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Estimating Short- and Long-run Supply Elasticities of Global Agricultural Commodities from Dynamic Heterogeneous Panels

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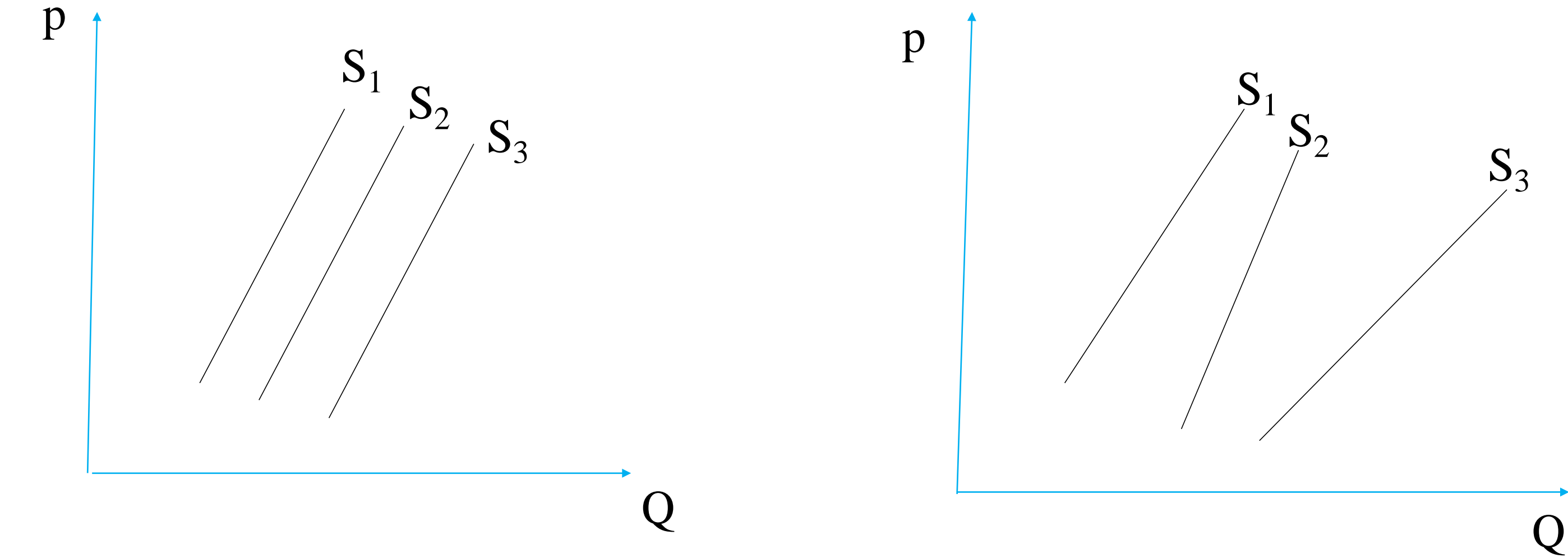
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Background

- Most empirical studies assume agricultural crop supply curve is parallel across individual units (e.g., Haile et al 2016)



- Existing studies provide only short-run supply response to prices

Objectives

- Accommodate country-specific (heterogeneous) slope coefficients in the global aggregate supply elasticity estimates of corn, soybeans, wheat, and rice
- Provide short- and long-run price elasticity estimates of global aggregate crop supply

Empirical Model and Estimation Methods

- (1) $Q_{it} = \mu_i + \delta_{10i}P_{it|t-1} + \delta_{11i}P_{i,t-1} + \delta_{20i}Z_{it} + \delta_{21i}Z_{i,t-1} + \lambda_i Q_{i,t-1} + \eta_i T + \varepsilon_{it}$
- (2) $\Delta Q_{it} = \phi_i (Q_{i,t-1} - \theta_{0i} - \theta_{1i}P_{it|t-1} - \theta_{2i}Z_{it}) - \delta_{11i}\Delta P_{it} - \delta_{21i}\Delta Z_{it} + \varepsilon_{it}$

Equation (1) is an autoregressive distributive lag (ARDL) model and equation (2) is the error correction model (ECM). $Q_t = A_t Y_t$ is total caloric production from four crops, $P_{it|t-1}$ is average crop futures price traded in futures market, $P_{i,t-1}$ is past year crop prices, Z denotes yield shocks and revenue risk and T is time trend. The subscript i denotes country. All variables are in natural logarithmic forms.

- Econometric methods: Mean group (MG) and pooled means group (PMG) estimators-developed by Pesaran and Smith (1995) and Pesaran, Shin, and Smith (1999), respectively.

- The MG estimator allows the intercepts, slope coefficients (short- and long-term), and error variances to vary across groups.

- The PMG estimator combines both pooling and averaging and allows intercept, short-run coefficients, and error variances to differ across groups.

Data

- Production and growing area: FAOSTAT of the FAO, Futures Price: Chicago Board of Trade (CBOT)
- Sample Observation: 1961 to 2014
- Panel groups are 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).

