curve type effect of exchange rate on produce trade balance equation is observed, none of the three models used in this study support the J-curve hypothesis. However, the results from the long run model show a significantly positive impact of exchange rate on trade balance. This result is consistent with the modified version of the J-curve hypothesis, which states that a devaluation of U.S. dollar would deteriorate trade balance in the short run but improves it in the long run (Bahmani-Oskooee and Brooks).

References

Magee, S.P. "Currency Contracts, Pass-Through, and the J-Curve." *Brookings Papers of Economic Activity* 1(1973):303-323.

Carter, C.A. and D.H. Pick. "The J-Curve Effect and the U.S. Agricultural Trade Balance." *American Journal of Agricultural Economics* (1989):712-720.

Cho, G.C., I. M. Sheldon, and S.M. Corriston. "Exchange Rate Uncertainty and Agricultural Trade." *American Journal of Agricultural Economics* 84(4)(November 1989):931-942.

Kristinek, J.J. and D.P. Anderson. "Exchange Rates and Agriculture: A Literature Review." AFPC Working Paper 02-2, February 2002.

Pesaran, M.H., Y. Shin, and R.J. Smith. "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Econometrics* 16(2001):289-326.

Bahmani-Oskooee, M. and A. Ratha. "The J-Curve Dynamics of U.S. Bilateral Trade." *Journal of Economics and Finance* 28(Spring 2004):32-38.

Table 1. Descriptive Statistics

Variable Description	Mean	St. Dev.
Fruit Imports ($ '000)	209660.7	81261.0
Fruit Exports ($ '000)	156764.0	35967.8
Vegetable Imports ($ '000)	145355.8	85206.0
Vegetable Exports ($ '000)	84572.4	26389.5
Total Produce Exports ($ '000)	241336.4	55539.8
Total Produce Imports ($ '000)	355016.5	160280.4
Real U.S. GDP	661.5	96.8
Trade Weighted Real GDP for Partner countries	135.4	20.0
Trade Weighted Real Exchange Rate	189.2	16.8
Fruit Trade Ratio	1.4	0.4
Vegetable Trade Ratio	1.7	0.5
Produce Trade Balance	1.5	0.6

Table 2. AIC Statistics for Selecting the Lag Order of the Trade Balance Equation

Lag Length	**Fresh Fruits**	**Fresh Vegetables**	**Fresh Produce**
1 Lag	-581.87	-441.55	-612.28
2 Lags	-585.44	-440.72	-604.70
3 Lags	-585.87	-433.73	-602.70
4 Lags	-581.73	-429.56	-600.19
5 Lags	-576.03	-425.33	-594.15
6 Lags	-571.80	-418.42	-586.04
7 Lags	-570.84	**-412.43**	-586.44
8 Lags	-564.19	-413.25	-579.15
9 Lags	-553.94	-418.07	-576.52
10 Lags	-551.29	-435.32	**-575.37**
11 Lags	-556.01	-466.75	-588.20
12 Lags	**-549.67**	-464.13	-588.35
13 Lags	-550.26	-458.19	-579.53

Table 3. F-test for Cointegration Among the Variables of the Produce Trade Balance Equation

Lag Length	Fresh Produce	Fruits	Vegetable
1 Lag	4.77	5.58	4.64
2 Lags	5.75	7.38	6.31
3 Lags	3.77	5.34	4.53
4 Lags	3.47	4.18	4.15
5 Lags	4.03	4.67	4.49
6 Lags	3.55	3.46	3.78
7 Lags	4.82	3.72	4.44
8 Lags	4.22	3.09	4.37
9 Lags	3.57	2.16	5.07
10 Lags	3.41	2.12	4.96
11 Lags	3.78	2.50	9.29
12 Lags	5.30	2.26	8.86
13 Lags	4.72	2.28	8.07

Note: The asymptotic critical value of F-statistics for testing the existence of levels relationship with four variables in the cointegrating space is 3.52 (see Table CI in Pesaran et al 2001, p.300).

Table 4. Coefficient Estimates of *dlnREX*$_{t-i}$ and Error Correction Term Based on Akaike Information Criteria

Lag Length	Fruits		Vegetables		Fresh Produce	
	Coefficient	t-Value	Coefficient	t-Value	Coefficient	t-Value
1 Lag	-0.280	-1.31	-0.444	-2.00	-0.411*	-1.76
2 Lags	-0.033	-0.15	-0.143	-0.62	-0.089	-0.37
3 Lags	-0.128	-0.62	-0.061	-0.28	-0.237	-1.00
4 Lags	0.137	0.69	-0.424*	-1.82	-0.023	-0.10
5 Lags	-0.206	-1.06	-0.323	-1.33	-0.532*	-2.25
6 Lags	-0.106	-0.58	-0.203	-0.85	-0.384	-1.66
7 Lags	-0.103	-0.58	-0.239	-0.99	-0.206	-0.90
8 Lags	0.002	0.01	-0.442*	-1.86	-0.206	-0.90
9 Lags	0.018	0.11	-0.185	-0.81	-0.025	-0.12
10 Lags	0.016	0.10	-0.391*	-1.80	-0.262	-1.35
11 Lags	-0.112	-0.77	0.042	0.19	-0.075	-0.40
12 Lags	0.350**	2.56	-0.012	-0.06	0.257	1.48
EC_{t-1}	-0.417**	-2.54	-0.398**	-4.69	-0.497**	-3.77

Note: Only the coefficients associated with the lagged difference of exchange rate variable are reported because we are mainly interested on the impact of exchange rate on fresh produce trade balance. Other results are available on request from the authors.

**, * Denote significance at 1 and 5 percent level.

Table 5. Estimated Long-Run Coefficients of the Trade Balance Equations

Variable	Fresh Fruits		Fresh Vegetables		Fresh Produce	
	Coefficient	t-Value	Coefficient	t-Value	Coefficient	t-Value
Intercept	-8.857**	-3.26	-12.758**	-3.21	-10.004**	-3.10
$\ln Y_{us}$	0.591**	2.89	1.043**	4.02	0.741**	3.52
$\ln Y_{w}$	0.037	0.16	-0.350	-1.18	-0.157	-0.65
lnREX	0.996**	4.31	1.549**	3.71	1.198**	3.53

**, * Denote significance at 1 and 5 percent level.