UNIVERSITY of GUELPH OAC

Food, Agricultural & Resource Economics FARE

Effects of Exchange Rate Volatility on Fresh Tomato Imports into the United States from Mexico: Does the Specification of Volatility Matter?

Rakhal Sarker
and
Jose Luis Jaramillo-Villanueva

A Contributed Paper Presented at the Winter Meeting of the International Agricultural Trade Research Consortium, January 7-9, 2008
Washington, DC

Introduction

- Mexico is an important partner in the NAFTA. Agriculture in Mexico is less developed and production of grains and fresh vegetables are dominated by small and mid-sized farms.
- The United States has been the most important trade partner of Mexico.
- The border between Mexico and the United States became increasingly open due to NAFTA, trade has also been influenced by changes in exchange rate and exchange rate volatility among other factors. What are the relative contributions of these factors to the growth of Mexico-U.S. agri-food trade?
- Does it matter how ER volatility is measured?

Motivation

- There is a general agreement that flexible exchange rate period has been characterized by a high level of ER volatility. No agreement on how ER volatility can be measured.
- Only a few studies investigated the effects of ER volatility on agricultural trade flows with mixed results (Anderson and Garcia 1989; Pick 1990; Langley et al. 2000; Cho et al. 2002)
- None investigated the effects of volatility on trade flows between Mexico and the United States and focused on fresh tomato exports from Mexico to the United States.
- We focus on exports of fresh tomato from Mexico to the United States from January 1989 to December 2004. Why fresh tomatoes?

Empirical Questions

- How did changes in the value of Mexican Peso relative to the US dollar contribute to the growth of Mexican fresh tomato exports to the United States?
- How did exchange rate volatility influence Mexican fresh tomato exports to the United States?
- What is the effect of NAFTA on Mexican fresh tomato exports to the United States?
- Does it matter how the exchange rate volatility is measured?

Mexican Fresh Tomatoes

- Tomato is the most important export crop in Mexico. Mexico is a large exporter of fresh tomatoes to the United States. Export of fresh tomatoes account for 37% of all vegetable exports and 16% of total agricultural exports from Mexico.
- Only 6 states (Sinaloa, Baja California, San Luis Potosi, Jalisco and Nayarit) dominate tomato production.
- Fresh tomato exports increased dramatically from $200 million in 1989 to almost $1 billion in 2006 .

Analytical Framework: Key Features

- Following Appelbaum and Kohli (1997) an attempt is made to model import demand under exchange rate uncertainty.

- Production theory is used to derive the US import demand for fresh tomatoes produced in Mexico.

- Import decisions are made by profit maximizing firms operating under competitive conditions. All domestic factors are assumed to be mobile between firms and their rental rates are determined by respective marginal products.

- Exchange rate is a random variable and so are the foreign price and firms' profits in this model.

- The imported fresh tomato is considered as a differentiated product.

Econometric Issues, Data and Estimation Method

- Empirical specification of the Import Demand function:
- Since ER is assumed to be a random variable with an unknown density function $g(\theta)$, the moments of this distribution need to be estimated before the estimation of the import demand function.
- Most studies deal with aggregate data (unable to determine the effects of exchange rate or its volatility on a single commodity).
- Did not consider the effects of ER variability on trade flows. Also, previous studies did not consider data nonstationarity in empirical analysis.

Econometric Issues, Data and Estimation Method

- The econometric analysis consists of four steps:
  - determination of time-series properties of data (ADF & FPE)
  - specification and estimation of ER volatility
  - the cointegration analysis (trace and maximum eigenvalue tests)
  - specification and estimation of the vector error-correction model
- We employed two alternative specifications of the ER volatility:
  - V1: a three period moving average of the standard deviation of the growth rate of the peso-dollar exchange rate
  - VGARCH: a volatility measure based on an estimated GARCH (1,1) function;
- The estimated function is: $\hat{h}_t = 0.00059 + 0.0031\varepsilon^2_{t-1} + 0.967\hat{h}_{t-1}$

Unit Root Test & Cointegration Analysis

- Unit Root Test

- The simplest form of the Augmented Dickey-Fuller (ADF) test involves the estimation of the following regression:

- Cointegration Analysis

Johansen's Maximum Likelihood procedure:

where,

X_t = a (p x 1) vector of *I(1)* variables;

