Estimation of Asymmetric Price Adjustment in the U.S. Soybean Trade Using Rolling TAR: The Relation with Market Structure

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INTRODUCTION

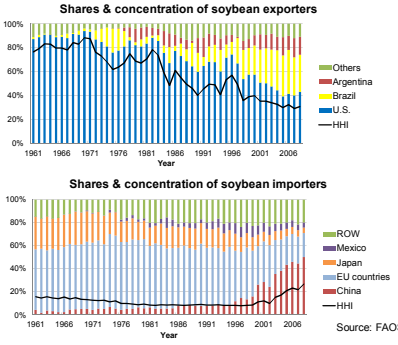
- The threshold autoregressive (TAR) model by Enders and Granger (1998) and Enders and Siklos (2001) is a popular econometric model that estimates asymmetric price transmission (APT) with non-stationary time series data.
- However, empirical studies have not considered much the arbitrariness of sample period selection and possible temporal variation of parameters or asymmetry.
- The U.S. has been the largest producer and exporter of soybeans.
- Pick and Park (1991) showed that the U.S. had no market power in soybean exports over any major importers except for the Netherlands in 1978-1988.
- Song *et al.* (2009) pointed out that importing companies in China had more market power than did exporters in the U.S. from 1999 to 2005.

OBJECTIVE

- A purpose of this study is to estimate the APT from the U.S. domestic soybean prices to the export prices using the TAR model, and to trace the changes of APT using rolling woindow methodology of TAR.
- Another purpose is to analyze the relation between the APT and the market structure in the world soybean trade.
- The hypothesis is that the APT was positive, which means that the U.S. enjoyed long-lasting positive margins, when the share of the U.S. in the world soybean exports was high, but it changed to negative, which means that the importers enjoyed long-lasting positive margins, when the share of the U.S. decreased and the concentration of importers increased.

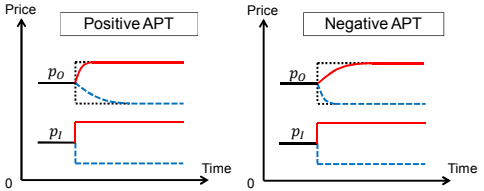
MARKET STRUCTURE

- The share of the U.S. in soybean exports has been the largest but has been decreasing since the 1970s.
- Meanwhile, the shares of Brazil and Argentina have increased since the 1970s and drastically since the 2000s.
- The concentration of exporters has decreased since the 1970s.
- On the other hand, the concentration of importers has sharply increased in the early 2000s due to the surge in the Chinese soybean imports.



MODEL & METHODOLOGY

- Price transmission is said to be asymmetric if the speed of adjustment of the output price is different after the input price increases or decreases.
- Positive (negative) APT indicates that the squeezed margin between domestic and export prices are restored more quickly (slowly) than the stretched margin.



Source: authors (refered to Meyer and von Cramon-Taubadel, 2004)
Note: Solid lines (red) represent the price increase and dashed lines (blue) represent the price decrease.

TAR model

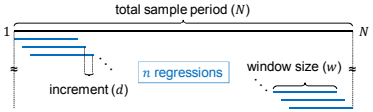
- The TAR model is written as follows, using residuals $\{\hat{\mu}_t\}$ of the OLS regression of p_O on p_I:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\rho_2\mu_{t-1} + \sum_{i=1}^{T}\gamma_i\Delta\mu_{t-i} + \varepsilon_t$$

- For TAR, $I_t = \begin{cases} 1 & \text{if} \quad \mu_{t-1} \geq \tau \\ 0 & \text{if} \quad \mu_{t-1} < \tau \end{cases}$.
- For M(momentum)-TAR, $I_t = \begin{cases} 1 & \text{if} \quad \Delta\mu_{t-1} \geq \tau \\ 0 & \text{if} \quad \Delta\mu_{t-1} < \tau \end{cases}$.
- τ: super-consistent estimator of threshold (Chan, 1993).
- If $\rho_1 = \rho_2 = 0$ is rejected, p_I and p_O are cointegrated.
- If $\rho_1 = \rho_2$ is rejected and $|\rho_1| < |\rho_2|$, APT is positive.
- If $\rho_1 = \rho_2$ is rejected and $|\rho_1| > |\rho_2|$, APT is negative.

Rolling window

- (M-)TAR regressions are conducted by shifting the starting and ending time point with a fixed window size.



- If $d = 1$, there are $n = N - w + 1$ regressions.

Indexation of APT

- For $t \in (i, i+w-1)$, define APT_i as:

a. $APT_i = \begin{cases} 1/w & \text{if significantly} \quad |\rho_1| < |\rho_2| \\ -1/w & \text{if significantly} \quad |\rho_1| > |\rho_2|, \\ 0 & \text{otherwise} \end{cases}$

b. $APT_i = \begin{cases} \frac{|\rho_2|-|\rho_1|}{w} & \text{if significantly} \quad \rho_1 \neq \rho_2, \text{ or} \\ 0 & \text{otherwise} \end{cases}$

c. $APT_i = \frac{|\rho_2|-|\rho_1|}{w}$.

