IDENTIFYING SUPPLY AND DEMAND ELASTICITIES OF AGRICULTURAL COMMODITIES: IMPLICATIONS FOR THE US ETHANOL MANDATE

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ONLINE APPENDIX

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A1 Model

A1.1 Validity of ω_t as Instrument

Our baseline model uses log yield deviations ξ_{cit} for crops c in country i and year t. We are fitting crop-and-country specific time trends $g_{ci}(t)$ in regressions of log yields y_{cit}, i.e., $y_{cit} = g_{ci}(t) + \xi_{cit}$.The annual shock ω_t is a weighted average of all shocks. The weights ρ_{cit} depend on predicted yields $\hat{y}_{cit} = e^{g_{ci}(t)+\frac{\sigma^2}{2}}$ (where σ^2 is the estimated variance of the error terms), growing area a_{cit}, and the caloric content of one production unit of crop c, κ_c.

$$\begin{aligned} \omega_t &= \frac{\sum_c \sum_i \hat{\xi}_{cit} \times \hat{y}_{cit} \times a_{cit} \times \kappa_c}{\sum_c \sum_i \hat{y}_{cit} \times a_{cit} \times \kappa_c} = \sum_c \sum_i \hat{\xi}_{cit} \rho_{cit} \\ \rho_{cit} &= \frac{\hat{y}_{cit} \times a_{cit} \times \kappa_c}{\sum_c \sum_i \hat{y}_{cit} \times a_{cit} \times \kappa_c} \end{aligned}$$

Here we show that ω_t is exogenous despite the endogeneity of ρ_{cit}, given:

(i) $\mathbb{E}[\xi_{cit}] = 0$, which is true by construction of the shocks

(ii) ξ_{cit} is exogenous, which is otherwise assumed and defended in the text

(iii) ξ_{cit} is independent of the weight ρ_{cit}, which may be a stronger assumption, but follows if yield shocks follow from weather experienced after planting decisions are made. Assumption (iii) is testable: when we regress country-and-crop specific weights ρ_{cit} on the shocks ξ_{cit}, the p-value is never below 0.69 regardless whether we use FAO or FAS data and whether we include country-by-crop specific fixed effects or not.

A valid instruments requires that u_t is orthogonal to ω_t, or $COV(u_t, \omega_t) = 0$. We have

$$\begin{aligned} COV(u_t, \omega_t) &= COV\left(u_t, \sum_c \sum_i \xi_{cit} \rho_{cit}\right) \\ &= \mathbb{E}\left[u_t \sum_c \sum_i \xi_{cit} \rho_{cit}\right] - \underbrace{\mathbb{E}\left[u_t\right]}_{=0} \mathbb{E}\left[\sum_c \sum_i \xi_{cit} \rho_{cit}\right] \\ &= \mathbb{E}\left[\sum_c \sum_i \xi_{cit}\right] \mathbb{E}\left[\sum_c \sum_i u_t \rho_{cit}\right] \\ &= 0 \end{aligned}$$

The second line uses the definition of the covariance, the third line use the fact that ξ_{cit} is exogenous (orthogonal to u_t) and independent of ρ_{cit}. Finally, the fourth line uses $E[\xi_{cit}] = 0$.

A1.2 Price Effect in Muti-crop System

In the main paper we estimate the effect of new biofuel demand on price using a model that aggregates the four major food commodities based on caloric content. Here we present the algebra for modeling price effects on n commodities. Denote the log demand for commodity i by q_i, the log price by p_i, and the elasticity of demand for commodity i with respect to price of commodity j as $\beta_{d,ij}$. We have:

$$\underbrace{\begin{bmatrix} q_1 \\ q_2 \\ \vdots \\ q_n \end{bmatrix}}_{\mathbf{q}} = \underbrace{\begin{bmatrix} \alpha_{d,1} \\ \alpha_{d,2} \\ \vdots \\ \alpha_{d,n} \end{bmatrix}}_{\boldsymbol{\alpha}_\mathbf{d}} + \underbrace{\begin{bmatrix} \beta_{d,11} & \beta_{d,12} & \cdots & \beta_{d,1n} \\ \beta_{d,21} & \beta_{d,22} & \cdots & \beta_{d,2n} \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{d,n1} & \beta_{d,n2} & \cdots & \beta_{d,nn} \end{bmatrix}}_{\boldsymbol{\beta}_\mathbf{d}} \underbrace{\begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \end{bmatrix}}_{\mathbf{p}} = \boldsymbol{\alpha}_\mathbf{d} + \boldsymbol{\beta}_\mathbf{d}\mathbf{p}$$

Similar, the supply system is given by:

$$\underbrace{\begin{bmatrix} q_1 \\ q_2 \\ \vdots \\ q_n \end{bmatrix}}_{\mathbf{q}} = \underbrace{\begin{bmatrix} \alpha_{s,1} \\ \alpha_{s,2} \\ \vdots \\ \alpha_{s,n} \end{bmatrix}}_{\boldsymbol{\alpha}_\mathbf{s}} + \underbrace{\begin{bmatrix} \beta_{s,11} & \beta_{s,12} & \cdots & \beta_{s,1n} \\ \beta_{s,21} & \beta_{s,22} & \cdots & \beta_{s,2n} \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{s,n1} & \beta_{s,n2} & \cdots & \beta_{s,nn} \end{bmatrix}}_{\boldsymbol{\beta}_\mathbf{s}} \underbrace{\begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \end{bmatrix}}_{\mathbf{p}} = \boldsymbol{\alpha}_\mathbf{s} + \boldsymbol{\beta}_\mathbf{s}\mathbf{p}$$

The equilibrium is given by equating demand and supply

$$\boldsymbol{\alpha}_\mathbf{d} + \boldsymbol{\beta}_\mathbf{d}\mathbf{p} = \boldsymbol{\alpha}_\mathbf{s} + \boldsymbol{\beta}_\mathbf{s}\mathbf{p} \qquad \Leftrightarrow \qquad [\boldsymbol{\alpha}_\mathbf{d} - \boldsymbol{\alpha}_\mathbf{s}] = [\boldsymbol{\beta}_\mathbf{s} - \boldsymbol{\beta}_\mathbf{d}]\,\mathbf{p}$$

And hence the equilibrium prices are

$$\mathbf{p} = [\boldsymbol{\beta}_\mathbf{s} - \boldsymbol{\beta}_\mathbf{d}]^{-1}[\boldsymbol{\alpha}_\mathbf{d} - \boldsymbol{\alpha}_\mathbf{s}]$$

If biofuels shift out the demand by $\Delta\alpha_{d,1}$ for commodity 1, the resulting effect on equilibrium prices is

$$\Delta\mathbf{p} = [\boldsymbol{\beta}_\mathbf{s} - \boldsymbol{\beta}_\mathbf{d}]^{-1}[\Delta\alpha_{d,1} \quad 0 \quad \ldots \quad 0]'$$

Note that all prices adjust, even though the demand for only one commodity increases because the prices are linked through cross-price elasticities. Uncertainty of the estimate is derived by drawing one million random draws from the estimated joint distribution of the $\beta_{d,ij}$ and $\beta_{s,ij}$, inverting the matrix $[\boldsymbol{\beta}_{\mathbf{s}} - \boldsymbol{\beta}_{\mathbf{d}}]^{-1}$, and derive the predicted price increase $[\boldsymbol{\beta}_{\mathbf{s}} - \boldsymbol{\beta}_{\mathbf{d}}]^{-1} [\Delta\alpha_{d,1} \quad 0 \quad \dots \quad 0]'$ for each commodity on each draw.

If there is just one commodity, this simplifies to the baseline case: $\Delta p = \frac{\Delta\alpha_{d,1}}{\beta_{s,11} - \beta_{d,11}}$.

A2 Data Appendix

A2.1 Agricultural Production Data

Yield data for the four staple commodities, maize, rice, soybeans, and wheat, were obtained from two data sources. The baseline model uses data from the Food and Agriculture Organization (FAO) of the United Nations (http://faostat.fao.org/) for the years 1961-2010. The data include production, area harvested, yields (ratio of total production divided by area harvested), and stock variation (change in inventories) for each of the four key crops. Production and area are assigned to the calendar year given by FAO. Demand is annual production plus the change in inventory, which is given by the *negative* of the "Stock Variation" variable in the FAO data. The last variable is only available until 2007, so the baseline regression uses data for the 47 years from 1961 to 2007. Since most regressions include one lag of yield shocks, those using FAO data generally have 46 observations.

In a sensitivity check, we use data from the Foreign Agricultural Service (FAS) by the United States Department of Agriculture (http://http://www.fas.usda.gov/) that has data for 1961-2010 for all variables, including stocks. FAS reports production for marketing years, i.e., the 12-month period between the last harvest and the next harvest, when the amount produced is being sold. To be consistent with the FAO data, we assign production data to calendar years based on the year when the marketing year starts. We adjust the year for Argentina maize and Romanian soybeans, as they seem to be off by one year. Consumption quantities are set equal to production plus the inventory levels at the beginning of the marketing year minus inventory levels at the end of the marketing year, which are given in the data.

The FAS data does not provide production data for soybeans before 1964, so we manually fill in production numbers from USDA. Soybeans were a small share of overall calorie production at that time, and the US produced a dominant share of global production, so the omitted countries should have little influence. The FAS data does not give an estimate for the world total. Instead we simply sum the numbers for all countries in the data to get the total production of all major producers. Since the FAS data does exclude countries that are not major producers, consumption estimates tend to be smaller than production estimates.

We model yields in each country that on average account for at least 0.5% of global production and sum the remaining countries as "Rest of the World." Countries that produce at least 0.5% of any of the four commodities are given in Tables A1 and A2. The geographic location of these countries is shown in the bottom panels of Figures A1-A4. Individual yield observations in our baseline model using FAO data as well as time trends using restricted cubic spline with 3 knots are shown in Figures A5-A7.[A1] The knots are 1963, 1984, and 2005. Regressions with 4 spline knots use the knots 1962, 1976, 1992, and 2006. Regressions with 5 spline knots use the knots 1962, 1973, 1984, 1995, and 2006.

Figure A8 shows the correlation of annual yield shocks of the two biggest exporters for each of the four commodities. The two largest exporters are engaged in the world market and farmers should respond to changes in world prices. If yields are endogenous to price, yield shocks between the two largest producers should be correlated as they both respond to the same price shock. However, the figure shows little correlation between the shocks.

A2.2 Weather Data

Weather data from Center for Climatic Research at the University of Delaware (version 2.01) gives monthly temperature and precipitation readings on a 0.5 degree grid for the entire world for the years 1901-2008.[A2] Weather outcomes for a particular crop in a country are the area-weighted average of all grids that fall in a country over the growing season.

The crop-specific area weights from Chad Monfreda, Navin Ramankutty & Jonathan A. Foley (2008) are displayed in the top panels of Appendix Figures A1-A4. The authors provide the fraction of each 5 minute grid cell that is used for various crops.[A3] Fraction greater than 1 indicate double cropping.

The growing season for each crop and country was obtained from W. J. Sacks, D. Deryng, J.A. Foley & N. Ramankutty (2010). The authors provide planting and harvest dates on a 5 minute grid.[A4] We include the entire months between planting and harvest. For example, if average planting is on April 8th and harvest on September 12th, we use weather data from

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[A1] We use STATA's command `mkspline` to obtain restricted cubic splines with three knots. This gives two variables, which captures a trend in a more flexible way than using a quadratic time trend.

[A2] http://climate.geog.udel.edu/∼climate/

[A3] http://www.geog.mcgill.ca/landuse/pub/Data/175crops2000/NetCDF/ (accessed November 2008).

[A4] http://www.sage.wisc.edu/download/sacks/crop_calendar.html (accessed January 2010).

April through September.

A2.3 Price Data

Our baseline model uses futures prices during the month of delivery (December for maize and wheat and November for rice and soybeans) in the demand equation and futures prices as they are traded in the previous December in the supply equation. Prices are converted into dollars per calorie by using the conversion ratios of Lucille Williamson & Paul Williamson (1942) that list the edible amount of calories in each production unit.

Since futures data are only available since 1960s, Figure 2, which shows a longer history of prices converted to the real annual cost of a 2000 calories/day, uses annual prices received by farmers as reported by the National Agricultural Statistics Service.[A5] Food commodity prices have declined over the long run, except for price spikes during World War II, in the 1970s, and the recent run-up. Despite the recent run-up, prices are still low relative to most of history. The top panel of Figure A9 replicates this time series for the time frame of our analysis 1961-2010.

The bottom panel of Figure A9 no longer uses the conversion ratios of Williamson & Williamson (1942), but backs them out implicitly by assuming the average price of a calorie is the same for all crops. This calibration tracks relative changes in prices over time. In effect, the bottom panel shows each price series multiplied by a constant such that the average prices of rice, soybeans and wheat in 1961-2010 equal that of maize.

A2.4 Ethanol Production

Renewable fuel standards and ethanol tax credits have led to a rapid expansion of the US ethanol production capacity as shown in the top panel of Figure A10. As a result, the United States produces far more than 50% of the global production capacity in 2010, followed by South America (primarily Brazil), which accounted for roughly one-third. Production shares are shown in the botttom panel of Figure A10.

[A5] www.nass.usda.gov

Table A1: Countries Used to Derive Maize and Soybean Yield Shocks

	Data from FAO						**Data from FAS**					
	Production Share			**Years in Data**			**Production Share**			**Years in Data**		
Country	**Avg**	**Min**	**Max**	**N**	**Min**	**Max**	**Avg**	**Min**	**Max**	**N**	**Min**	**Max**
Panel A: Maize Yields												
United States of America	41.76	30.55	48.11	50	1961	2010	45.09	32.98	50.50	50	1961	2010
China	15.96	7.95	21.72	50	1961	2010	17.03	9.77	23.56	50	1961	2010
Brazil	5.29	3.45	7.49	50	1961	2010	5.71	3.66	7.79	50	1961	2010
USSR	3.52	1.98	8.35	31	1961	1991	3.96	2.11	8.66	26	1961	1986
Mexico	3.00	2.02	3.94	50	1961	2010	3.06	1.66	4.41	50	1961	2010
Yugoslav SFR	2.47	1.39	3.25	31	1961	1991	2.65	1.48	3.46	31	1961	1991
Argentina	2.35	1.03	3.52	50	1961	2010	2.53	1.11	3.78	50	1961	2010
France	2.29	0.91	3.65	50	1961	2010	.	.	.	.	.	.
Romania	2.08	0.49	3.29	50	1961	2010	2.61	1.37	3.73	38	1961	1998
South Africa	1.98	0.61	3.62	50	1961	2010	2.12	0.66	3.88	50	1961	2010
India	1.93	1.26	2.82	50	1961	2010	2.09	1.35	3.02	50	1961	2010
Italy	1.51	0.96	1.93	50	1961	2010	.	.	.	.	.	.
Hungary	1.37	0.51	2.10	50	1961	2010	1.57	0.80	2.19	38	1961	1998
Indonesia	1.31	0.72	2.17	50	1961	2010	1.14	0.76	1.79	49	1961	2010
Canada	1.16	0.36	1.71	50	1961	2010	1.23	0.38	1.84	50	1961	2010
Serbia And Montenegro	0.89	0.50	1.19	14	1992	2005	0.95	0.55	1.20	14	1992	2005
Egypt	0.89	0.70	1.09	50	1961	2010	0.95	0.78	1.16	49	1961	2010
Ukraine	0.80	0.27	1.42	19	1992	2010	1.03	0.29	2.34	24	1987	2010
Philippines	0.77	0.59	1.10	50	1961	2010	0.83	0.61	1.23	50	1961	2010
Thailand	0.67	0.29	1.16	50	1961	2010	0.71	0.30	1.23	50	1961	2010
Nigeria	0.65	0.12	1.34	50	1961	2010	0.71	0.32	1.44	50	1961	2010
Spain	0.58	0.34	0.89	50	1961	2010	.	.	.	.	.	.
North Korea	0.52	0.14	0.89	50	1961	2010	.	.	.	.	.	.
Bulgaria	0.50	0.04	0.96	50	1961	2010	0.64	0.18	1.03	38	1961	1998
Kenya	.	.	.	.	.	.	0.53	0.28	0.78	50	1961	2010
Rest Of World	9.09	6.95	12.04	50	1961	2010	8.22	6.30	11.64	50	1961	2010
Panel B: Soybeans Yields												
United States of America	55.55	33.17	73.48	50	1961	2010	58.22	32.88	100.00	50	1961	2010
Brazil	15.11	1.01	27.23	50	1961	2010	17.29	1.59	29.59	46	1965	2010
China	12.63	5.77	27.26	50	1961	2010	11.83	5.64	27.47	47	1964	2010
Argentina	7.31	0.00	21.61	50	1961	2010	8.05	0.05	22.03	46	1965	2010
India	1.79	0.02	4.99	50	1961	2010	1.89	0.03	4.27	42	1969	2010
Paraguay	1.09	0.01	2.85	50	1961	2010	1.11	0.03	2.75	46	1965	2010
Canada	1.07	0.44	1.90	50	1961	2010	1.09	0.44	1.85	47	1964	2010
USSR	0.94	0.46	1.75	31	1961	1991	0.89	0.48	1.61	23	1964	1986
Indonesia	0.94	0.27	1.63	50	1961	2010	0.91	0.24	1.65	47	1964	2010
Italy	.	.	.	.	.	.	0.76	0.01	1.69	10	1981	1990
Rest Of World	3.93	2.52	6.72	50	1961	2010	3.25	0.01	5.84	48	1963	2010

