IOWA STATE UNIVERSITY

Are Futures Prices Endogenous to Global Supply Analysis of Agricultural Commodities? New Empirical Evidence

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Background

- Recently, Roberts and Schlenker (2014) Hendricks, Janzen, and Smith (2015) have found substantial endogeneity bias in regressions of supply on futures prices, where future prices are endogenous to supply analysis.
- Without correcting for the endogeneity of prices, the estimates of supply elasticity would be downward (upward) biased and inconsistent.
- Consistent empirical estimates of supply response to prices are valuable inputs in measuring the magnitude of output/land use changes caused by external economic shocks

Objectives/Research Questions

- To revisit the endogeneity of futures prices in supply models of global key agricultural crops (corn, soybeans, wheat, and rice)
- Whether endogeneity of futures prices is sensitive to the alternate model specifications or is it the problem of aggregation?

Methods and Data

- To examine the endogeneity bias as well as to estimate supply responses, this poster mainly uses the equation as follows

$$q_t = \alpha + \beta\, p_{t|t-1} + \gamma\psi_{t|t-1} + \psi_t + f(t) + v_t$$

where q_t , $p_{t|t-1}$, $\psi_{t|t-1}$, and ψ_t are output, futures prices, expected yield (weather) shocks (addresses endogeneity) and realized yield shocks, respectively, at time t. All are in natural logarithmic forms.

- Omitting $\psi_{t|t-1}$ may induce endogeneity and $Cov(P_{t|t-1}, v_t + \psi_{t|t-1}) \neq 0$
- The empirical models use data from FAOSTAT of the FAO and Quandl
- The comprehensive database cover the period from 1961 to 2014
- The total sample countries/groups in the panel data model is 31
- Countries with a share of less than 0.5 % of global caloric production for each crop are grouped as the rest of the world (ROW).
- The futures price in our aggregate econometric model is the calorie-weighted December (previous year) average of the harvest/delivery time price of corn, soybeans, and wheat, deflated by the U.S. urban consumer price index (CPI).
- This poster follows the theoretical framework of aggregation as suggested by Zellner (1969) and Pesaran, Pierse, and Kumar (1989) to model the global aggregate model
- The econometric methods this poster applies to estimate the empirical models are simple ordinary least squares (OLS) , fixed effect (FE) panel regression, and seemingly unrelated regressions (SUR)

Results & Discussion

Table 1. Global Aggregate (four crops) Supply Responses to Futures Prices

Methods		Caloric Production Response		Area Response	
	N	No Yield Shocks	With Yield Shocks	No Yield Shocks	With Yield Shocks
Zellner (1969) Aggregation Framework (level form): Simple OLS	54	0.006	0.067	0.028	0.029
Pesaran, Pierce, Kumar (1989) Aggregation framework (log form) Simple OLS	54	0.063	0.062	0.039	0.038
Fixed Effect Panel	1674	0.063	0.062	0.039	0.038

Notes: 1. All price elasticity coefficients are significant at the 5 % level of alpha except the shaded one. 2. All models use flexible time trend to capture technological change

From the Table 1, this poster finds

- With Zellner (1969) aggregation, it seems that the price elasticity of supply (production) is biased downward significantly due to omitting predicted yield shocks. But, the cause for downward bias is the negative correlation between current yield shock and futures price, not the endogeneity of futures price*.
- With all other methods/regressions techniques, the price elasticity of supply (production or growing area) are the same with and without current yield shock as additional control variable.

Table 2. Predictability of Yield Shock w. r. to Futures Prices with Cubic Time Trend (Symmetry of cross-price imposed): SUR Estimates

VARIABLES	(1) Shock maize	(2) Shock soybean	(3) Shock wheat	(4) Shock rice
Log maize price	0.020	0.018***	-0.030***	-0.008
	(0.013)	(0.006)	(0.010)	(0.005)
Log soybeans price	0.018***	-0.000	-0.013**	-0.000
	(0.006)	(0.006)	(0.005)	(0.003)
Log wheat price	-0.030***	-0.013**	0.014	-0.002
	(0.010)	(0.005)	(0.011)	(0.005)
Log rice price	-0.008	-0.000	-0.002	-0.003
	(0.005)	(0.003)	(0.005)	(0.004)
Observations	54	54	54	54
R-squared	0.121	0.152	0.174	0.298

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 3. Global Crop Specific Growing Area Response to Futures Prices with Cubic Spline Time Trend (Symmetry of cross-price imposed): SUR Estimates

VARIABLES	(1) log maize area	(2) Log soybean area	(3) log wheat area	(4) log rice area
Log maize price	0.135***	-0.089***	-0.006	0.019**
	(0.023)	(0.020)	(0.017)	(0.009)
Log soybeans price	-0.089***	0.190***	-0.030	0.019
	(0.020)	(0.033)	(0.019)	(0.012)
Log wheat price	-0.006	-0.030	0.075***	-0.007
	(0.017)	(0.019)	(0.019)	(0.008)
Log rice price	0.019**	0.019	-0.007	0.012
	(0.009)	(0.012)	(0.008)	(0.008)
Observations	54	54	54	54
R-squared	0.985	0.998	0.721	0.981

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

From the Tables 2 and 3, this poster finds

- None of the own price coefficients are statistically significant when shocks are crop-specific, even two (for maize and wheat) of them are positive (Table 2). These results imply that the negative correlations between yield shocks and futures prices are the result of aggregation across crops.
- The own price elasticities of supply (growing area) are positive and statistically significant except for rice (Table 3). The cross price elasticities of supply (growing area) is negative and statistically significant only for maize and soybeans (Table 3)

Conclusions and Policy Implications

- Substantial endogeneity bias in supply models as found in the previous literature was the result of aggregation error
- The estimates of supply elasticties are lower compared to existing studies
- Futures prices may be endogenous due to omitting input costs and/or some policy variables that simultaneously affect supply and prices. This area of research needs to be further explored

References

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* Details mathematical derivation and empirical results on this issue are available on request