Online Appendix to *Tropical Economics*

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Appendix A Data

ENSO index ENSO variations can be detected using different indices, with the most commonly used being equatorial Pacific sea surface temperature (SST) anomalies. We utilize monthly values of the Kaplan NINO3.4 index which averages SST over the area 5°N - 5°S, 170°W - 120°W (Kaplan et al., 1998). Following Hsiang, Meng and Cane (2011) we construct an annual winter index by averaging months from May to December to capture the months in which ENSO is typically most active.

Global gridded temperature and precipitation data Temperature (in degrees centigrade) and precipitation (in mm per month) variables constructed from monthly gridded global weather data at a 0.5° latitude by 0.5° degree longitude resolution from the Center for Climatic Research at the University of Delaware (Legates and Willmott, 1990a,b). Monthly data was first spatially aggregated from pixel to country-level using cross-sectional crop area weights from Ramankutty et al. (2008). Annual measures constructed by averaging January-December monthly values.

Agricultural outcome variables Country-level cereal yield (in kg/hectare), cereal output (in metric ton) and agricultural-value added (in 2000 USD) was obtained from the World Bank World Development indicators.

References

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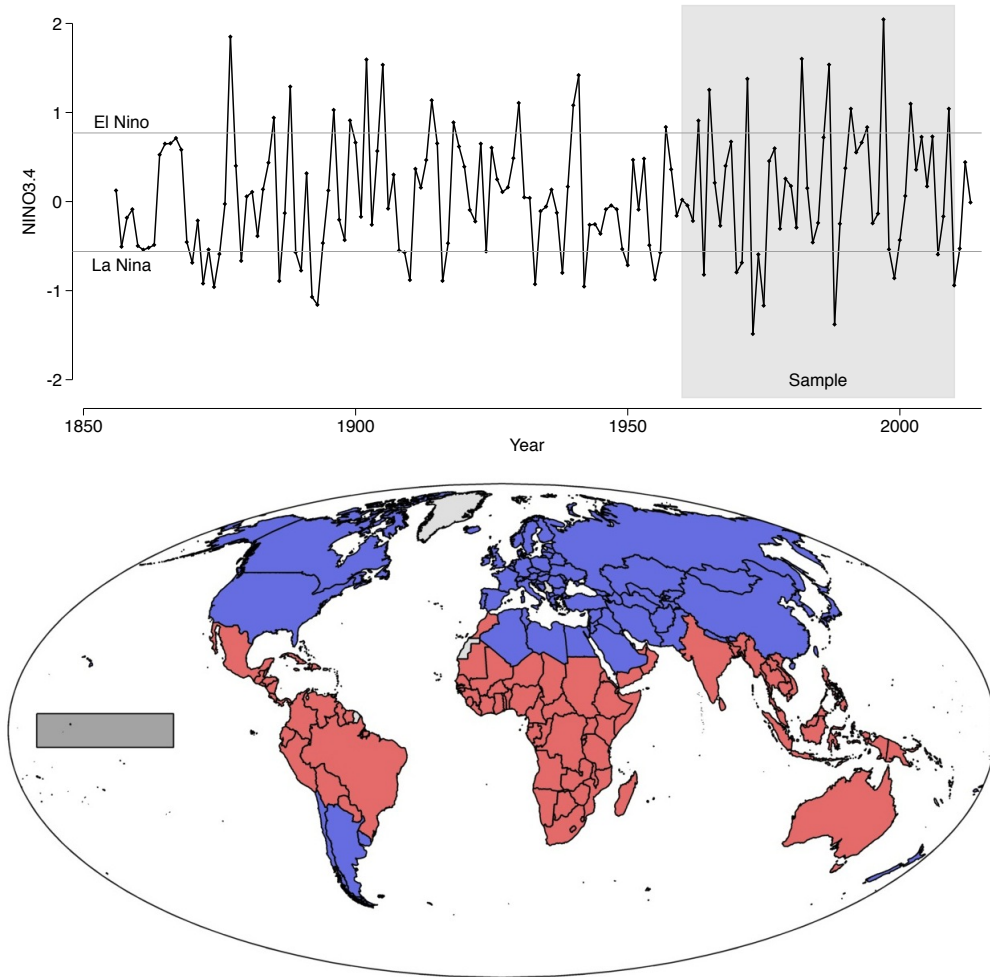
Appendix B   Figures

Figure 1: Top: Annual averaged May-December NINO3.4 index. La Niña years are often defined as ENSO index in 1st quintile. El Niño year are often defined as ENSO index in 5th quintile. Data sample period in shaded area. Bottom: Tropical countries strongly affected by ENSO in "Tropical" sample are red. "Temperate" sample countries are blue. See Hsiang, Meng and Cane (2011) for the method used to identify these two samples. Light gray countries have no population data, which is needed for sample assignment. Dark grey rectangle spanning 5°N-5°S and 170°W-120°W is the NINO3.4 region over which sea surface temperatures are averaged to compute the NINO3.4 index.