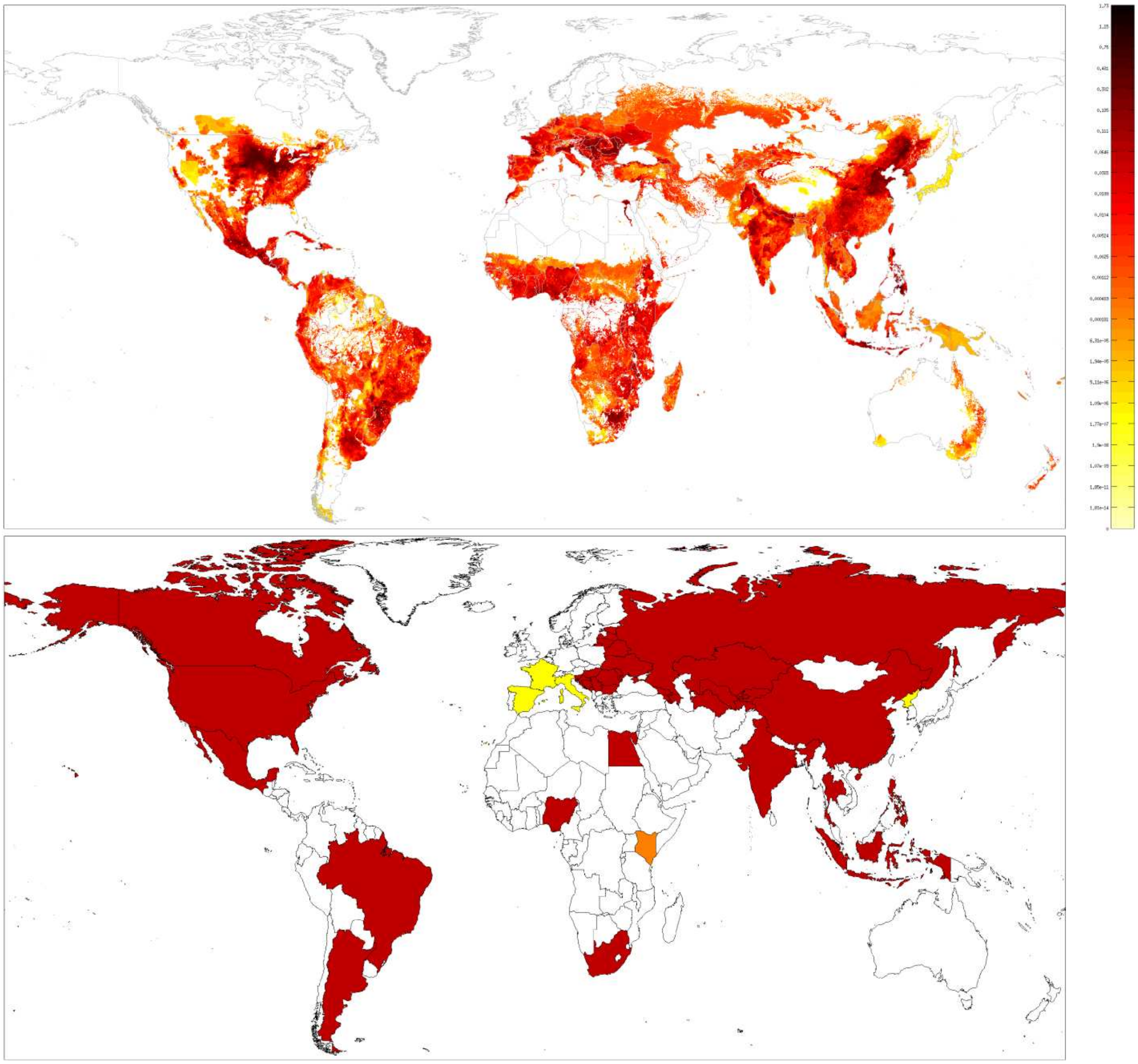
Notes: Tables displays countries used to derive yield deviations, sorted from largest producer to smallest producer. The first six columns summarize the data from FAO, the last six columns from FAS. Within each data set, the first three give average, minimum, and maximum annual share of global production, respectively, while the last three give the number of years for which we have data as well as the first and last year, respectively.

Table A2: Countries Used to Derive Wheat and Rice Yield Shocks

	Data from FAO						**Data from FAS**					
	Production Share			**Years in Data**			**Production Share**			**Years in Data**		
Country	**Avg**	**Min**	**Max**	**N**	**Min**	**Max**	**Avg**	**Min**	**Max**	**N**	**Min**	**Max**
							Panel A: Wheat Yields					
USSR	21.23	12.68	31.10	31	1961	1991	26.54	15.35	35.94	26	1961	1986
China	14.23	6.43	20.10	50	1961	2010	17.25	7.71	24.52	50	1961	2010
United States of America	11.91	7.60	16.86	50	1961	2010	14.52	10.00	19.90	50	1961	2010
India	8.73	3.42	13.04	50	1961	2010	10.58	4.01	16.92	50	1961	2010
Russian Federation	7.07	4.55	9.33	19	1992	2010	8.96	5.54	11.99	24	1987	2010
France	5.35	3.72	6.78	50	1961	2010	.	.	.	.	.	.
Canada	4.75	2.78	8.44	50	1961	2010	5.80	3.46	10.25	50	1961	2010
Turkey	3.44	2.60	4.37	50	1961	2010	3.42	2.56	4.12	50	1961	2010
Australia	3.14	1.70	4.67	50	1961	2010	3.84	2.03	5.87	50	1961	2010
Germany	2.94	1.99	4.02	50	1961	2010	.	.	.	.	.	.
Ukraine	2.76	0.64	3.87	19	1992	2010	3.85	0.81	6.12	24	1987	2010
Pakistan	2.54	1.29	3.80	50	1961	2010	3.09	1.51	4.74	50	1961	2010
Argentina	2.20	1.25	4.19	50	1961	2010	2.70	1.74	5.10	50	1961	2010
United Kingdom	2.02	1.06	2.92	50	1961	2010	.	.	.	.	.	.
Italy	2.00	0.92	3.79	50	1961	2010	.	.	.	.	.	.
Kazakhstan	1.88	0.80	3.23	19	1992	2010	2.44	0.96	3.85	24	1987	2010
Iran	1.56	0.98	2.59	50	1961	2010	1.89	1.14	3.23	50	1961	2010
Poland	1.38	0.93	1.79	50	1961	2010	1.62	1.10	2.16	38	1961	1998
Yugoslav SFR	1.29	0.90	1.78	31	1961	1991	1.55	1.08	2.16	31	1961	1991
Romania	1.25	0.44	2.25	50	1961	2010	1.64	0.64	2.79	38	1961	1998
Spain	1.14	0.58	2.09	50	1961	2010	.	.	.	.	.	.
Czechoslovakia	1.05	0.66	1.41	32	1961	1992	1.25	0.81	1.71	31	1961	1991
Hungary	0.96	0.45	1.44	50	1961	2010	1.24	0.64	1.76	38	1961	1998
Bulgaria	0.76	0.31	1.11	50	1961	2010	1.00	0.37	1.37	38	1961	1998
Egypt	0.73	0.35	1.37	50	1961	2010	0.90	0.43	1.76	49	1961	2010
Uzbekistan	0.68	0.16	1.03	19	1992	2010	0.69	0.08	1.26	24	1987	2010
Mexico	0.67	0.37	1.04	50	1961	2010	0.77	0.50	1.06	50	1961	2010
Czech Republic	0.66	0.47	0.80	18	1993	2010	.	.	.	.	.	.
Afghanistan	0.57	0.25	1.02	50	1961	2010	0.70	0.33	1.23	50	1961	2010
Brazil	0.56	0.17	1.21	50	1961	2010	0.64	0.05	1.45	50	1961	2010
Morocco	0.56	0.20	1.05	50	1961	2010	0.66	0.23	1.34	50	1961	2010
Serbia And Montenegro	.	.	.	.	.	.	0.51	0.31	0.74	14	1992	2005
Syria	.	.	.	.	.	.	0.56	0.19	1.10	50	1961	2010
Rest Of World	7.04	4.67	9.83	50	1961	2010	4.94	2.86	6.96	50	1961	2010
							Panel B: Rice Yields					
China	34.08	26.07	39.13	50	1961	2010	34.74	25.61	39.66	50	1961	2010
India	20.59	16.77	24.81	50	1961	2010	20.59	16.52	24.33	50	1961	2010
Indonesia	7.61	4.68	9.88	50	1961	2010	7.64	5.35	9.03	50	1961	2010
Bangladesh	5.56	4.66	7.34	50	1961	2010	5.58	4.63	7.40	50	1961	2010
Thailand	4.33	3.32	5.17	50	1961	2010	4.15	3.27	4.70	50	1961	2010
Vietnam	4.08	2.54	6.03	50	1961	2010	4.03	2.50	5.86	50	1961	2010
Japan	3.55	1.55	7.49	50	1961	2010	3.83	1.72	7.71	50	1961	2010
Myanmar	3.23	2.39	4.94	50	1961	2010	2.50	2.12	3.11	50	1961	2010
Brazil	2.06	1.33	2.98	50	1961	2010	2.07	1.47	2.87	49	1961	2010
Philippines	1.90	1.48	2.47	50	1961	2010	1.84	1.36	2.43	50	1961	2010
South Korea	1.55	0.86	2.26	50	1961	2010	1.68	0.96	2.41	50	1961	2010
United States of America	1.44	1.01	2.02	50	1961	2010	1.52	1.05	2.16	50	1961	2010
Pakistan	1.09	0.72	1.51	50	1961	2010	1.08	0.71	1.54	50	1961	2010
Egypt	0.76	0.44	1.07	50	1961	2010	0.75	0.41	1.14	50	1961	2010
Nepal	0.68	0.43	0.98	50	1961	2010	0.69	0.44	0.96	49	1961	2010
Cambodia	0.65	0.14	1.23	50	1961	2010	0.63	0.13	1.18	50	1961	2010
North Korea	0.58	0.25	0.90	50	1961	2010	0.59	0.31	0.77	50	1961	2010
Madagascar	0.53	0.41	0.71	50	1961	2010	0.50	0.40	0.68	50	1961	2010
Taiwan	.	.	.	.	.	.	0.70	0.22	1.34	49	1961	2010
Rest Of World	5.74	4.54	7.16	50	1961	2010	4.98	3.87	6.42	50	1961	2010

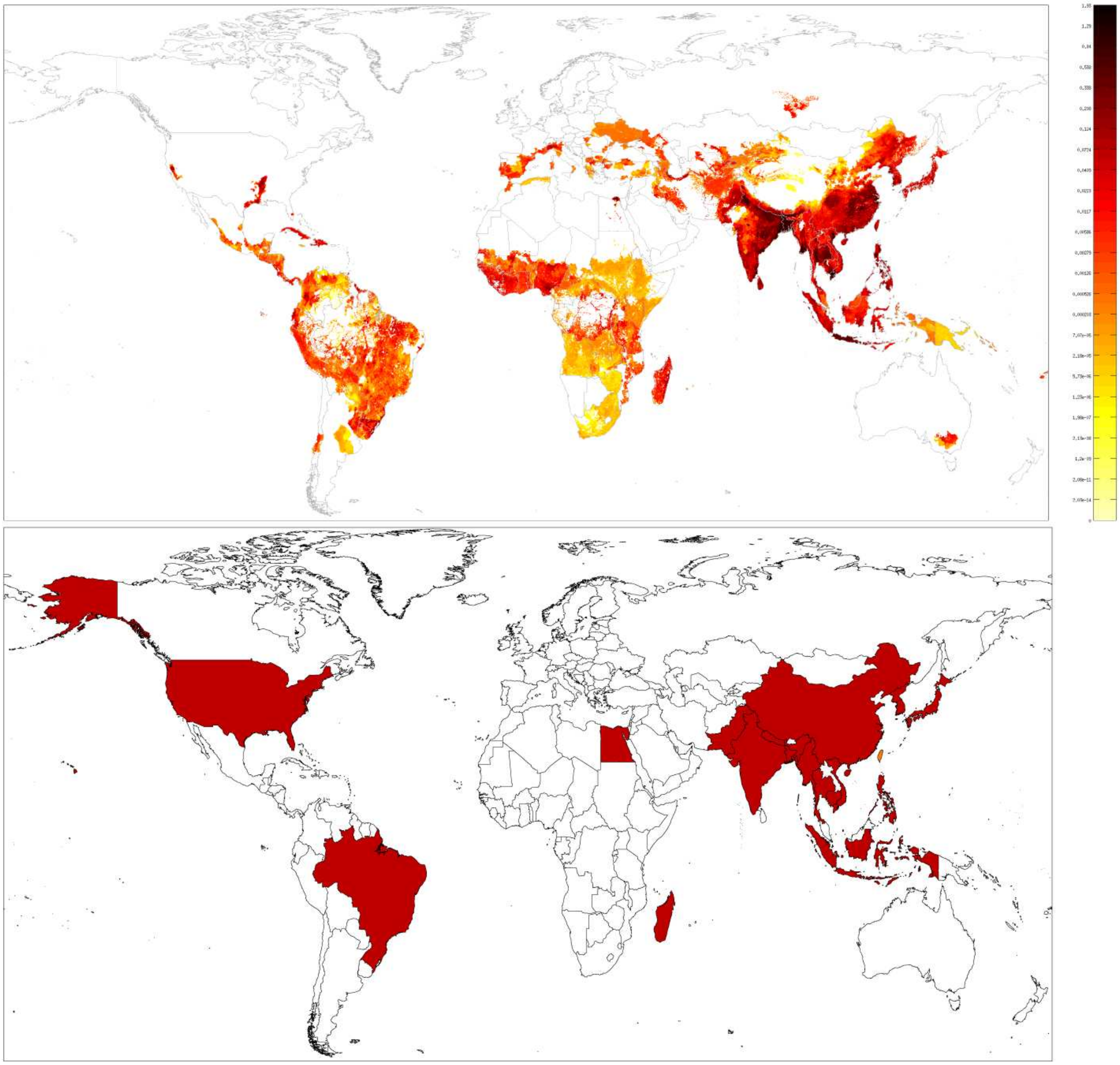
Notes: Table displays countries used to derive yield deviations, sorted from largest producer to smallest producer. The first six columns summarize the data from FAO, the last six columns from FAS. Within each data set, the first three give average, minimum, and maximum annual share of global production, respectively; the last three give the number of years for which we have data as well as the first and last available year.

