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Impact of Asymmetric Exchange Rate Changes on the U.S. Agricultural Trade: Evidence from a Nonlinear ARDL Approach

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Introduction

Agricultural trade flows are becoming increasingly important in the U.S. In 2017, 64 percent of the total U.S. agricultural products exports has land to six major countries (Figure 1). The U.S. bulk exports to certain countries highlights the important relationship between exchange rate and bilateral trade and further reckon the trade elasticities.

Figure 1. The U.S. agricultural exports

Consequently, it is important to address the following question:
Do positive and negative changes in the exchange rate affect the U.S. agricultural trade differently?

Objective

We determine the long- and short-run effects of asymmetric exchange rate changes on the U.S. agricultural exports and imports with Canada, Mexico, South Korea, Japan, China, and the EU using a nonlinear autoregressive distributed lag (ARDL) model included in an error correction format.

Data and Exchange Rate

The real exchange rate is collected from the Economic Research Service (ERS) and expressed as trading partner currency per unit of the U.S. dollar. We create the partial sum process of positive and negative exchange rate changes as follows:

$$\ln ER_{i,t}^+ = \sum_{j=1}^t \max(\ln ER_{i,j} - \ln ER_{i,j-1}, 0) \text{ and} \\ \ln ER_{i,t}^- = \sum_{j=1}^t \min(\ln ER_{i,j} - \ln ER_{i,j-1}, 0),$$

where ER_{it} : real exchange rate between the U.S. trading partner i .

Figure 2. Examples of partial sum of exchange rate

Econometric Model

We employ a nonlinear ARDL model (Baek and Koo 2009; and Bahmani-Oskooee and Mitra 2010).

$$\Delta \ln X_{it} = \tau_0 + \sum_{k=1}^p \mu_k' \Delta \ln X_{i,t-k} + \sum_{k=1}^p \phi_k' \Delta \ln Y_{i,t-k} + \sum_{k=1}^p \omega_k^+ \Delta \ln ER_{i,t-k}^+ \\ + \sum_{k=1}^p \omega_k^- \Delta \ln ER_{i,t-k}^- + \delta_i' \ln X_{i,t-1} + \lambda_{i,1}' \ln Y_{i,t-1} + \lambda_{i,2}' \ln ER_{i,t-1}^+ \\ + \lambda_{i,2}' \ln ER_{i,t-1}^- + u_t$$

where X_{it} : the U.S. agricultural exports to trading partner i

Y_{it} : trading partners real income

ω_k^+ and ω_k^- represent short-run effects of exchange rate on the U.S. agricultural export.

$$\alpha_1' = -\frac{\lambda_{i,1}'}{\delta_i'}, \alpha_2^+ = -\frac{\lambda_{i,2}^+}{\delta_i'}, \alpha_2^- = -\frac{\lambda_{i,2}^-}{\delta_i'}.$$

where α_1' represents the long run income coefficients in the export equations. α_2^+ , and α_2^- imply long-run effects of exchange rate on the U.S. agricultural trade.

Results (1)

Table 1. Long- and short-run coefficients of export equations

	Canada	Mexico	Korea	Japan	China	EU
Long-run coefficients						
α_2^+	-1.34** (-3.54)	-0.71** (-2.58)	-1.92** (-2.80)	-0.65** (-2.54)	2.93 (0.66)	-1.36** (-2.55)
α_2^-	-1.48** (-6.50)	-0.76** (-2.26)	-1.36* (-1.86)	-0.98** (-2.67)	3.27 (1.34)	-2.61** (-2.73)
α_1'	1.79 (5.38)	3.23** (6.23)	1.06 (72.01)	-0.17 (-0.26)	1.70* (1.73)	-3.59* (-1.86)
Short-run coefficients						
ω_0^+	-0.37** (-4.84)	-0.92** (-2.48)	-0.33** (-3.12)	-0.20** (-3.60)	1.12 (0.74)	-0.33** (-2.69)
ω_0^-	-0.41** (-7.11)	0.04 (0.05)	-0.23** (-2.00)	-0.29** (-3.63)	0.17 (0.04)	-1.65** (-2.81)
ω_1^+		0.15 (0.35)				
ω_1^-		-1.71** (-2.19)			-5.73 (-1.13)	-0.34 (-0.58)
ω_2^+		-0.04 (-0.10)				
ω_2^-		-0.53 (-0.64)			-9.45* (1.72)	-1.36** (-2.54)
ϕ_0'	1.64** (2.05)	2.94* (1.87)	0.18** (3.84)	0.44 (0.70)	1.73** (4.19)	-3.87 (-1.14)
ϕ_1'	0.34 (0.38)	-3.04* (-1.96)		1.75** (2.76)	1.16** (2.30)	8.81** (2.82)
Speed of adjustment						
δ	-0.27** (-10.26)	-0.41** (-7.27)	-0.21** (-5.46)	-0.18** (-5.81)	-0.41** (-3.57)	-0.14** (-5.23)
R^2	0.67	0.34	0.26	0.57	0.81	0.85

Note: ** and * denote significance at the 5% and 10% levels, respectively. Parentheses are t-statistics.

Results (2)

Table 2. Test for Asymmetry (Null Hypothesis of symmetry)

	Canada	Mexico	Korea	Japan	China	EU
Agricultural exports						
LR $\alpha_2^+ = \alpha_2^-$	1.14	0.06	2.53	3.15	0.04	2.34
SR $\omega_0^+ = \omega_0^-$	0.33	0.97	4.97*	5.08**	0.04	4.73**
SR $\omega_1^+ = \omega_1^-$		3.26*				
SR $\omega_2^+ = \omega_2^-$		0.21				
SR $\omega_3^+ = \omega_3^-$		13.73**				
Agricultural imports						
LR $\beta_2^+ = \beta_2^-$	2.33	0.12	2.91	0.80	0.13	0.71
SR $\pi_0^+ = \pi_0^-$	3.92**	0.10	1.26	0.17	0.21	3.74*
SR $\pi_1^+ = \pi_1^-$		0.60				0.91
SR $\pi_2^+ = \pi_2^-$						0.09
SR $\pi_3^+ = \pi_3^-$						2.59**

Note: ** and * denote significance at the 5% and 10% levels, respectively

Summary and Conclusions

□ Long- and short-run effects (Table 1)

- The long-run effects for the negative exchange rate change are larger relative to the positive exchange rate change.
- The U.S. agricultural exports demand raises as income in foreign countries rise, except for EU, suggesting that the EU increases production substituting the U.S. commodities as their income increases.
- In the short-run, the U.S. agricultural exports are more sensitive to the negative exchange rate change (depreciation of U.S. dollar) than the positive exchange rate change (appreciation of U.S. dollar).
- For the U.S. agricultural imports, the exchange rate change and the U.S. real income are not critically important in the long-run, but they play greater roles in estimating the U.S. agricultural imports in the short-run.

□ Asymmetric exchange rate effects (Table 2)

- The long-run effect of the exchange rate changes are symmetric both in terms of the U.S. agricultural exports and imports.
- However, the short-run exchange rate change effects on the U.S. agricultural exports are asymmetric for Mexico, Korea, Japan, and the EU, suggesting that those countries are likely to be more responded to the negative exchange rate changes than the positive exchange rate changes.
- The short-run exchange rate changes effects on the U.S. agricultural imports are asymmetric for Canada and the EU.

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