Appendix C   Tables

Table 1: ENSO country assignment

ENSO TELECONNECTED TROPICAL COUNTRIES	Angola, Australia, Bangladesh, Belize, Benin, Bolivia, Botswana, Brazil, Brunei Darussalam, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Colombia, Congo, Rep., Costa Rica, Cote d'Ivoire, Cuba, Djibouti, Dominican Republic, Ecuador, El Salvador, Eritrea, Ethiopia, Gabon, Gambia, The, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Honduras, India, Indonesia, Jamaica, Kenya, Lao PDR, Lesotho, Liberia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mexico, Morocco, Mozambique, Namibia, Nicaragua, Niger, Oman, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Sierra Leone, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Tanzania, Thailand, Timor-Leste, Togo, Trinidad and Tobago, Uganda, United Arab Emirates, Venezuela, RB, Vietnam, Yemen, Rep., Zambia, Zimbabwe
ENSO WEAKLY AFFECTED TEMPERATE COUNTRIES	Albania, Algeria, Argentina, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bhutan, Bosnia and Herzegovina, Bulgaria, Canada, Chile, China, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Arab Rep., Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iran, Islamic Rep., Iraq, Ireland, Italy, Japan, Jordan, Kazakhstan, Korea, Rep., Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lithuania, Luxembourg, Macedonia, FYR, Moldova, Mongolia, Nepal, Netherlands, New Zealand, Norway, Pakistan, Poland, Portugal, Romania, Russian Federation, Saudi Arabia, Slovak Republic, Slovenia, Solomon Islands, Spain, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tunisia, Turkey, Turkmenistan, Ukraine, United Kingdom, United States, Uruguay, Uzbekistan.

Notes: ENSO country partition using method based on correlation between local temperature and ENSO index. See Hsiang, Meng, and Cane (2011) for details.

Table 2: ENSO effects by region: contempt and lagged effects

Outcome	Temp		Precip		log yield		log output		log ag value added	
Sample	Tropics	Temperate	Tropics	Temperate	Tropics	Temperate	Tropics	Temperate	Tropics	Temperate
$ENSO_t$	0.088	-0.094	-3.864	0.405	-0.008	0.014	-0.016	0.022	-0.007	0.01
	[0.011]***	[0.032]***	[0.500]***	[0.376]	[0.005]*	[0.006]**	[0.007]**	[0.008]***	[0.003]**	[0.004]**
$ENSO_{t-1}$	0.186	-0.038	-0.772	0.222	-0.012	0.003	-0.019	0.002	-0.011	0.007
	[0.011]***	[0.032]	[0.467]*	[0.405]	[0.005]**	[0.006]	[0.008]**	[0.008]	[0.003]***	[0.004]*
$ENSO_t+ENSO_{t-1}$	0.274	-0.132	-4.636	0.627	-0.020	0.017	-0.035	0.024	-0.018	0.016
	[0.017]***	[0.054]**	[0.720]***	[0.579]	[0.008]***	[0.010]*	[0.012]***	[0.013]*	[0.005]***	[0.006]***
Observations	2769	2,043	2,756	2,043	2,756	2,043	2756	2043	2756	2043
No. of countries	78	69	78	69	78	69	78	69	78	69

Notes: Each column estimated from a separate country-level panel data model with country fixed effects and country-specific trends. Sample period is 1961-2009 for all models. Standard errors in brackets are adjusted for spatial (2000km) and serial (5-years) correlation. *** p<0.01, ** p<0.05, * p<0.1