Figure A1: Maize Growing Area and Countries in Study



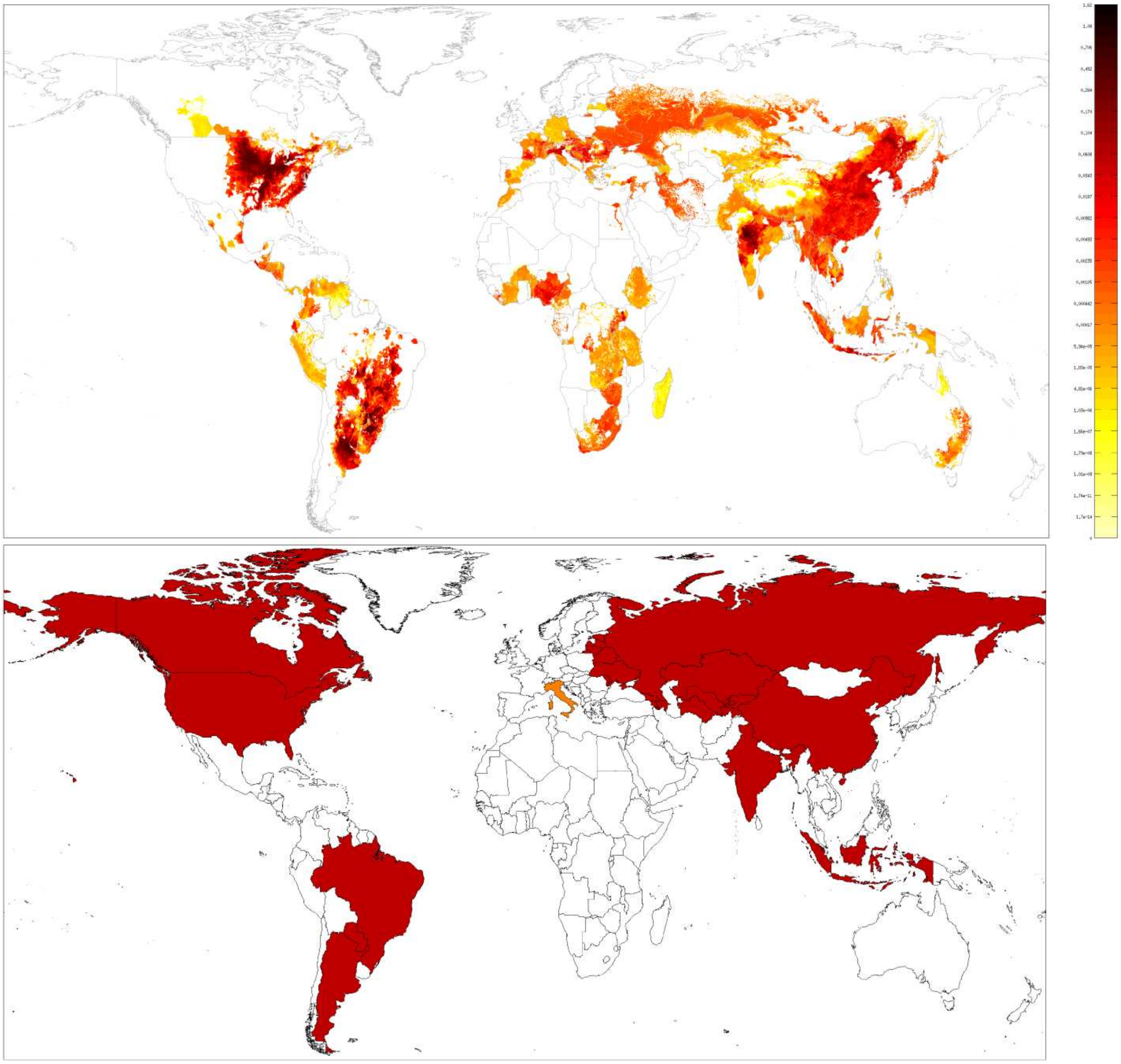
Notes: Top panel displays the fraction of each grid cell in Monfreda, Ramankutty & Foley (2008) used to grow maize (note the nonlinear scale on the right). Numbers greater than 1 indicate double cropping. The bottom panel displays countries that on average produce at least 0.5% of global production. Colors indicate whether this is the case in both the FAO and FAS data (red), only the FAS data (orange), or only the FAO data (yellow).

Figure A2: Rice Growing Area and Countries in Study



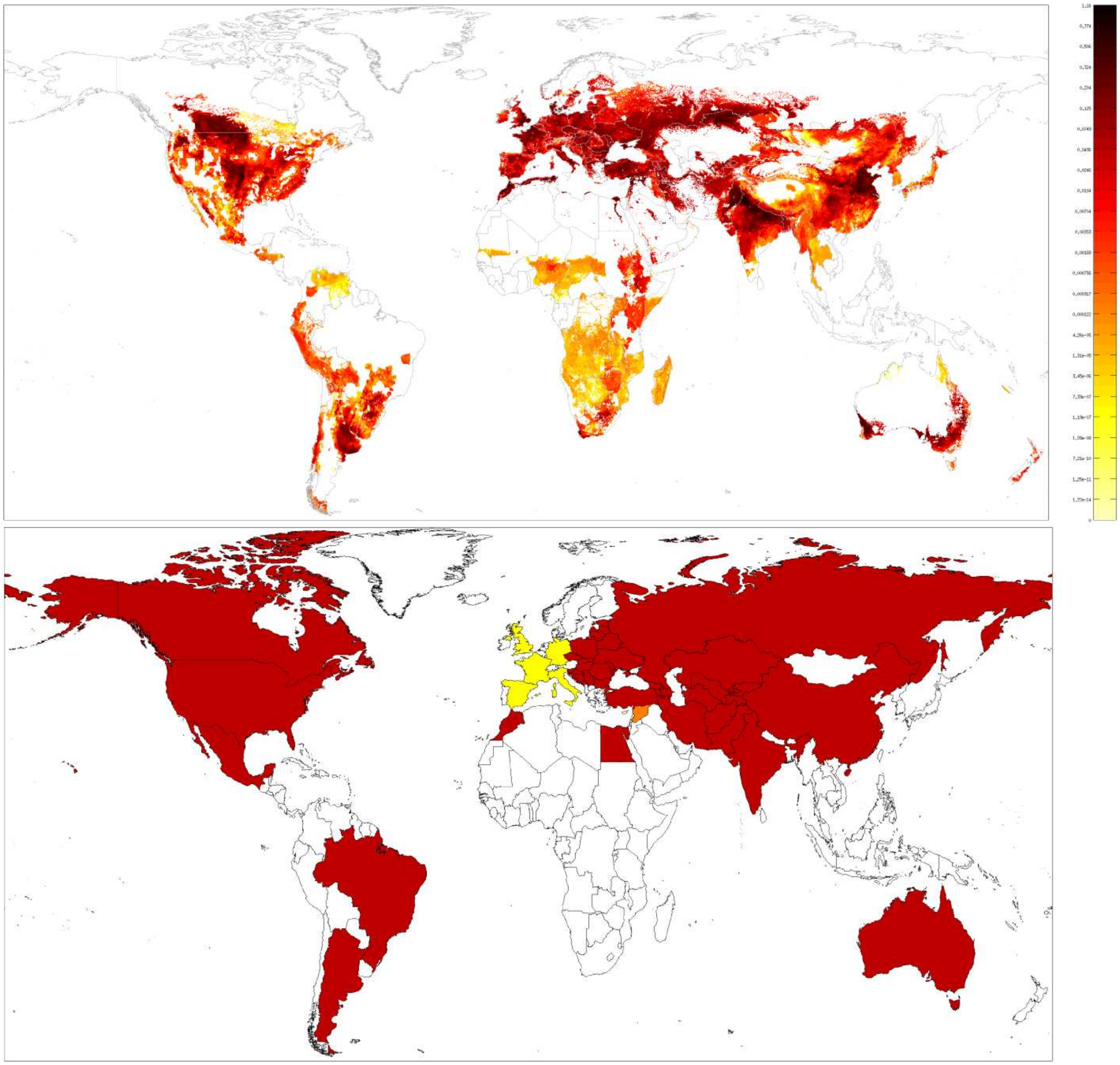
Notes: Top panel displays the fraction of each grid cell in Monfreda, Ramankutty & Foley (2008) used to grow rice (note the nonlinear scale on the right). Numbers greater than 1 indicate double cropping. The bottom panel displays countries that on average produce at least 0.5% of global production. Colors indicate whether this is the case in both the FAO and FAS data (red), only the FAS data (orange), or only the FAO data (yellow).

Figure A3: Soybeans Growing Area and Countries in Study



Notes: Top panel displays the fraction of each grid cell in Monfreda, Ramankutty & Foley (2008) used to grow soybeans (note the nonlinear scale on the right). Numbers greater than 1 indicate double cropping. The bottom panel displays countries that on average produce at least 0.5% of global production. Colors indicate whether this is the case in both the FAO and FAS data (red), only the FAS data (orange), or only the FAO data (yellow).

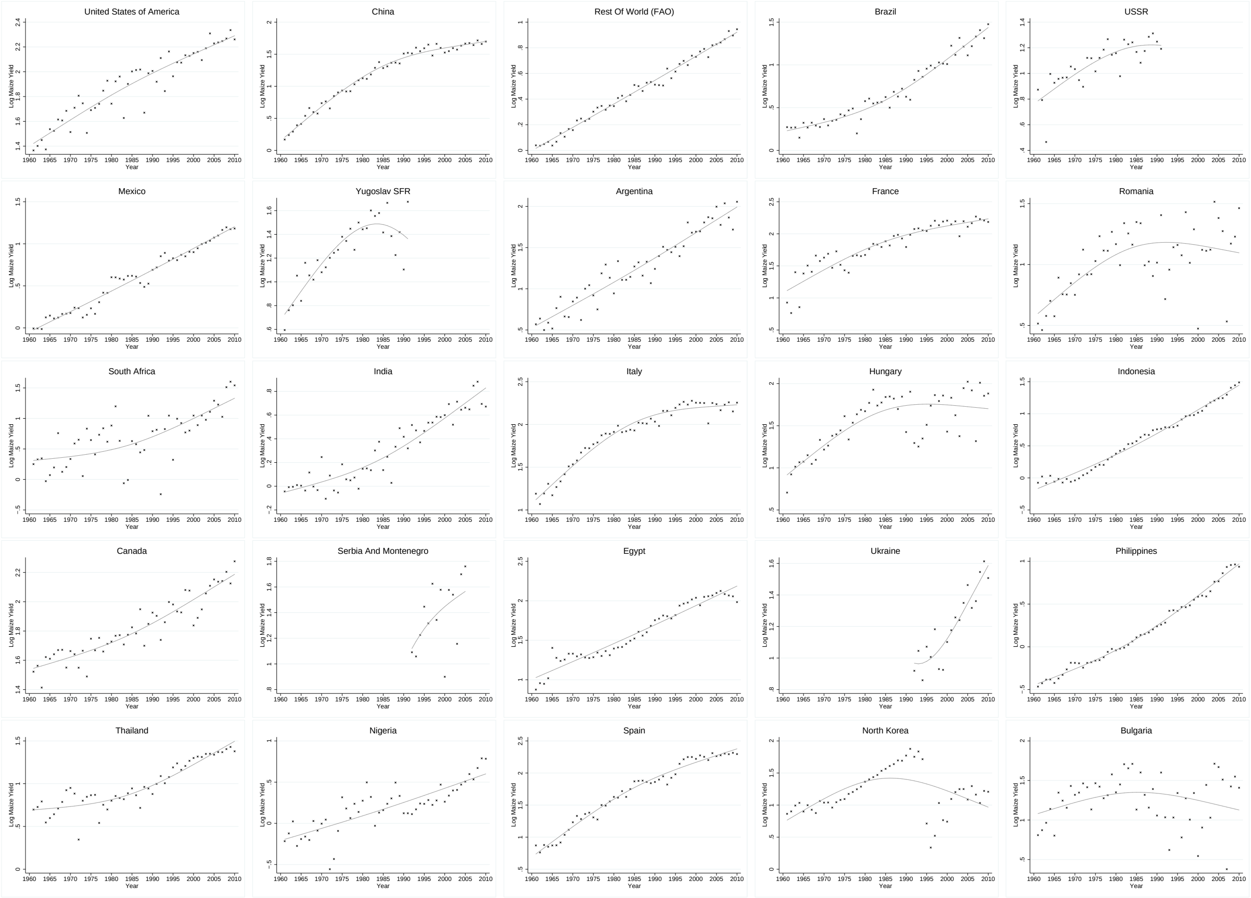
Figure A4: Wheat Growing Area and Countries in Study



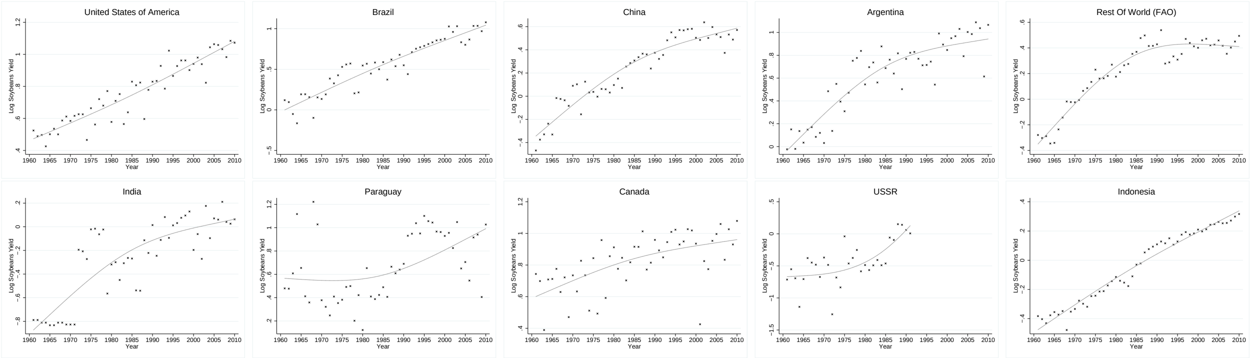
Notes: Top panel displays the fraction of each grid cell in Monfreda, Ramankutty & Foley (2008) used to grow wheat (note the nonlinear scale on the right). Numbers greater than 1 indicate double cropping. The bottom panel displays countries that on average produce at least 0.5% of global production. Colors indicate whether this is the case in both the FAO and FAS data (red), only the FAS data (orange), or only the FAO data (yellow).