D_t = eleven (p x 1) seasonal dummy variables which sum to zero over a full year;

NAFTA = free trade dummy variable;

A_i = a (p x p) matrix of parameters;

μ = a (p x 1) vector of constant terms; and;

$\varepsilon_t \sim$ IND (0,Ω)

Results of Unit Root Tests

- Augmented Dickey-Fuller Test to verify the type of nonstationarity in data
- Each of the seven variables is integrated of order one.
- OLS would lead to spurious results.
- Johansen's maximum likelihood procedure to determine if cointegration relationship exists among seven variables and if so, what is the nature of this relationship.
- Sim's modified likelihood ratio test is used to determine optimum lag-length (9) for the system.

Long-run Results of US Fresh Tomato Imports (V1)

- $Q_t = -0.687 P_t - 2.068 P_{CA} + 1.008 USY + 1.425 ER - 0.362 V1 + 1.424 W1$

- $P_t = -0.603 Q_t + 0.357 USY + 0.737 ER + 1.202 V1 + 1.287 P_{CA} + 0.400 W1$

US Import Demand for Fresh Tomatoes from Mexico (VG)

Testing for the number of cointegrating vectors

Null Hypothesis	Trace Statistic	Trace (0.95)	Maxλ	Maxλ (0.95)
r = 0	**166.80***	**150.40**	**49.95**	**50.51**
r ≤ 1	116.85	117.49	36.22	44.37
r ≤ 2	80.63	88.59	26.19	38.22
r ≤ 3	54.44	63.66	20.40	31.99
r ≤ 4	34.04	42.70	19.43	25.68
r ≤ 5	14.61	25.64	10.75	19.21
r ≤ 6	3.85	12.34	3.85	12.34

*significant at the 95% level(MacKinnon,1999)

Long-Run Results of the US Import Demand Function for Fresh Tomatoes from Mexico (VGARCH)

- $Qt = -0.285\ P_t + 0.844\ P_{CA} + 0.246\ USY + 0.589\ ER - 0.460\ VG + 0.505\ W1$

Results from the Error Correction Model: the US Import Demand for Fresh Tomatoes from Mexico.

Variables	Estimated Coefficients	t-statistics
QT_{t-12}	0.198	3.274
USY_{t-10}	0.110	3.750
ER_{t-1}	0.663	3.269
VG_{t-2}	-0.043	-2.671
$W1_{t-6}$	0.130	2.936
$PT_{(t-10)}$	-0.099	-3.360
$P_{CA(t-11)}$	0.195	1.508
ECT_{t-1}	-0.030	-3.453
NAFTA	0.427	2.081
M3	0.011	0.809
M11	0.070	0.809

Results from the Error Correction Model: the US Import Demand for Fresh Tomatoes from Mexico (Cont'd).

Variables	Estimated Coefficient	t-statistics
Constant	0.309	2.365
R^2	0.364	
R^2 Adjusted	0.332	
F-Value	9.198	
DW-h Statistic	1.677	
J-B Normality test	8.209	

Main Results:

- The import demand for fresh tomatoes is price inelastic.
- As per capita income increases in the US, larger quantities of vine ripped fresh tomatoes will be imported from Mexico.
- While changes in exchange rate have a positive impact on fresh tomato imports from Mexico, changes in exchange rate volatility have a significant negative impact.
- The import price of tomatoes, the price of a substitute and the quantity of fresh tomato imports will adjust faster than other variables in this system.
- It does matter how the ER volatility is specified and measured.

Main Results:

- The coefficient of the error-correction term (ECT) is negative and statistically significant. Implications?
- NAFTA is having a large and statistically significant effect on the US fresh tomato imports from Mexico.
- Increase in agricultural wage in the US relative to that in Mexico would encourage larger imports of fresh tomatoes in the US.

Concluding Remarks:

- The small value of the estimated price elasticities both in the short-run and long-run suggest that little substitution possibilities exist for Mexican fresh tomatoes imported in the US.
- While changes in the peso-dollar exchange rate and NAFTA both have positive impacts on fresh tomato imports, the former effect dominates in the short-run.
- Appropriate specification of the ER volatility is important for generating more reliable estimates.
- Since volatility has a significant negative effect on maize imports, can Mexico benefit from adopting a common currency (i.e., the US $)?

THANK YOU!

Any Questions or Comments?