Results & Discussion

Table 1. Estimates of Global Aggregate (four crops) Caloric Supply Responses

	(1) ln(Prod) PMG No shock	(2) ln(Prod) MG No shock	(3) ln(Prod) PMG Same shock	(4) ln(Prod) MG Same shock	(5) ln(Prod) PMG Varying shock	(6) ln(Prod) MG Varying shock
Long Run						
Supply Elast.	0.069* (0.032)	0.013 (0.039)	0.032 (0.033)	0.019 (0.040)	0.357* (0.068)	0.092* (0.045)
Yield Shock			-0.011 (0.444)	0.555 (0.440)	0.706* (0.123)	1.076* (0.209)
Revenue Risk	-0.000 (0.004)	0.006 (0.005)	0.005 (0.004)	0.008 (0.005)	-0.023* (0.009)	-0.003 (0.004)
Trend	0.022* (0.001)	0.022* (0.002)	0.022* (0.001)	0.022* (0.002)	0.018* (0.002)	0.022* (0.003)
Short Run						
Error Correction	-0.265* (0.046)	-0.556* (0.051)	-0.252* (0.042)	-0.539* (0.047)	-0.063* (0.016)	-0.244* (0.025)
Supply Elast.	0.021 (0.021)	-0.002 (0.028)	0.024 (0.020)	0.003 (0.027)	0.014 (0.009)	0.009 (0.009)
Yield Shock			0.527* (0.149)	0.245+ (0.130)	0.984* (0.025)	0.777* (0.034)
Revenue Risk	0.000 (0.001)	-0.002 (0.002)	-0.000 (0.001)	-0.002 (0.002)	0.001* (0.000)	0.001* (0.001)
Constant	4.597* (0.813)	9.638* (0.856)	4.397* (0.724)	9.315* (0.782)	1.013* (0.244)	4.187* (0.435)
N (31*49)	1519	1519	1519	1519	1519	1519

Standard errors in parentheses
+ $p < 0.10$, * $p < 0.05$

Several findings from the Tables 1 and 2 are worth mentioning here:

- The estimated long-run caloric supply elasticities are positive across all models, no matter which shock variable we use and these vary with a range of **0.069 to 0.357** (Table 1)
- The estimates of short-run caloric supply elasticities are close to zero, perhaps due to negative short-term yield response to prices
- The long-run price elasticities of growing area are positive and statistically significant across all models and the estimates vary with a range of **0.056 to 0.085** (Table 2).
- The short-run price elasticities of growing area are also positive and these vary from **0.013 to 0.025**
- The effects revenue risk on growing area are positive in the short-run but negative in the long-run

Table 2. Estimates of Global Aggregate (four crops) Growing Area Responses

	(1) ln(area) PMG No shock	(2) ln(area) MG No shock	(3) ln(area) PMG Same shock	(4) ln(area) MG Same shock	(5) ln(area) PMG Varying shock	(6) ln(area) MG Varying shock
Long Run						
Supply Elast.	0.030 (0.034)	0.059* (0.025)	0.084* (0.026)	0.056* (0.026)	0.085* (0.025)	0.068* (0.028)
Yield Shock			0.148 (0.312)	0.082 (0.285)	0.132 (0.108)	0.175 (0.124)
Revenue Risk	-0.011* (0.005)	-0.001 (0.004)	-0.003 (0.004)	-0.001 (0.004)	-0.004 (0.004)	-0.003 (0.004)
Trend	-0.002* (0.001)	0.006* (0.002)	0.006* (0.001)	0.006* (0.002)	0.006* (0.001)	0.006* (0.002)
Short Run						
ErrorCorrection	-0.111* (0.030)	-0.360* (0.040)	-0.126* (0.025)	-0.364* (0.042)	-0.120* (0.025)	-0.367* (0.041)
Supply Elast.	0.025* (0.007)	0.013+ (0.007)	0.019* (0.006)	0.013+ (0.007)	0.021* (0.007)	0.010 (0.009)
Yield Shock			0.096+ (0.053)	0.108+ (0.065)	0.103* (0.018)	0.056+ (0.031)
Revenue Risk	0.002* (0.001)	0.001* (0.001)	0.001* (0.000)	0.001+ (0.001)	0.001* (0.000)	0.001* (0.001)
Constant	1.764* (0.471)	5.641* (0.652)	1.952* (0.395)	5.700* (0.677)	1.866* (0.386)	5.715* (0.666)
N (31*49)	1519	1519	1519	1519	1519	1519

+ $p < 0.10$, * $p < 0.05$

Conclusion

- The short-term price elasticity estimates of growing area are significantly lower than the estimates of the existing studies
- More future research works on this topic are necessary, e.g., i) use of country-specific producer prices in estimating global mean supply response can be one possible area of research, ii) estimation of crop-specific global mean supply response using heterogeneous panel data model can be the another possible area of future research.

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