Figure A5: Country-Level Yields and Yield Trends for Maize and Soybeans

Panel A: Maize Yields

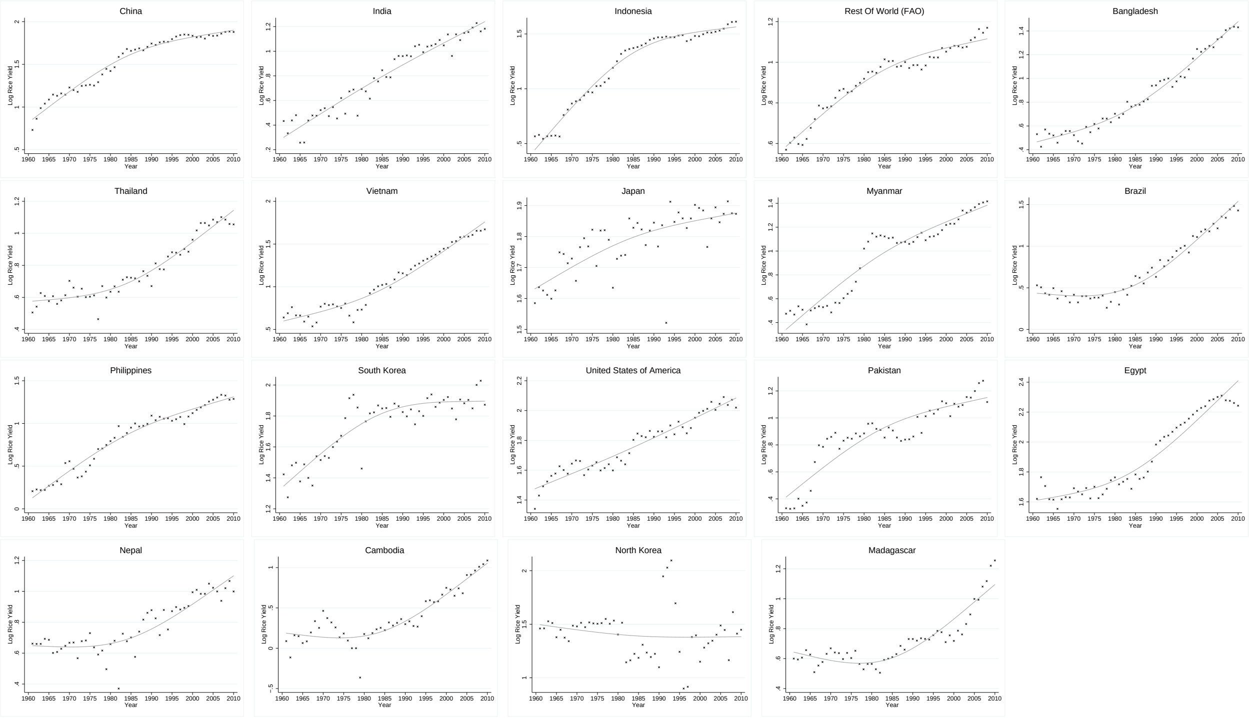


Panel B: Soybean Yields



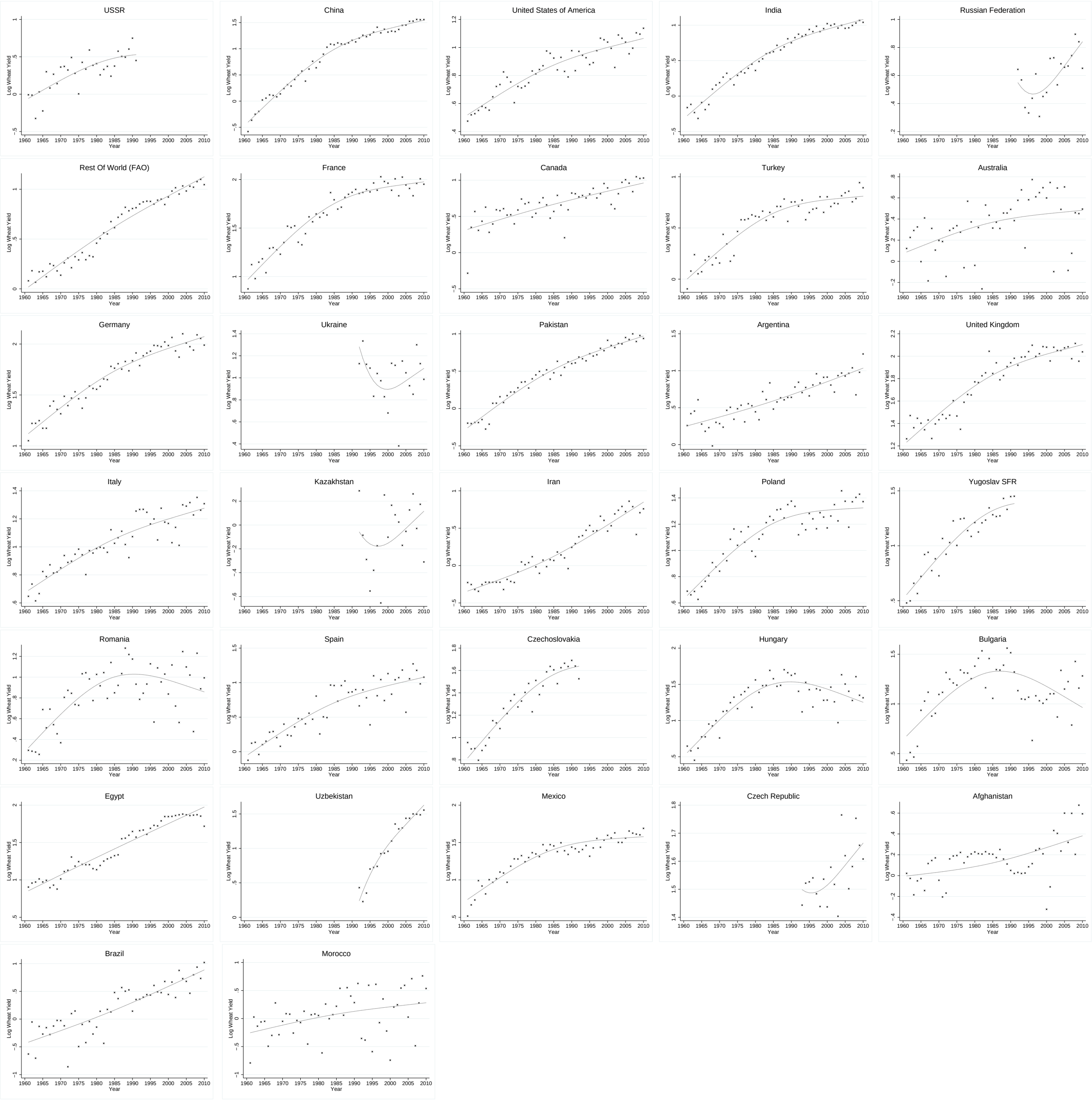
Notes: Figure displays yields in FAO data as well as trends (restricted cubic spline with 3 knots). Countries are sorted from largest producer to smallest producer.

Figure A6: Country-Level Yields and Yield Trends for Rice



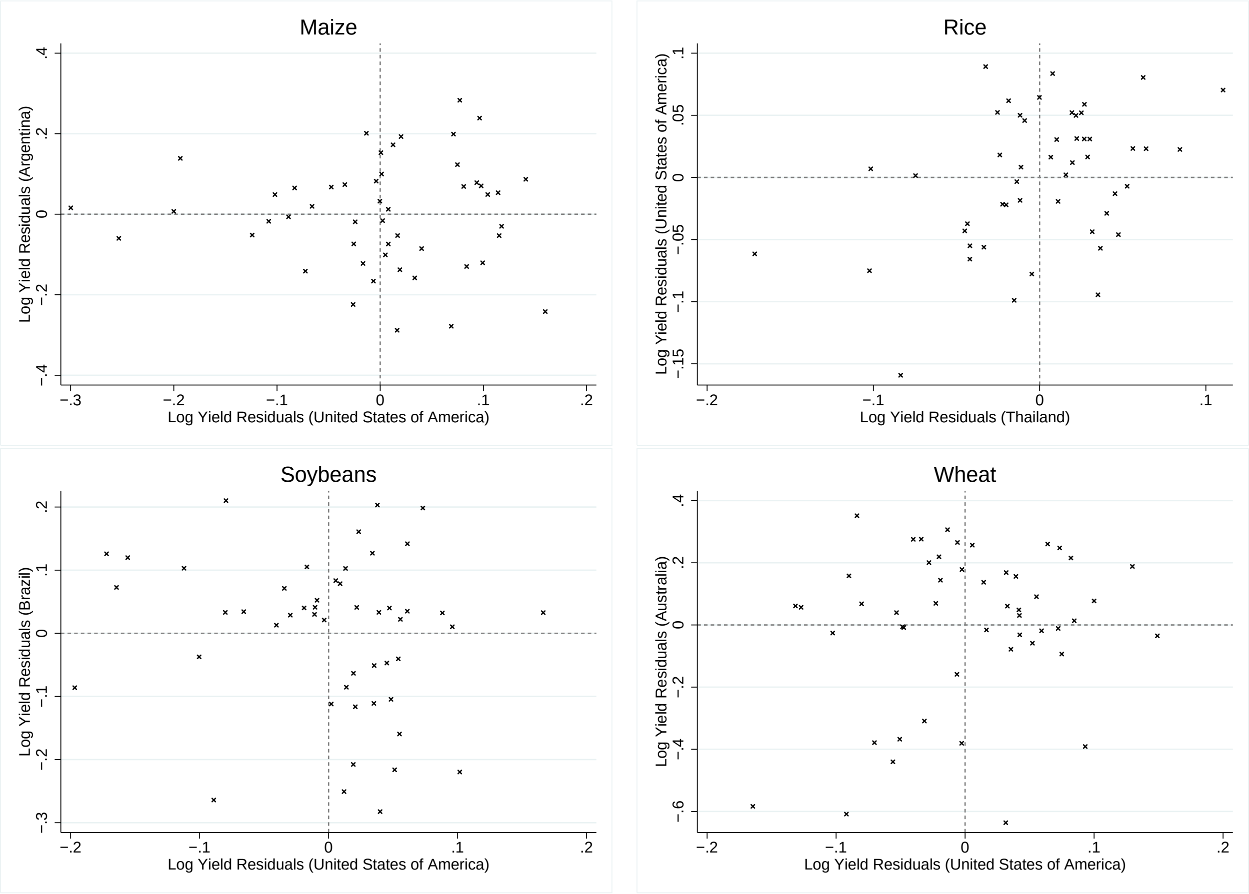
Notes: Figure displays yields in FAO data as well as trends (restricted cubic spline with 3 knots). Countries are sorted from largest producer to smallest producer.

Figure A7: Country-Level Yields and Yield Trends for Wheat



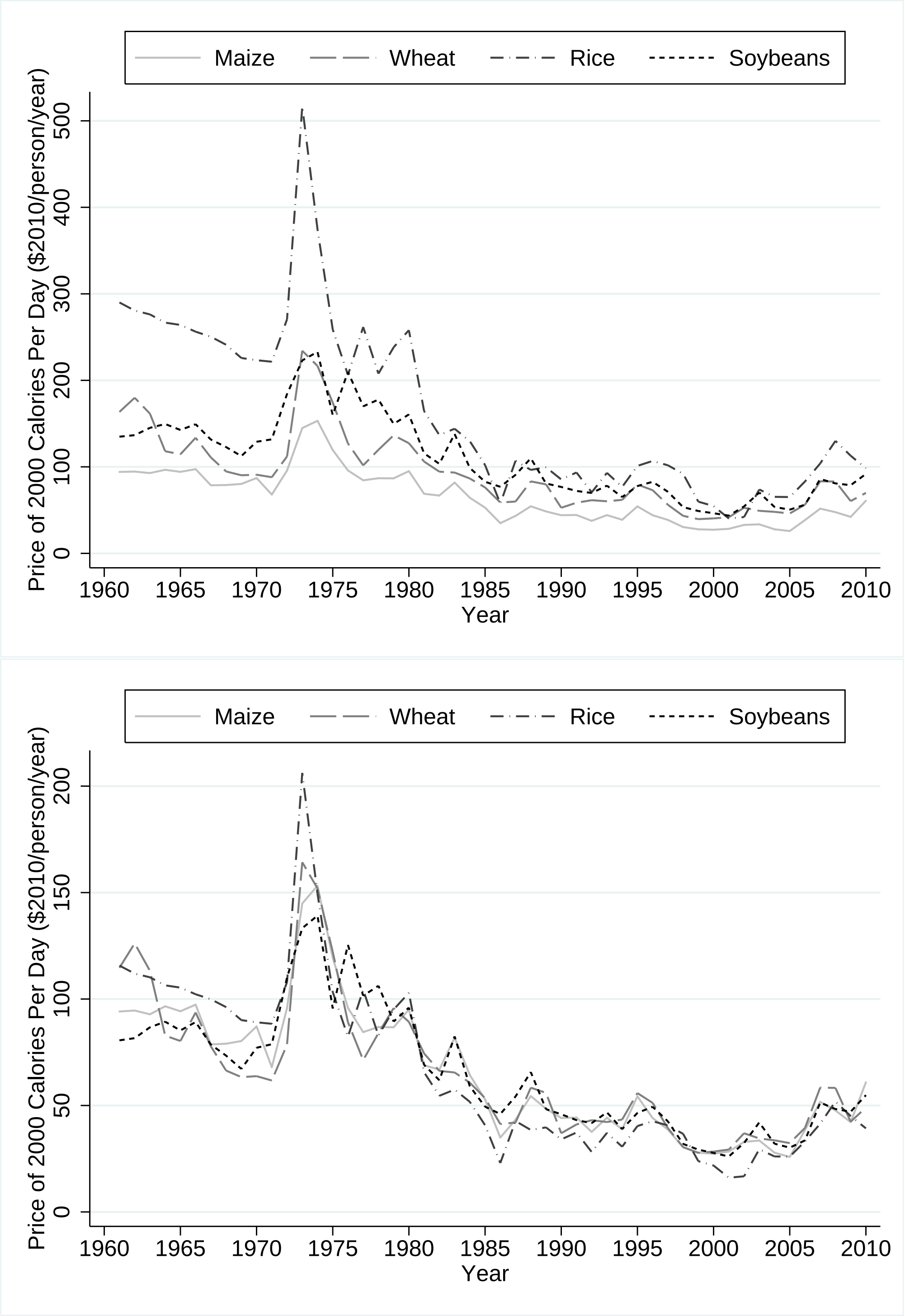
Notes: Figure displays yields in FAO data as well as trends (restricted cubic spline with 3 knots). Countries are sorted from largest producer to smallest producer.