- Then APT_t is written as:

$$APT_t = \frac{1}{n_t}\sum_{i=\max(1,t-w+1)}^{\min(t,N-w+1)} APT_i$$

where $n_t = \min(t, w, N-t+1)$.

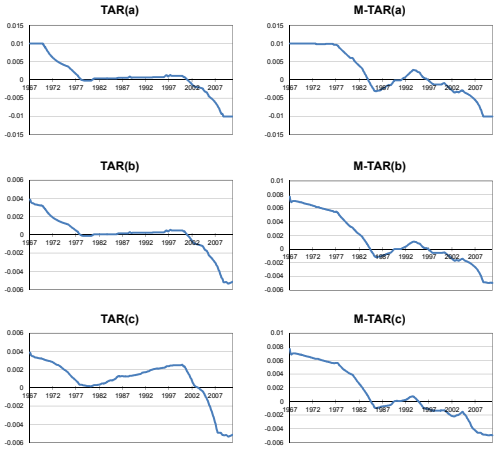
RESULTS

Data

- p_I: U.S. average domestic soybean prices, USDA-NASS.
- p_O: U.S. soybean export (FOB) prices to major 6 countries or regions (weighted average of China, EU, Japan, Mexico, South Korea, and Taiwan) and the ROW, USDA-GATS.
- Monthly data from January 1967 to September 2010 (max), sample size is 525.
- Prices are in logarithmic form.
- According to the unit root tests (ADF and KPSS), prices are found to be I(1) variables.

Result 1: by indexes of APT

- The results of rolling (M-)TAR with 100 window using p_O as weighted average of Major 6.
- The movements of APT are similar with some differences: APT was positive in earlier periods, changed to no APT or slightly negative in the 1980s, returned to positive a bit, and then became negative to a larger degree in the 2000s.
- According to BIC in each regression, M-TAR is preferred in any indexations of APT.



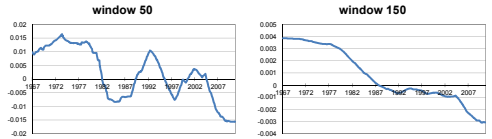
Relations to market structure

- Correlation coefficients between APTs and the indexes of market structure are calculated.
- Rolling M-TAR fits better with the market structures of soybean exporters than rolling TAR, while rolling TAR fits better with the market structures of soybean importers than rolling M-TAR.

	TAR(a)	TAR(b)	TAR(c)	M-TAR(a)	M-TAR(b)	M-TAR(c)
The U.S. share	0.784	0.785	0.610	0.840	0.844	0.872
HHI (exporters)	0.774	0.746	0.519	0.856	0.875	0.895
HHI (importers)	-0.367	-0.504	-0.672	-0.269	-0.199	-0.240
HHI (importers from the U.S.)	-0.425	-0.555	-0.727	-0.272	-0.212	-0.219

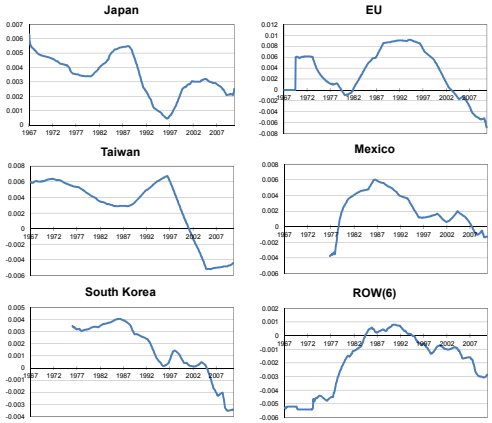
Result 2: different windows

- Using M-TAR with indexation of c.
- Smaller window makes the movement of APT more volatile.
- Larger window makes it more smooth.



Result 3: different importers

- Using M-TAR with 100 window and indexation of c.
- The APTs of major importers are similar to that of Major 6, although there are differences in countries.
- The impact of ROW(6) should be limited.



CONCLUSIONS

- There is high correlation between the indexes of APT and those of market structure.
- Therefore, the hypothesis presented at first is considered to have been verified: that is, the U.S. enjoyed long-lasting positive margins when the share of the U.S. in the world soybean exports was high, but the importers enjoyed long-lasting positive margins, when the share of the U.S. decreased and the concentration of importers increased.
- However, the result is not applicable to some countries. The U.S. might have more power to set prices over Japan throughout the periods.
- The window size of 100 may be moderate, because it captures detailed changes of APT but disregards its too detailed movements.
- Because the APT has changed as shown in this study, (M-) TAR estimations with total sample or any subsamples in which the total sample is separated must bring unreliable results.
- Previous studies on the U.S. market power may be consistent with this study because they targeted only limited periods.