Table 3: ENSO effects by region: standard errors

Outcome	Std. err.		Tropics	Temperate
Temperature (in °C, crop weighted)			0.274	-0.132
	Spatial HAC	Dist=2000 Year=5	[0.017]***	[0.054]**
		Dist=2000 Year=10	[0.016]***	[0.054]**
		Dist=4000 Year=5	[0.020]***	[0.063]**
		Dist=4000 Year=10	[0.020]***	[0.063]**
	Clustering	country	[0.018]***	[0.031]***
		year	[0.032]***	[0.073]*
Precipitation (in mm/month, crop weighted)			-4.636	0.627
	Spatial HAC	Dist=2000 Year=5	[0.720]***	[0.579]
		Dist=2000 Year=10	[0.679]***	[0.556]
		Dist=4000 Year=5	[0.827]***	[0.581]
		Dist=4000 Year=10	[0.791]***	[0.558]
	Clustering	country	[1.018]***	[0.551]
		year	[0.946]***	[0.491]
log cereal yield (in kg/hectare)			-0.020	0.017
	Spatial HAC	Dist=2000 Year=5	[0.008]***	[0.010]*
		Dist=2000 Year=10	[0.008]***	[0.010]*
		Dist=4000 Year=5	[0.008]***	[0.010]*
		Dist=4000 Year=10	[0.008]***	[0.010]*
	Clustering	country	[0.008]***	[0.009]**
		year	[0.007]***	[0.010]*
log cereal output (in metric tons)			-0.035	0.024
	Spatial HAC	Dist=2000 Year=5	[0.012]***	[0.013]*
		Dist=2000 Year=10	[0.011]***	[0.012]**
		Dist=4000 Year=5	[0.012]***	[0.014]*
		Dist=4000 Year=10	[0.012]***	[0.013]*
	Clustering	country	[0.010]***	[0.013]*
		year	[0.013]**	[0.015]
log ag value added (in 2000 USD)			-0.018	0.016
	Spatial HAC	Dist=2000 Year=5	[0.005]***	[0.006]***
		Dist=2000 Year=10	[0.005]***	[0.006]***
		Dist=4000 Year=5	[0.005]***	[0.007]**
		Dist=4000 Year=10	[0.005]***	[0.007]**
	Clustering	country	[0.004]***	[0.006]**
		year	[0.005]***	[0.009]*
Number of countries			78	69

Notes: Each coefficient estimated from a separate country-level panel data model with country fixed effects and country-specific trends. Coefficients captures β in Eq. 1, the combined linear effect of $ENSO_t$ on outcome in year t and in year $t+1$. Sample period is 1961-2009 for all models. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 4: ENSO effects by region: nonlinearity

Outcome	Temp		Precip		log yield		log output		log ag value added	
Sample	Tropics	Temperate	Tropics	Temperate	Tropics	Temperate	Tropics	Temperate	Tropics	Temperate
$\text{ENSO}_t \in [-1.5, -.75)$	-0.314 [0.044]***	0.496 [0.124]***	4.949 [2.076]**	-1.944 [1.682]	-0.021 [0.022]	-0.037 [0.030]	0.028 [0.032]	-0.055 [0.038]	0.036 [0.015]**	-0.0078 [0.019]
$\text{ENSO}_t \in [-.75, -.25)$	-0.095 [0.048]**	0.592 [0.152]***	1.035 [1.948]	2.200 [1.562]	-0.018 [0.021]	-0.016 [0.027]	-0.010 [0.033]	-0.018 [0.034]	0.04 [0.014]***	0.0087 [0.017]
$\text{ENSO}_t \in [-.25, -.25)$	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
$\text{ENSO}_t \in [25, .75)$	0.152 [0.035]***	0.144 [0.118]	-2.606 [1.584]*	1.343 [1.181]	-0.045 [0.017]***	0.012 [0.021]	-0.032 [0.028]	0.026 [0.027]	0.022 [0.010]**	0.041 [0.013]***
$\text{ENSO}_t \in [.75, 1.25)$	0.140 [0.063]**	0.522 [0.187]***	-6.648 [2.555]***	0.711 [2.059]	-0.062 [0.029]**	-0.0005 [0.033]	-0.046 [0.046]	-0.019 [0.045]	-0.021 [0.017]	0.043 [0.023]*
$\text{ENSO}_t \in [1.25, 2.0]$	0.535 [0.056]***	0.230 [0.169]	-8.356 [2.226]***	1.191 [1.830]	-0.062 [0.026]**	0.014 [0.029]	-0.070 [0.038]*	0.033 [0.038]	0.007 [0.016]	0.016 [0.020]
Observations	2769	2,043	2,756	2,043	2,756	2,043	2756	2043	2756	2043
No. of countries	78	69	78	69	78	69	78	69	78	69

Notes: Each column estimated from a separate country-level panel data model with country fixed effects and country-specific trends. Coefficients captures β in Eq. 1, the combined linear effect of ENSO_t in each bin on outcome in year t and in year $t+1$ relative to years when ENSO is in neutral state, $\text{ENSO}_t \in [-.25, .25)$. Sample period is 1961-2009 for all models. Standard errors in brackets are adjusted for spatial (2000km) and serial (5-years) correlation. *** p<0.01, ** p<0.05, * p<0.1