Figure A8: Correlation of Shocks of Two Biggest Exporters (FAO Data)



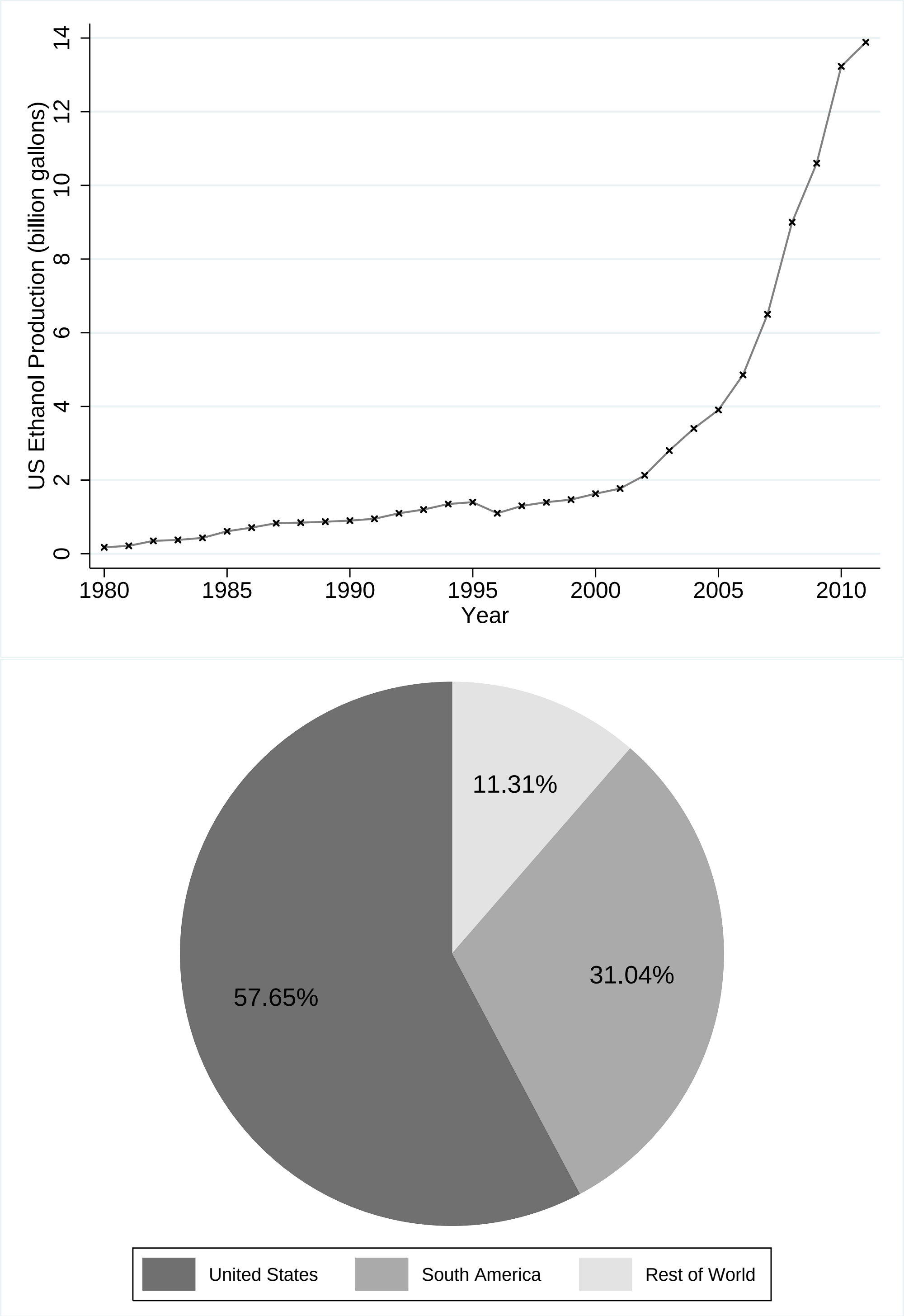
Notes: Figure shows scatter plots of log yield residuals (deviations from the trend, which is modeled using restricted cubic splines with 3 knots) of the two largest exporters of each crop in 1961-2010. The correlation coefficients are 0.002 for maize, 0.40 for rice, -0.16 for soybeans, and 0.19 for wheat. For wheat, the second largest exporter is Canada, but since the growing area is adjacent to the United States, the largest exporter, we instead use the third largest exporter (Australia).

Figure A9: Commodity Prices



Notes: Figure displays caloric prices over time for maize, wheat, rice, and soybeans in the years 1961-2010. The y-axis are the annual cost for 2000 calories per day. The bottom panel rescales prices by a constant so the average price in 1961-2010 is the same as for maize.

Figure A10: US Ethanol Production Capacity Over Time and as Share of World Capacity



Notes: Top panel shows ethanol production capacity in billion gallons 1980-2011. The bottom panel shows the US share of global capacity in 2010, South America, and the rest of the world. Data is taken from: http://www.ethanolrfa.org/pages/statistics

A3 FAO Data - Additional Results

This section presents additional results that were omitted from the main paper due to space constraints.

Table A3 weighs crop and country-specific shocks by predicted area (using the same restricted cubic spline with 3 knots in a regression of log area, i.e., using the same setup that was used to derive predicted yield), but the results remain robust.

Table A4 presents the coefficients on US yield shocks as well as yield shocks for the rest of the world. Table 5 in the main paper listed the elasticities as well as test results whether the coefficients on the instruments are equal, but not the coefficients themselves. Note that the coefficients are close in magnitude: a shock outside the US moves futures prices by a similar amount as shocks in the US. We normalize shocks by the fraction of global production (according to predicted yields) to make the shocks comparable: Since the US produces around 23% of global calories, the US shock is multiplied by roughly 0.23, while the shock on the rest of the world is multiplied by 0.77. To get the effect of 1% shock in the US on world prices, one simply has to divide the first-stage parameter by roughly one-fourth. The first-stage instrument in the supply equation is around -4, which implies that a negative 1% yield shock in the US increase global commodity prices in the next period by 1%. The coefficient in the demand equation is slightly larger in magnitude (around -5), suggesting that a negative 1% yield shock in the US increase global commodity prices in the current period by 1.25%.

Similarly, Table A5 splits overall shocks, our instrument, into each of the four commodities. The coefficients on the different instruments are not significantly different except when we use 3 spline knots as the time trend in the IV regression (column 1a) or 3SLS regression (column 2a). Since we are using one "combined" price (production-weighted average of maize, soybeans, and wheat, where we use predicted yields along the trend), this regression should be interpreted with caution as the weighted price basket will be related to all four commodity shocks even if they only impact the price of one crop.

Table A6 replicates Table 7 of the main paper but shows results not only for time trends that are modeled as restricted cubic splines with 4 knots but also 5 knots.

Table A7 estimates a 4x4 system using FAO data similar to Table 8 in the main paper that uses FAS data.

Table A3: Supply and Demand Elasticity: Weighting Yield Schocks by Predicted Growing Area (FAO Data)

	Instrumental Variables			**Three Stage Least Squares**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
			Panel A: Supply Equation			
Supply Elast. β_s	0.107***	0.102***	0.092***	0.122***	0.119***	0.102***
	(0.026)	(0.027)	(0.020)	(0.019)	(0.020)	(0.018)
Shock ω_t	1.178***	1.216***	1.202***	1.237***	1.266***	1.232***
	(0.147)	(0.145)	(0.102)	(0.107)	(0.099)	(0.086)
First Stage ω_{t-1}	-3.748***	-3.519***	-3.740***	-3.453***	-3.054***	-3.165***
	(1.162)	(0.945)	(0.903)	(0.782)	(0.683)	(0.713)
First Stage ω_t	-2.801*	-2.211*	-2.326*	-2.788***	-2.283***	-2.380***
	(1.633)	(1.283)	(1.260)	(0.956)	(0.804)	(0.806)
			Panel B: Demand Equation			
Demand Elast. β_d	-0.028	-0.054**	-0.054**	-0.033	-0.058***	-0.063***
	(0.021)	(0.023)	(0.021)	(0.024)	(0.022)	(0.020)
First Stage ω_t	-5.362***	-4.533***	-4.674***	-5.219***	-4.406***	-4.345***
	(1.487)	(1.271)	(1.205)	(1.364)	(1.190)	(1.168)
			Panel C: Effect of Demand Shift			
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	7.41	6.41	6.87	6.49	5.65	6.07
Exp. Multiplier	8.01	6.83	7.18	6.73	5.81	6.24
(95% Conf. Int.)	(5.0,14.4)	(4.4,11.7)	(4.9,11.3)	(4.8,10.1)	(4.3,8.3)	(4.6,8.9)
$\text{F}_{\text{1st-stage}}$ Supply	10.41	13.86	17.15			
$\text{F}_{\text{1st-stage}}$ Demand	13.01	12.73	15.06			
Observations	46	46	46	46	46	46
Spline Knots	3	4	5	3	4	5

Notes: Table replicates Table 1 except that log yield residuals are not averaged using actual area but area as given by a restricted cubic spline with 3 knots (same trend used in the derivation of the yield shocks). Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A4: Supply and Demand Elasticity - Separating Shocks in US from Rest of World (FAO Data)

	Instrumental Variables			**Three Stage Least Squares**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
Panel A: Supply Equation						
Supply Elast. β_s	0.107***	0.089***	0.083***	0.112***	0.105***	0.091***
	(0.022)	(0.025)	(0.020)	(0.019)	(0.020)	(0.018)
Shock $\omega_{t,US}$	1.481***	1.383***	1.374***	1.342***	1.429***	1.396***
	(0.145)	(0.167)	(0.130)	(0.111)	(0.123)	(0.108)
Shock $\omega_{t,RW}$	0.922***	1.007***	0.995***	0.973***	1.040***	1.018***
	(0.155)	(0.133)	(0.105)	(0.143)	(0.132)	(0.119)
First Stage $\omega_{t-1,US}$	-2.619**	-4.218***	-4.086***	-3.163***	-3.660***	-3.610***
	(1.244)	(1.107)	(1.064)	(1.159)	(1.062)	(1.084)
First Stage $\omega_{t-1,RW}$	-4.935***	-3.033*	-3.551**	-3.570***	-2.544**	-2.753**
	(1.610)	(1.587)	(1.498)	(1.171)	(1.098)	(1.133)
First Stage $\omega_{t,US}$	-1.157	-2.751	-2.549	-1.629	-2.770**	-2.659**
	(2.518)	(2.239)	(2.223)	(1.355)	(1.207)	(1.218)
First Stage $\omega_{t,RW}$	-4.234***	-1.918	-2.258*	-4.346***	-2.025	-2.386*
	(1.513)	(1.235)	(1.240)	(1.331)	(1.260)	(1.259)
Panel B: Demand Equation						
Demand Elast. β_d	-0.021	-0.053**	-0.053**	0.003	-0.049**	-0.051***
	(0.020)	(0.022)	(0.021)	(0.017)	(0.019)	(0.017)
First Stage $\omega_{t,US}$	-4.696**	-5.855***	-5.871***	-5.517***	-5.787***	-5.741***
	(1.915)	(1.460)	(1.366)	(1.939)	(1.625)	(1.569)
First Stage $\omega_{t,RW}$	-6.438***	-3.248*	-3.498*	-6.305***	-3.707**	-3.897**
	(1.821)	(1.896)	(1.879)	(1.952)	(1.658)	(1.558)
Panel C: Effect of Demand Shift						
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	7.84	7.07	7.39	9.14	6.50	7.05
Exp. Mult. (s.e.)	8.35	7.44	7.78	9.62	6.71	7.28
(95% Conf. Int.)	(5.3,14.7)	(4.8,13.3)	(5.2,12.6)	(6.5,15.5)	(4.9,9.8)	(5.3,10.6)
Panel D: P-value on Equal Coefficients						
$S_{\text{1st-stage}}$ ω_{t-1} equal	0.20	0.56	0.77	0.81	0.50	0.61
$D_{\text{1st-stage}}$ ω_t equal	0.42	0.24	0.27	0.77	0.36	0.38
$F_{\text{1st-stage}}$ Supply	5.74	9.73	10.19			
$F_{\text{1st-stage}}$ Demand	7.17	8.57	9.92			
Observations	46	46	46	46	46	46
Spline Knots	3	4	5	3	4	5

Notes: Table list all coefficient estimates of Table 5 in the main paper. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A5: Supply and Demand Elasticity - Separating Shocks of Four Crops (FAO Data)

	Instrumental Variables			**Three Stage Least Squares**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
			Panel A: Supply Equation			
Supply Elast. β_s	0.113***	0.099***	0.086***	0.118***	0.109***	0.094***
	(0.023)	(0.023)	(0.017)	(0.020)	(0.020)	(0.018)
Shock $\omega_{t,M}$	1.787***	1.685***	1.539***	1.541***	1.686***	1.542***
	(0.188)	(0.192)	(0.158)	(0.162)	(0.167)	(0.158)
Shock $\omega_{t,R}$	1.022***	1.415***	0.996***	1.130***	1.454***	1.042***
	(0.348)	(0.321)	(0.286)	(0.285)	(0.284)	(0.273)
Shock $\omega_{t,S}$	-0.210	-0.060	0.702	0.308	0.027	0.721
	(0.724)	(0.640)	(0.569)	(0.543)	(0.545)	(0.557)
Shock $\omega_{t,W}$	0.982***	0.934***	0.976***	0.990***	0.991***	1.012***
	(0.173)	(0.156)	(0.151)	(0.179)	(0.176)	(0.163)
First Stage $\omega_{t-1,M}$	-0.831	-1.834	-0.617	0.205	-0.125	0.232
	(1.527)	(1.475)	(1.530)	(1.502)	(1.497)	(1.637)
First Stage $\omega_{t-1,R}$	-6.933*	-4.790	-4.605	-4.411*	-2.517	-2.845
	(3.420)	(3.601)	(3.846)	(2.560)	(2.630)	(2.630)
First Stage $\omega_{t-1,S}$	-10.736**	-7.811	-12.694**	-10.104*	-8.342	-10.037*
	(5.144)	(5.176)	(6.072)	(5.236)	(5.137)	(5.895)
First Stage $\omega_{t-1,W}$	-3.963**	-3.963**	-5.112***	-4.397***	-4.563***	-5.142***
	(1.909)	(1.817)	(1.612)	(1.385)	(1.303)	(1.430)
First Stage $\omega_{t,M}$	0.036	-0.702	0.253	1.406	-0.557	0.420
	(2.179)	(2.431)	(2.347)	(1.737)	(1.757)	(1.799)
First Stage $\omega_{t,R}$	-7.072	-4.633	-3.812	-8.486***	-5.447*	-4.218
	(4.282)	(4.085)	(4.203)	(2.613)	(2.919)	(2.962)
First Stage $\omega_{t,S}$	-3.799	-1.761	-6.580	-5.725	-1.177	-5.796
	(6.328)	(6.396)	(8.848)	(5.574)	(5.611)	(6.263)
First Stage $\omega_{t,W}$	-3.752**	-3.782***	-4.802***	-4.459***	-4.636***	-5.465***
	(1.499)	(1.339)	(1.711)	(1.664)	(1.630)	(1.699)
			Panel B: Demand Equation			
Demand Elast. β_d	0.000	-0.062***	-0.056***	0.009	-0.067***	-0.061***
	(0.019)	(0.024)	(0.021)	(0.015)	(0.019)	(0.017)
First Stage $\omega_{t,M}$	-4.506**	-6.910***	-6.763**	-5.098*	-7.601***	-7.063***
	(2.054)	(2.475)	(2.824)	(2.757)	(2.259)	(2.328)
First Stage $\omega_{t,R}$	-14.164***	-5.859	-5.822	-14.012***	-7.823**	-5.706
	(3.042)	(4.141)	(4.439)	(3.483)	(3.345)	(3.498)
First Stage $\omega_{t,S}$	-5.574	0.661	0.098	-4.367	8.889	4.427
	(8.268)	(9.669)	(12.006)	(9.177)	(6.742)	(7.585)
First Stage $\omega_{t,W}$	-3.559	-2.768	-3.069	-3.601	-2.166	-2.954
	(2.613)	(2.457)	(2.247)	(2.498)	(1.835)	(1.903)
			Panel C: Effect of Demand Shift			
Multiplier $\frac{1}{\beta_s - \beta_d}$	8.88	6.21	7.05	9.23	5.66	6.45
Exp. Mult. (s.e.)	9.71	6.51	7.33	9.74	5.80	6.62
(95% Conf. Int.)	(5.9,18.4)	(4.4,10.4)	(5.1,11.2)	(6.5,15.9)	(4.4,8.0)	(5.0,9.3)
			Panel D: P-value on Equal Coefficients			
$S_{\text{1st-stage}}$ ω_{t-1} equal	0.16	0.70	0.20	0.10	0.25	0.19
$D_{\text{1st-stage}}$ ω_t equal	0.01	0.70	0.77	0.08	0.10	0.59
$F_{\text{1st-stage}}$ Supply	4.44	4.56	5.79			
$F_{\text{1st-stage}}$ Demand	7.75	4.69	4.76			
Observations	46	46	46	46	46	46
Spline Knots	3	4	5	3	4	5

Notes: Table replicates Table 1 except that it includes separate shocks for each of the four crops: maize (M), rice (R), soybeans (S), and wheat (W). Shocks are normalized by the predicted fraction of global production to make them comparable. Panel D presents p-values from tests whether the coefficients on the shocks used as instruments are jointly the same. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A6: Supply and Demand Elasticity - Two Crop System (FAO Data)

	Unrestricted 2x2 System				**2x2 System with Symmetry Imposed**			
	Log Maize (1a)	**Log Other** (1b)	**Log Maize** (2a)	**Log Other** (2b)	**Log Maize** (3a)	**Log Other** (3b)	**Log Maize** (4a)	**Log Other** (4b)
	Panel A: Supply System							
Log Maize Price	0.086	-0.024	0.085	0.002	0.136*	-0.001	0.106	0.006
	(0.118)	(0.078)	(0.141)	(0.090)	(0.070)	(0.047)	(0.081)	(0.058)
Log Other Price	0.040	0.105*	0.024	0.068	-0.001	0.088**	0.006	0.064
	(0.088)	(0.058)	(0.109)	(0.070)	(0.047)	(0.036)	(0.058)	(0.046)
	Panel B: Demand System							
Log Maize Price	-0.271**	0.221*	-0.164	0.111	-0.269***	0.240**	-0.158**	0.134
	(0.123)	(0.124)	(0.120)	(0.101)	(0.099)	(0.102)	(0.078)	(0.086)
Log Other Price	0.248*	-0.336**	0.146	-0.244**	0.240**	-0.361***	0.134	-0.274***
	(0.136)	(0.132)	(0.139)	(0.119)	(0.102)	(0.113)	(0.086)	(0.104)
	Panel C: Effect of Maize Demand Shift							
Multiplier	4.14	2.31	4.82	1.67	3.63	1.95	4.64	1.76
Exp. Multiplier	4.58	2.57	3.12	0.95	4.08	1.90	3.22	2.15
(95% Conf. Int.)	(1.7,15.6)	(-1.0,9.1)	(-23.6,36.8)	(-12.1,17.1)	(2.6,7.1)	(0.5,3.6)	(2.6,16.1)	(-3.4,5.2)
P-val (symmetry)	0.870	.	0.964	.	.	.	.	.
Observations	46	46	46	46	46	46	46	46
Spline Knots	4	4	5	5	4	4	5	5

Notes: Table replicates Table 7 using restricted cubic splines with both 4 as well as 5 knots to model the time trend. The multiplier gives the price increase for a 1% outward shift in demand for maize, while baseline results give the multiplier on aggregate demand for maize, rice, soybeans, and wheat. To make the multiplier comparable to the pooled analysis, we derive the production-weighted average multiplier of all commodities, which are 8.37, 7.88, 7.21, and 7.86, respectively, in the four 2x2 systems. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A7: Supply and Demand Elasticity - Four Crop System (FAO Data)

	Unrestricted System				**Symmetry Imposed**			
	Log Maize (1a)	**Log Rice** (1b)	**Log Soybeans** (1c)	**Log Wheat** (1d)	**Log Maize** (2a)	**Log Rice** (2b)	**Log Soybeans** (2c)	**Log Wheat** (2d)
Panel A: Supply System								
Log Maize Price	0.196	0.016	-0.588***	-0.089	0.232**	0.026	-0.224***	0.031
	(0.231)	(0.051)	(0.185)	(0.240)	(0.101)	(0.047)	(0.085)	(0.072)
Log Rice Price	-0.121	0.019	-0.121	0.220	0.026	0.000	-0.054	0.081*
	(0.297)	(0.066)	(0.243)	(0.310)	(0.047)	(0.059)	(0.067)	(0.046)
Log Soybeans Price	-0.121	0.017	0.530*	-0.085	-0.224***	-0.054	0.549***	-0.035
	(0.351)	(0.077)	(0.278)	(0.362)	(0.085)	(0.067)	(0.143)	(0.086)
Log Wheat Price	0.100	0.022	0.297	0.029	0.031	0.081*	-0.035	0.015
	(0.250)	(0.055)	(0.195)	(0.257)	(0.072)	(0.046)	(0.086)	(0.082)
Panel B: Demand System								
Log Maize Price	-0.356***	0.203***	-0.414***	0.038	-0.117**	0.150***	-0.060	0.039
	(0.084)	(0.045)	(0.119)	(0.080)	(0.051)	(0.030)	(0.047)	(0.039)
Log Rice Price	0.334***	-0.100***	0.184**	0.007	0.150***	-0.103***	-0.058*	-0.069**
	(0.057)	(0.032)	(0.086)	(0.057)	(0.030)	(0.028)	(0.033)	(0.031)
Log Soybeans Price	0.241***	-0.127***	0.506***	-0.028	-0.060	-0.058*	0.172**	-0.023
	(0.092)	(0.049)	(0.125)	(0.085)	(0.047)	(0.033)	(0.068)	(0.052)
Log Wheat Price	-0.171**	-0.057	-0.169	-0.135*	0.039	-0.069**	-0.023	-0.089
	(0.084)	(0.044)	(0.113)	(0.076)	(0.039)	(0.031)	(0.052)	(0.059)
Panel C: Effect of Maize Demand Shift								
Multiplier	3.43	1.20	2.41	1.94	2.68	-2.46	1.32	3.87
Exp. Multiplier	1.15	0.73	0.24	0.89	3.45	1.08	0.95	2.19
(95% Conf. Int.)	(-10.0,14.8)	(-8.1,10.7)	(-11.3,13.2)	(-6.0,10.1)	(-6.1,12.9)	(-18.3,16.3)	(-6.6,9.8)	(-9.5,15.1)
P-val (symmetry)	0.025	.	.	.	.	.	.	.
Observations	46	46	46	46	46	46	46	46
Spline Knots	5	5	5	5				

Notes: Table replicates Table 8 except that it uses FAO data instead of FAS data. The multiplier gives the price increase for a 1% outward shift in demand for maize, while baseline results give the multiplier on aggregate demand for maize, rice, soybeans, and wheat. To make the multiplier comparable to the pooled analysis, we derive the production-weighted average multiplier of all commodities, which is 6.63 in the unrestricted system and 4.26 if we impose symmetry. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

A4 FAS Data

Results in the main paper used data from FAO. This section replicates the analysis using a different data set from the Foreign Agricultural Service of USDA. Each data set has advantages: On the one hand data from FAO gives production estimates for the entire world, while FAS only covers the biggest countries. Figure A11 shows total production for FAO in the top left column and for FAS in the top right column, which is lower as several countries are missing in the latter database. On the other hand, data for FAS is available until 2010, i.e., including the recent run-up in prices.

The advantage of the FAS data is the longer temporal coverage. The disadvantage of the FAS data is the smaller spatial coverage. Yield shocks for the biggest producers will still be a valid instrument. The larger concern relates to derived consumption quantities, which depend on changes in inventory levels for the largest producers, which are an incomplete proxy for overall changes.

The main paper relies on FAO data except for the four-crop system that has so many parameters that any additional data point (year) seems important. This section replicates Tables of the main paper and generally finds similar results using FAO or FAS data.

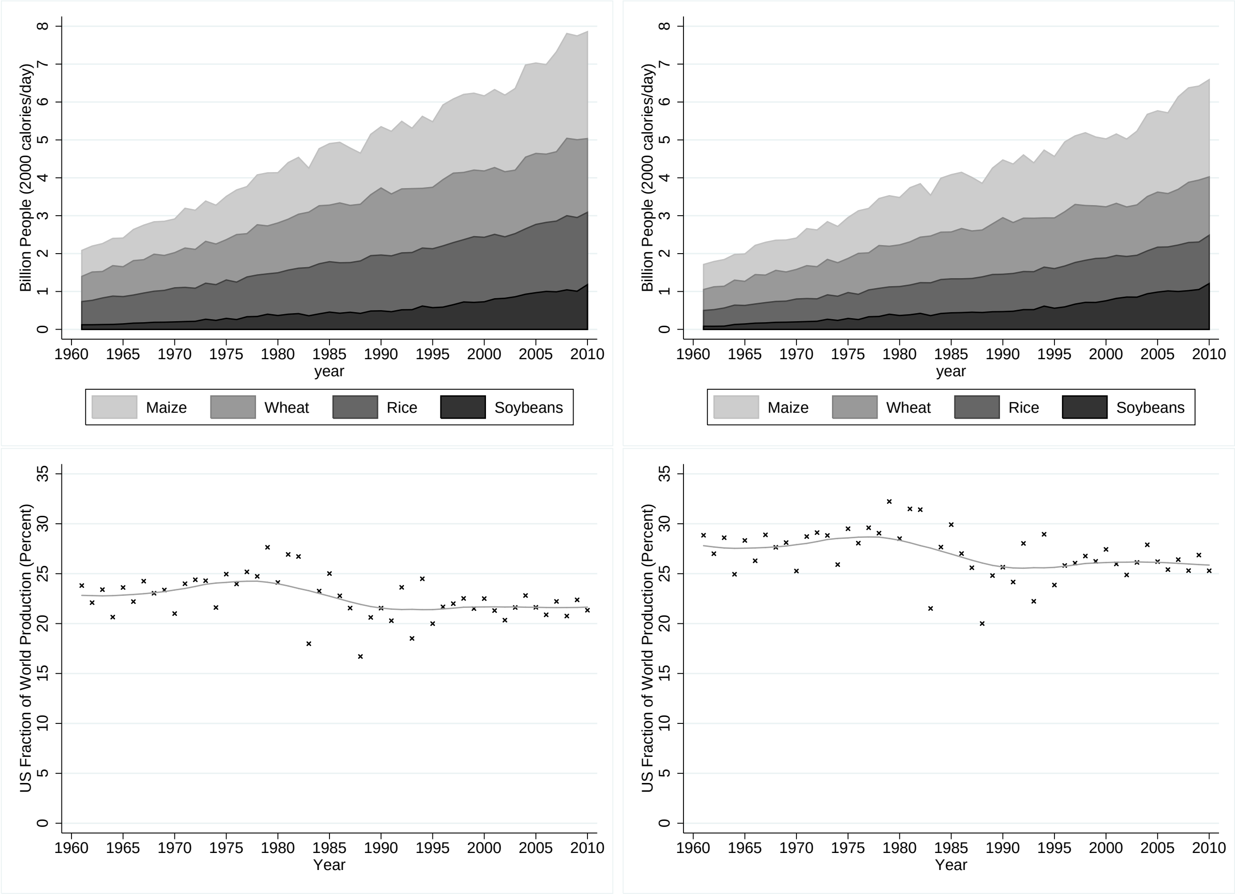
The baseline supply and demand elasticity for calories (Table 1 in the main paper using FAO data) is replicated in Table A8 using FAS data.

Table 2 in the main paper used weather shocks instead of yield shocks as instruments. Table A9 replicates the analysis using FAS data.

Table 7 in the main paper estimated a two-crop system splitting crops into maize as well as the sum of the other three: rice, soybeans and wheat. Table A10 replicates this analysis using FAS data and presents results using both 4 and 5 spline knots to capture overall time trends.

Finally, Table A11 presents the results when we separate yield shocks of each of the four commodities are included. The coefficients are not significantly different from another (see Panel D) except when the time trend is modeled with only three spline knots.

Figure A11: World Production of Calories (FAO and FAS Data)



Notes: Figure displays world production of calories from maize, wheat, rice, and soybeans for 1961-2010 (top row) and the fraction of calories produced in the US (bottom row). The left column uses FAO data, and the right column uses FAS data. The y-axis in the top row gives the number of people who could be fed on a 2000 calories/day diet if they hypothetically only consumed the four commodities. In the bottom row, the y-axis is the percent of global production.

Table A8: Supply and Demand Elasticity (FAS Data)

	Instrumental Variables			**Three Stage Least Squares**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
	Panel A: Supply Equation					
Supply Elast. β_s	0.129***	0.103***	0.106***	0.119***	0.111***	0.112***
	(0.032)	(0.034)	(0.032)	(0.022)	(0.026)	(0.026)
Shock ω_t	1.148***	1.195***	1.186***	1.114***	1.209***	1.197***
	(0.166)	(0.131)	(0.126)	(0.114)	(0.096)	(0.096)
First Stage ω_{t-1}	-3.399***	-2.645***	-2.709***	-2.802***	-2.535***	-2.595***
	(1.159)	(0.921)	(0.948)	(0.840)	(0.776)	(0.776)
First Stage ω_t	-2.480	-1.557	-1.627	-2.578**	-1.557*	-1.630*
	(1.628)	(1.199)	(1.239)	(1.121)	(0.888)	(0.880)
	Panel B: Demand Equation					
Demand Elast. β_d	-0.034	-0.093**	-0.087**	-0.031	-0.094**	-0.088**
	(0.034)	(0.038)	(0.038)	(0.037)	(0.043)	(0.039)
First Stage ω_t	-4.642***	-3.489***	-3.532***	-4.709***	-3.464***	-3.512***
	(1.415)	(1.170)	(1.178)	(1.356)	(1.106)	(1.080)
	Panel C: Effect of Demand Shift					
Multiplier $\frac{1}{\widehat{\beta_s - \beta_d}}$	6.15	5.12	5.18	6.69	4.89	5.00
Exp. Multiplier	6.96	3.95	5.65	7.20	5.25	5.32
(95% Conf. Int.)	(3.9,14.2)	(3.4,10.6)	(3.4,10.5)	(4.5,12.9)	(3.3,9.2)	(3.5,9.0)
$F_{\text{1st-stage}}$ Supply	8.60	8.25	8.17			
$F_{\text{1st-stage}}$ Demand	10.76	8.89	9.00			
Observations	49	49	49	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates Table 1 except that it uses FAS data instead of FAO data, which runs through 2010. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A9: Supply and Demand Elasticity - Weather as Instrument (FAS Data)

	(1a) **log Q**	(1b) **log P**	(2a) **log Q**	(2b) **log P**	(3a) **log Q**	(3b) **log P**
			Panel A: Supply Equation			
Supply Elast. β_s	0.092*		0.086		0.086	
	(0.048)		(0.059)		(0.057)	
Temperature T_{t-1}		3.443***		3.147***		3.149***
		(0.847)		(0.728)		(0.762)
Temperature T_{t-1}^2		-0.090***		-0.082***		-0.082***
		(0.021)		(0.018)		(0.019)
Precipitation P_{t-1}		2.432		2.823		2.996
		(2.239)		(1.913)		(2.053)
Precipitation P_{t-1}^2		0.599		-0.150		-0.263
		(1.075)		(0.928)		(0.986)
Temperature T_t	0.051	2.039***	0.039	1.617**	0.011	1.564**
	(0.201)	(0.750)	(0.222)	(0.692)	(0.218)	(0.717)
Temperature T_t^2	-0.002	-0.052***	-0.002	-0.041**	-0.001	-0.039**
	(0.005)	(0.019)	(0.006)	(0.018)	(0.006)	(0.018)
Precipitation P_t	0.344	2.367	0.513	2.230	0.644	2.724
	(0.351)	(1.819)	(0.389)	(1.671)	(0.399)	(1.798)
Precipitation P_t^2	-0.381**	-0.546	-0.500***	-0.698	-0.551***	-0.871
	(0.149)	(0.836)	(0.165)	(0.764)	(0.168)	(0.793)
			Panel B: Demand Equation			
Demand Elast. β_d	-0.004		-0.068*		-0.071*	
	(0.029)		(0.036)		(0.037)	
Temperature T_t		1.269		0.819		0.965
		(1.167)		(0.948)		(0.962)
Temperature T_t^2		-0.033		-0.021		-0.025
		(0.029)		(0.023)		(0.024)
Precipitation P_t		0.947		-0.582		-1.231
		(3.198)		(2.584)		(2.649)
Precipitation P_t^2		1.655		1.631		1.839
		(1.455)		(1.176)		(1.192)
			Panel C: Effect of Demand Shift			
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	10.43		6.46		6.36	
Exp. Multiplier	7.38		9.63		7.48	
(95% Conf. Int.)	(4.7,58.9)		(3.5,25.0)		(3.6,23.0)	
Observations	47	47	47	47	47	47
Spline Knots	3	3	4	4	5	5

Notes: Table replicates Table 2 except that it uses FAS data instead of FAO data. The sample runs through 2008 as the weather data set ends in 2008. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A10: Supply and Demand Elasticity - Two Crop System (FAS Data)

	Unrestricted 2x2 System				**2x2 System with Symmetry Imposed**			
	Log Maize (1a)	**Log Other** (1b)	**Log Maize** (2a)	**Log Other** (2b)	**Log Maize** (3a)	**Log Other** (3b)	**Log Maize** (4a)	**Log Other** (4b)
Panel A: Supply System								
Log Maize Price	0.061	-0.046	0.055	-0.054	0.124	-0.013	0.135	-0.020
	(0.123)	(0.069)	(0.132)	(0.074)	(0.089)	(0.056)	(0.092)	(0.060)
Log Other Price	0.044	0.139***	0.051	0.148***	-0.013	0.115**	-0.020	0.125**
	(0.090)	(0.051)	(0.099)	(0.056)	(0.056)	(0.046)	(0.060)	(0.049)
Panel B: Demand System								
Log Maize Price	-0.532**	0.183	-0.444**	0.091	-0.382***	0.369**	-0.315**	0.285*
	(0.226)	(0.162)	(0.225)	(0.136)	(0.132)	(0.164)	(0.123)	(0.153)
Log Other Price	0.610**	-0.363*	0.506*	-0.233	0.369**	-0.617***	0.285*	-0.496**
	(0.288)	(0.207)	(0.290)	(0.176)	(0.164)	(0.216)	(0.153)	(0.205)
Panel C: Effect of Maize Demand Shift								
Multiplier	2.99	1.36	3.06	1.16	3.25	1.69	3.33	1.63
Exp. Multiplier	7.23	3.61	4.02	1.54	3.71	1.81	3.70	1.73
(95% Conf. Int.)	(0.7,13.1)	(-1.8,7.0)	(-4.4,18.1)	(-5.1,9.4)	(2.2,7.5)	(0.6,4.0)	(2.2,8.2)	(-0.0,3.9)
P-val (symmetry)	0.223	.	0.221	.	.	.	.	.
Observations	49	49	49	49	49	49	49	49
Spline Knots	4	4	5	5	4	4	5	5

Notes: Table replicates Table 7 except that it uses FAS data and uses restricted cubic splines with both 4 as well as 5 knots to model the time trend. The multiplier gives the price increase for a 1% outward shift in demand for maize, while baseline results give the multiplier on aggregate demand for maize, rice, soybeans, and wheat. To make the multiplier comparable to the pooled analysis, we derive the production-weighted average multiplier of all commodities, which are 5.48, 5.19, 6.35, and 6.33, respectively, in the four 2x2 systems. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A11: Supply and Demand Elasticity - Separating Shocks of Four Crops (FAS Data)

	Instrumental Variables			**Three Stage Least Squares**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
			Panel A: Supply Equation			
Supply Elast. β_s	0.162***	0.113***	0.112***	0.155***	0.120***	0.118***
	(0.036)	(0.037)	(0.036)	(0.027)	(0.026)	(0.026)
Shock $\omega_{t,M}$	1.474***	1.436***	1.415***	1.136***	1.430***	1.400***
	(0.208)	(0.165)	(0.150)	(0.190)	(0.154)	(0.155)
Shock $\omega_{t,R}$	0.955	1.715***	1.385**	1.129**	1.745***	1.470***
	(0.659)	(0.414)	(0.568)	(0.512)	(0.373)	(0.443)
Shock $\omega_{t,S}$	1.296*	1.309**	1.446***	1.236**	1.313***	1.370***
	(0.743)	(0.523)	(0.462)	(0.555)	(0.440)	(0.448)
Shock $\omega_{t,W}$	1.038***	0.880***	0.879***	0.958***	0.917***	0.910***
	(0.207)	(0.174)	(0.181)	(0.195)	(0.167)	(0.166)
First Stage $\omega_{t-1,M}$	0.047	-0.962	-1.307	1.086	-0.017	-0.197
	(2.026)	(1.676)	(1.732)	(1.424)	(1.483)	(1.574)
First Stage $\omega_{t-1,R}$	-10.353**	-4.151	-4.745	-4.651	0.045	-0.847
	(4.856)	(4.937)	(5.019)	(3.680)	(3.922)	(4.003)
First Stage $\omega_{t-1,S}$	-9.453	-4.586	-2.812	-8.844**	-5.164	-4.086
	(7.901)	(6.833)	(7.472)	(3.981)	(4.128)	(4.495)
First Stage $\omega_{t-1,W}$	-3.097*	-3.431**	-3.466**	-3.377**	-4.131***	-4.258***
	(1.719)	(1.681)	(1.692)	(1.441)	(1.445)	(1.489)
First Stage $\omega_{t,M}$	1.136	0.607	0.573	1.928	0.790	0.802
	(2.801)	(2.508)	(2.468)	(1.910)	(1.744)	(1.764)
First Stage $\omega_{t,R}$	-8.147	-2.644	-3.646	-11.912***	-4.338	-4.129
	(5.688)	(5.946)	(5.825)	(4.074)	(4.215)	(4.717)
First Stage $\omega_{t,S}$	-7.815	-3.904	-3.016	-7.961	-3.658	-3.522
	(8.408)	(6.951)	(6.919)	(4.937)	(4.549)	(4.758)
First Stage $\omega_{t,W}$	-3.090**	-3.437**	-3.406**	-3.868**	-3.987**	-4.143**
	(1.441)	(1.371)	(1.408)	(1.854)	(1.694)	(1.747)
			Panel B: Demand Equation			
Demand Elast. β_d	0.036	-0.096***	-0.082**	0.043**	-0.099***	-0.076***
	(0.029)	(0.037)	(0.035)	(0.019)	(0.029)	(0.026)
First Stage $\omega_{t,M}$	-3.472	-4.896**	-5.204***	-3.374	-4.964***	-5.557***
	(2.264)	(1.978)	(1.914)	(2.396)	(1.646)	(1.771)
First Stage $\omega_{t,R}$	-19.207***	-6.327	-8.208	-19.284***	-6.114*	-5.735
	(3.752)	(4.264)	(5.538)	(4.384)	(3.529)	(4.533)
First Stage $\omega_{t,S}$	-7.708	-1.933	-0.249	-7.711	-3.381	-3.724
	(7.569)	(6.587)	(6.264)	(6.450)	(3.891)	(4.543)
First Stage $\omega_{t,W}$	-2.216	-1.889	-1.841	-2.201	-1.228	-1.486
	(2.077)	(1.950)	(1.871)	(2.256)	(1.353)	(1.503)
			Panel C: Effect of Demand Shift			
Multiplier $\frac{1}{\beta_s-\beta_d}$	7.94	4.78	5.13	8.94	4.58	5.15
Exp. Mult. (s.e.)	9.98	5.16	5.61	9.97	4.73	5.34
(95% Conf. Int.)	(4.5,26.8)	(3.2,9.4)	(3.4,10.4)	(5.9,18.5)	(3.4,6.9)	(3.8,8.0)
			Panel D: P-value on Equal Coefficients			
$S_{\text{1st-stage}}$ ω_{t-1} equal	0.17	0.73	0.70	0.08	0.36	0.45
$D_{\text{1st-stage}}$ ω_t equal	0.00	0.65	0.47	0.01	0.29	0.36
$F_{\text{1st-stage}}$ Supply	2.40	1.72	1.55			
$F_{\text{1st-stage}}$ Demand	9.93	3.15	2.99			
Observations	49	49	49	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates Table A5 except that it uses FAS data. It includes separate shocks for each of the four crops: maize (M), rice (R), soybeans (S), and wheat (W). Shocks are normalized by the predicted fraction of global production to make them comparable. Panel D presents p-values from tests whether the coefficients on the shocks are jointly the same. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

A5 Sensitivity Checks

Table A12 presents two sets of standard errors for the IV regressions: one that is uncorrected as well as one that accounts for heteroscedasticity and serial correlation of unknown form. The estimates are generally similar in the second stage, suggesting that heteroscedasticity and serial correlation are not important in the estimated standard errors of the elasticities of interest. The remainder therefore presents results using three stage least square estimates, which are more efficient.

Table A13 limits the analysis to 1961-2003 or 1961-2005, so the data set stops before the recent run-up in prices and the implementation of the 2007 or 2009 Renewable Fuel standards, but results are similar.

Table A14 varies the timing at which we evaluate futures prices. Final results of a year's production shock are not fully revealed before December. On the other hand, planting decisions for the next year's harvest of winter wheat are made in September in the northern hemisphere. We therefore consider futures prices in September of the previous year (Panel A), or March of the concurrent year (Panel B), because production shocks in the Southern hemisphere are resolved by March of the concurrent year. Panel C again evaluates prices at the end of the year, but uses the spot price in the demand equation instead of the futures price during the month of delivery. Results are similar in all cases.

To check the sensitivity of our estimates to the derivation of yield shocks, Table A15 replicates the analysis using linear time trends, restricted cubic splines with 4 knots (3 variables), or restricted cubic splines with 5 knots (4 variables) in the derivation of the yield shocks. Our baseline specification used 3 spline knots (2 variables). The results are again insensitive to the chosen time trend in the derivation of yield shocks.

Table A16 further examines the derivation of yield shocks. Panel A replicates the analysis by using yield shocks that are *not* jackknifed as in our baseline. Panels B and C allow yields to be autocorrelated, which may arise from technological breakthroughs or if weather has autocorrelation. We fit models up to MA(1) or MA(3), respectively, for each country and crop. For example, in panel C, we fit four models.[A6] The model with the lowest BIC is chosen, and yield deviations are the innovations in a given period, i.e., the new information that has been revealed. Results remain robust.

Table A17 reports results from three further sensitivity checks. Given that prices show a high degree of persistence, we include the second lag of prices in panel A. Log futures prices

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[A6] MA(0), MA(1), MA(2), and MA(3).

for delivery in period t that are traded at the end of $t-1$ are instrumented with the yield shock in ω_{t-1}, while controlling for the second lag of the dependent variable, i.e., log futures prices with a maturity in $t-1$ that are traded in $t-2$. Panel B uses two lagged shocks ω_{t-1} and ω_{t-2} to instrument futures prices. The panel also presents results from overidentification tests as we now include two instruments, but none of them have p-values below 0.40. Panel C rescales the caloric conversion ratios so the average price in 1961-2010 of all four crops equals that of maize.[A7] The original as well as the rescaled price series are shown in Figure A9. We do this as the average price of rice is highest, and shifts in production between crops hence alters the overall price. However, the results are insensitive to this rescaling.

[A7] In other words, the price series of wheat, soybeans and rice are each multiplied by a constant so the average price equals the maize average price.

Table A12: Supply and Demand Elasticity (Standard vs Robust Errors)

	FAO Data			**FAS Data**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
			Panel A: Supply Equation			
Supply Elast. β_s	0.102***	0.096***	0.087***	0.129***	0.103***	0.106***
	[0.024]	[0.023]	[0.019]	[0.033]	[0.032]	[0.031]
	(0.025)	(0.025)	(0.020)	(0.032)	(0.034)	(0.032)
Shock ω_t	1.184***	1.229***	1.211***	1.148***	1.195***	1.186***
	[0.127]	[0.106]	[0.092]	[0.143]	[0.102]	[0.102]
	(0.146)	(0.138)	(0.105)	(0.166)	(0.131)	(0.126)
First Stage ω_{t-1}	-3.901***	-3.628***	-3.824***	-3.399***	-2.645***	-2.709***
	[1.016]	[0.853]	[0.877]	[1.202]	[0.944]	[0.945]
	(1.145)	(0.945)	(0.910)	(1.159)	(0.921)	(0.948)
First Stage ω_t	-2.918***	-2.276**	-2.372**	-2.480**	-1.557	-1.627*
	[1.031]	[0.876]	[0.891]	[1.202]	[0.949]	[0.951]
	(1.647)	(1.294)	(1.279)	(1.628)	(1.199)	(1.239)
			Panel B: Demand Equation			
Demand Elast. β_d	-0.028	-0.055**	-0.054***	-0.034	-0.093**	-0.087**
	[0.024]	[0.022]	[0.020]	[0.040]	[0.043]	[0.039]
	(0.021)	(0.024)	(0.022)	(0.034)	(0.038)	(0.038)
First Stage ω_t	-5.564***	-4.655***	-4.770***	-4.642***	-3.489***	-3.532***
	[1.461]	[1.290]	[1.291]	[1.445]	[1.169]	[1.155]
	(1.489)	(1.300)	(1.249)	(1.415)	(1.170)	(1.178)
			Panel C: Effect of Demand Shift			
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	7.73	6.63	7.06	6.15	5.12	5.18
Exp. Mult. [s.e.]	8.39	6.99	7.38	9.31	5.63	5.66
[95% Conf. Int.]	[5.1,15.8]	[4.7,11.4]	[5.1,11.5]	[3.8,16.0]	[3.3,11.0]	[3.4,10.6]
Exp. Mult. (s.e.)	8.39	7.08	7.42	6.96	3.95	5.65
(95% Conf. Int.)	(5.2,15.3)	(4.6,12.2)	(5.0,12.0)	(3.9,14.2)	(3.4,10.6)	(3.4,10.5)
			Panel D: Test whether ω_t is i.i.d.			
Autocorr. (p-val)	0.303	0.406	0.402	0.523	0.659	0.649
Heterosc. (p-val)	0.724	0.410	0.537	0.766	0.715	0.659
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates IV regressions of Tables 1 and A8 but displays two sets of errors: standard errors in square brackets [] are unadjusted, and standard errors in round brackets () adjust for heteroscedasticity and autocorrelation of an arbitrary form. The first three columns (1a)-(1b) use data from FAO, while columns (2a)-(2c) use data from FAS. Panel D regresses ω_t on the time controls given in the last row and tests whether the residuals exhibit autocorrelation or heteroscedasticity. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels and are based on standard errors in squared brackets: *** : 1%; ** : 5%; * : 10%.

Table A13: Supply and Demand Elasticity - Sensitivity to Years

	FAO Data			**FAS Data**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
	Panel A: Years 1961-2003					
Supply Elast. β_s	0.117^{***}	0.120^{***}	0.097^{***}	0.116^{***}	0.117^{***}	0.109^{***}
	(0.019)	(0.020)	(0.019)	(0.023)	(0.025)	(0.025)
Demand Elast. β_d	-0.041^{*}	-0.056^{**}	-0.076^{***}	-0.052^{*}	-0.082^{**}	-0.081^{***}
	(0.022)	(0.023)	(0.021)	(0.029)	(0.033)	(0.030)
Multiplier $\frac{1}{\widehat{\beta_s-\beta_d}}$	6.33	5.68	5.77	5.93	5.03	5.28
Exp. Multiplier	6.55	5.85	5.93	6.21	5.26	5.50
(95% Conf. Int.)	(4.7,9.7)	(4.3,8.5)	(4.4,8.4)	(4.2,9.8)	(3.6,8.3)	(3.8,8.5)
Observations	42	42	42	42	42	42
Spline Knots	3	4	5	3	4	5
	Panel B: Years 1961-2005					
Supply Elast. β_s	0.116^{***}	0.114^{***}	0.094^{***}	0.117^{***}	0.114^{***}	0.107^{***}
	(0.020)	(0.020)	(0.019)	(0.022)	(0.025)	(0.024)
Demand Elast. β_d	-0.043^{*}	-0.061^{***}	-0.072^{***}	-0.051	-0.086^{***}	-0.082^{***}
	(0.024)	(0.023)	(0.020)	(0.031)	(0.032)	(0.030)
Multiplier $\frac{1}{\widehat{\beta_s-\beta_d}}$	6.29	5.70	6.03	5.93	5.00	5.28
Exp. Multiplier	6.54	5.88	6.21	6.22	5.22	5.50
(95% Conf. Int.)	(4.6,9.9)	(4.3,8.5)	(4.6,8.9)	(4.2,9.9)	(3.6,8.1)	(3.9,8.4)
Observations	44	44	44	44	44	44
Spline Knots	3	4	5	3	4	5
	Panel C: Years 1961-2007 and 1961-2010 (Baseline)					
Supply Elast. β_s	0.116^{***}	0.112^{***}	0.097^{***}	0.119^{***}	0.111^{***}	0.112^{***}
	(0.019)	(0.020)	(0.019)	(0.022)	(0.026)	(0.026)
Demand Elast. β_d	-0.034	-0.062^{***}	-0.066^{***}	-0.031	-0.094^{**}	-0.088^{**}
	(0.023)	(0.022)	(0.021)	(0.037)	(0.043)	(0.039)
Multiplier $\frac{1}{\widehat{\beta_s-\beta_d}}$	6.65	5.75	6.12	6.69	4.89	5.00
Exp. Multiplier	6.90	5.92	6.31	7.20	5.25	5.32
(95% Conf. Int.)	(4.9,10.4)	(4.3,8.5)	(4.6,9.1)	(4.5,12.9)	(3.3,9.2)	(3.5,9.0)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates 3SLS regressions in Table 1 and Table A8 except that different years are used in the regression. The first three columns (1a)-(1b) use data from FAO, while columns (2a)-(2c) use data from FAS. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A14: Supply and Demand Elasticity - Sensitivity to Month of Price

	FAO Data			**FAS Data**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
	Panel A: Supply Price in September of Previous Year					
Supply Elast. β_s	0.110^{***}	0.107^{***}	0.092^{***}	0.113^{***}	0.108^{***}	0.109^{***}
	(0.019)	(0.020)	(0.018)	(0.023)	(0.027)	(0.026)
Demand Elast. β_d	-0.034	-0.062^{***}	-0.066^{***}	-0.031	-0.094^{**}	-0.088^{**}
	(0.023)	(0.022)	(0.021)	(0.037)	(0.043)	(0.039)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.95	5.91	6.33	6.93	4.95	5.09
Exp. Multiplier	7.23	6.10	6.52	7.56	5.32	5.44
(95% Conf. Int.)	(5.1,11.1)	(4.4,8.9)	(4.8,9.4)	(4.6,14.0)	(3.4,9.5)	(3.5,9.3)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5
	Panel B: Supply Price in March					
Supply Elast. β_s	0.125^{***}	0.120^{***}	0.105^{***}	0.127^{***}	0.119^{***}	0.121^{***}
	(0.020)	(0.021)	(0.019)	(0.027)	(0.030)	(0.030)
Demand Elast. β_d	-0.034	-0.062^{***}	-0.066^{***}	-0.031	-0.094^{**}	-0.088^{**}
	(0.023)	(0.022)	(0.021)	(0.037)	(0.043)	(0.039)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.29	5.50	5.84	6.33	4.69	4.79
Exp. Multiplier	6.51	5.66	6.00	6.80	5.13	5.10
(95% Conf. Int.)	(4.7,9.6)	(4.2,8.1)	(4.4,8.5)	(4.3,12.2)	(3.2,8.8)	(3.3,8.7)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5
	Panel C: Spot Price in Demand Equation					
Supply Elast. β_s	0.109^{***}	0.111^{***}	0.096^{***}	0.117^{***}	0.107^{***}	0.112^{***}
	(0.022)	(0.022)	(0.019)	(0.028)	(0.030)	(0.029)
Demand Elast. β_d	-0.059^{**}	-0.088^{***}	-0.094^{***}	-0.043	-0.120^{***}	-0.106^{***}
	(0.024)	(0.021)	(0.018)	(0.035)	(0.038)	(0.035)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	5.97	5.03	5.28	6.27	4.41	4.59
Exp. Multiplier	6.10	5.12	5.37	6.48	4.53	4.72
(95% Conf. Int.)	(4.6,8.4)	(4.0,6.7)	(4.2,7.1)	(4.7,9.5)	(3.3,6.5)	(3.5,6.7)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates 3SLS regressions in Table 1 and Table A8 except for the month at which futures prices are evaluated. The first three columns (1a)-(1b) use data from FAO, while columns (2a)-(2c) use data from FAS. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A15: Supply and Demand Elasticity - Sensitivity to Specification of Yield Trend in Derivation of Yield Shocks

	FAO Data			**FAS Data**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
			Panel A: Linear Yield Trend			
Supply Elast. β_s	0.128^{***}	0.124^{***}	0.094^{***}	0.122^{***}	0.120^{***}	0.116^{***}
	(0.022)	(0.022)	(0.019)	(0.028)	(0.026)	(0.025)
Demand Elast. β_d	-0.033	-0.056^{**}	-0.068^{***}	-0.088	-0.089^{**}	-0.084^{**}
	(0.025)	(0.022)	(0.021)	(0.067)	(0.039)	(0.035)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.22	5.56	6.18	4.77	4.78	4.99
Exp. Multiplier	6.47	5.73	6.37	5.40	5.07	5.25
(95% Conf. Int.)	(4.5,9.9)	(4.2,8.3)	(4.6,9.2)	(2.8,14.6)	(3.3,8.4)	(3.5,8.5)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5
			Panel B: Yield Trend with 4 Spline Knots			
Supply Elast. β_s	0.104^{***}	0.091^{***}	0.092^{***}	0.121^{***}	0.118^{***}	0.118^{***}
	(0.021)	(0.021)	(0.020)	(0.026)	(0.027)	(0.026)
Demand Elast. β_d	-0.059^{**}	-0.081^{***}	-0.073^{***}	-0.082	-0.097^{**}	-0.090^{**}
	(0.027)	(0.025)	(0.022)	(0.061)	(0.041)	(0.038)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.15	5.82	6.06	4.93	4.65	4.80
Exp. Multiplier	6.42	6.04	6.27	5.93	4.96	5.06
(95% Conf. Int.)	(4.4,10.0)	(4.3,9.1)	(4.5,9.3)	(3.0,12.7)	(3.2,8.5)	(3.4,8.3)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5
			Panel C: Yield Trend with 5 Spline Knots			
Supply Elast. β_s	0.100^{***}	0.086^{***}	0.083^{***}	0.080^{**}	0.074^{*}	0.077^{**}
	(0.026)	(0.025)	(0.024)	(0.035)	(0.038)	(0.036)
Demand Elast. β_d	-0.072^{**}	-0.089^{***}	-0.085^{***}	-0.076	-0.107^{**}	-0.100^{**}
	(0.031)	(0.026)	(0.024)	(0.065)	(0.052)	(0.048)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	5.85	5.72	5.93	6.41	5.52	5.63
Exp. Multiplier	6.20	5.99	6.21	9.10	7.44	6.52
(95% Conf. Int.)	(4.1,10.4)	(4.1,9.5)	(4.3,9.8)	(3.2,30.7)	(3.2,17.7)	(3.4,15.9)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates 3SLS regressions in Table 1 and Table A8 except that various time trends are used to derive yield deviations. The first three columns (1a)-(1b) use data from FAO, while columns (2a)-(2c) use data from FAS. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A16: Supply and Demand Elasticity - Sensitivity to Derivation of Yield Shocks

	FAO Data			**FAS Data**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
	Panel A: Residuals (Not Jackknifed)					
Supply Elast. β_s	0.118***	0.113***	0.098***	0.119***	0.110***	0.112***
	(0.019)	(0.020)	(0.018)	(0.022)	(0.026)	(0.025)
Demand Elast. β_d	-0.035	-0.063***	-0.067***	-0.030	-0.096**	-0.090**
	(0.023)	(0.023)	(0.021)	(0.036)	(0.043)	(0.040)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.57	5.69	6.06	6.70	4.86	4.97
Exp. Multiplier	6.82	5.87	6.24	7.16	5.19	5.29
(95% Conf. Int.)	(4.8,10.2)	(4.3,8.5)	(4.6,9.0)	(4.5,12.7)	(3.3,9.2)	(3.4,9.0)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5
	Panel B: Innovations in MA(1) Yield Model					
Supply Elast. β_s	0.117***	0.114***	0.076**	0.135***	0.134***	0.130***
	(0.034)	(0.036)	(0.033)	(0.037)	(0.042)	(0.040)
Demand Elast. β_d	-0.055	-0.064*	-0.086**	-0.093	-0.102*	-0.100*
	(0.046)	(0.036)	(0.036)	(0.088)	(0.058)	(0.054)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	5.83	5.60	6.20	4.38	4.25	4.33
Exp. Multiplier	6.82	6.20	7.03	6.16	5.02	4.52
(95% Conf. Int.)	(3.5,16.2)	(3.6,12.9)	(3.9,15.2)	(2.2,20.9)	(2.6,12.0)	(2.7,11.2)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5
	Panel C: Innovations in MA(3) Yield Model					
Supply Elast. β_s	0.119***	0.118***	0.078**	0.136***	0.136***	0.131***
	(0.036)	(0.037)	(0.034)	(0.041)	(0.043)	(0.040)
Demand Elast. β_d	-0.056	-0.061	-0.082**	-0.102	-0.103*	-0.103*
	(0.054)	(0.038)	(0.038)	(0.097)	(0.059)	(0.056)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	5.71	5.60	6.27	4.19	4.18	4.28
Exp. Multiplier	6.95	5.55	7.21	5.91	5.28	4.79
(95% Conf. Int.)	(3.2,20.2)	(3.5,13.5)	(3.8,16.5)	(1.9,23.8)	(2.5,11.9)	(2.6,11.2)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates 3SLS regressions in Table 1 and Table A8 except that yield deviations are from standard regressions (not jackknifed) or more general MA(1) or MA(3) models. The preferred model is selected using the BIC criteria, and yield residuals are innovations for the model in question. The first three columns (1a)-(1b) use data from FAO, while columns (2a)-(2c) use data from FAS. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

Table A17: Supply and Demand Elasticity - Price Rescale and Lag Structure

	FAO Data			**FAS Data**		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
			Panel A: Include Lagged Prices			
Supply Elast. β_s	0.104^{***}	0.099^{***}	0.100^{***}	0.134^{***}	0.117^{***}	0.121^{***}
	(0.014)	(0.015)	(0.014)	(0.015)	(0.016)	(0.015)
Demand Elast. β_d	-0.039	-0.055^{***}	-0.053^{***}	-0.019	-0.101^{**}	-0.090^{**}
	(0.026)	(0.017)	(0.017)	(0.039)	(0.043)	(0.040)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.97	6.51	6.51	6.57	4.59	4.74
Exp. Multiplier	7.29	6.66	6.63	-4.93	4.82	4.96
(95% Conf. Int.)	(5.0,11.5)	(5.1,9.1)	(5.1,8.9)	(4.2,15.1)	(3.3,7.7)	(3.4,7.8)
Observations	45	45	45	48	48	48
Spline Knots	3	4	5	3	4	5
			Panel B: Two Lags of Shocks in Supply			
Supply Elast. β_s	0.132^{***}	0.127^{***}	0.118^{***}	0.140^{***}	0.127^{***}	0.130^{***}
	(0.018)	(0.021)	(0.018)	(0.020)	(0.026)	(0.025)
Demand Elast. β_d	-0.027	-0.055^{***}	-0.057^{***}	-0.026	-0.063^{**}	-0.063^{**}
	(0.022)	(0.020)	(0.020)	(0.036)	(0.031)	(0.030)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	6.29	5.48	5.73	6.02	5.28	5.18
Exp. Multiplier	6.48	5.63	5.87	6.41	5.58	5.46
(95% Conf. Int.)	(4.7,9.4)	(4.2,7.9)	(4.4,8.2)	(4.2,10.9)	(3.7,9.3)	(3.7,8.8)
Overid. (p-value)	0.553	0.409	0.367	0.833	0.705	0.756
Observations	45	45	45	48	48	48
Spline Knots	3	4	5	3	4	5
			Panel C: Caloric Conversion to Equate Avg. Price			
Supply Elast. β_s	0.113^{***}	0.097^{***}	0.091^{***}	0.124^{***}	0.107^{***}	0.111^{***}
	(0.017)	(0.018)	(0.017)	(0.020)	(0.023)	(0.022)
Demand Elast. β_d	-0.016	-0.069^{***}	-0.067^{***}	0.001	-0.089^{**}	-0.080^{**}
	(0.015)	(0.022)	(0.019)	(0.022)	(0.038)	(0.034)
Multiplier $\frac{1}{\widehat{\beta_s}-\widehat{\beta_d}}$	7.72	6.03	6.32	8.12	5.11	5.25
Exp. Multiplier	7.94	6.21	6.49	8.47	5.41	5.50
(95% Conf. Int.)	(5.9,11.2)	(4.6,8.9)	(4.8,9.2)	(5.9,13.2)	(3.6,8.8)	(3.8,8.7)
Observations	46	46	46	49	49	49
Spline Knots	3	4	5	3	4	5

Notes: Table replicates 3SLS regressions in Table 1 and Table A8 except for caloric conversion factors and how many lags are included. Panel B also includes overidentification tests for the supply equation, which includes two instruments. The first three columns (1a)-(1b) use data from FAO, while columns (2a)-(2c) use data from FAS. Columns (a), (b), and (c) include restricted cubic splines in time with 3, 4, and 5 knots, respectively. Stars indicate significance levels: *** : 1%; ** : 5%; * : 10%.

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