Effects of El Niño Southern Oscillation on World Cereal Production

Nelson Villoria*and David Ubilava‡

August 10, 2012

Poster prepared for presentation at the Agricultural & Applied Economics Associations 2012 AAEA Annual Meeting, Seattle, Washington, August 12-14, 2012.

*Email: nvilloria@purdue.edu. Department of Agricultural Economics, Purdue University

†Email: david.ubilava@sydney.edu.au. Department of Agricultural and Resource Economics, The University of Sydney

Effects of El Niño Southern Oscillation on World Cereal Production

Nelson Villoria[1] and David Ubilava[2]

[1]Department of Agricultural Economics, Purdue University

[2]Department of Agricultural and Resource Economics, The University of Sydney

Motivation

- Unfavorable weather conditions associated with the two ENSO phases, El Niño (warm phase) and La Niña (cold phase) have considerable socio-economic implications in different parts of the world.
- An intriguing feature of the ENSO phenomenon is that it induces correlation in climates around the globe through the so-called teleconnections, nicely illustrated in this figure by Hsiang et al.:

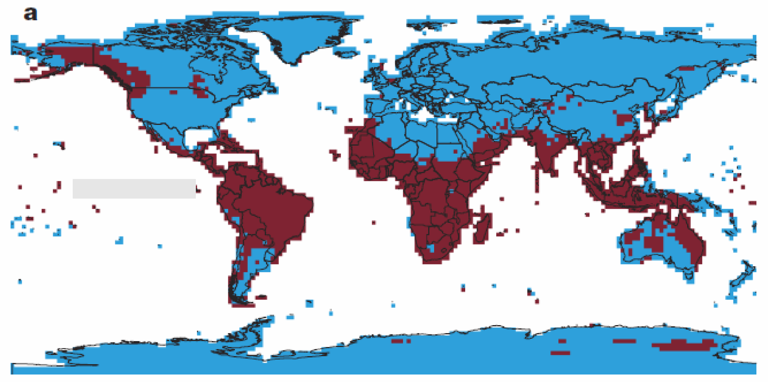


Figure: ENSO Teleconnections. Hsiang et al. assign red to land pixels with changes in temperature that are statistically and significantly correlated with the changes in the Sea Surface Temperature (SST) in the gray rectangle off the cost of Ecuador, where the occurrence of El Niño (SST increases) or La Niña (SST decreases) is first detected.

- Brunner and Ubilava have found that ENSO has a non-trivial role driving world commodity prices, suggesting that ENSO teleconnections induce positive correlation in the supply shocks faced by different parts of the world during the growing-season.
- Such a synchronization challenges the common assumption of independently and identically distributed supply shocks across countries, with implications for trade and spatial price stabilization.

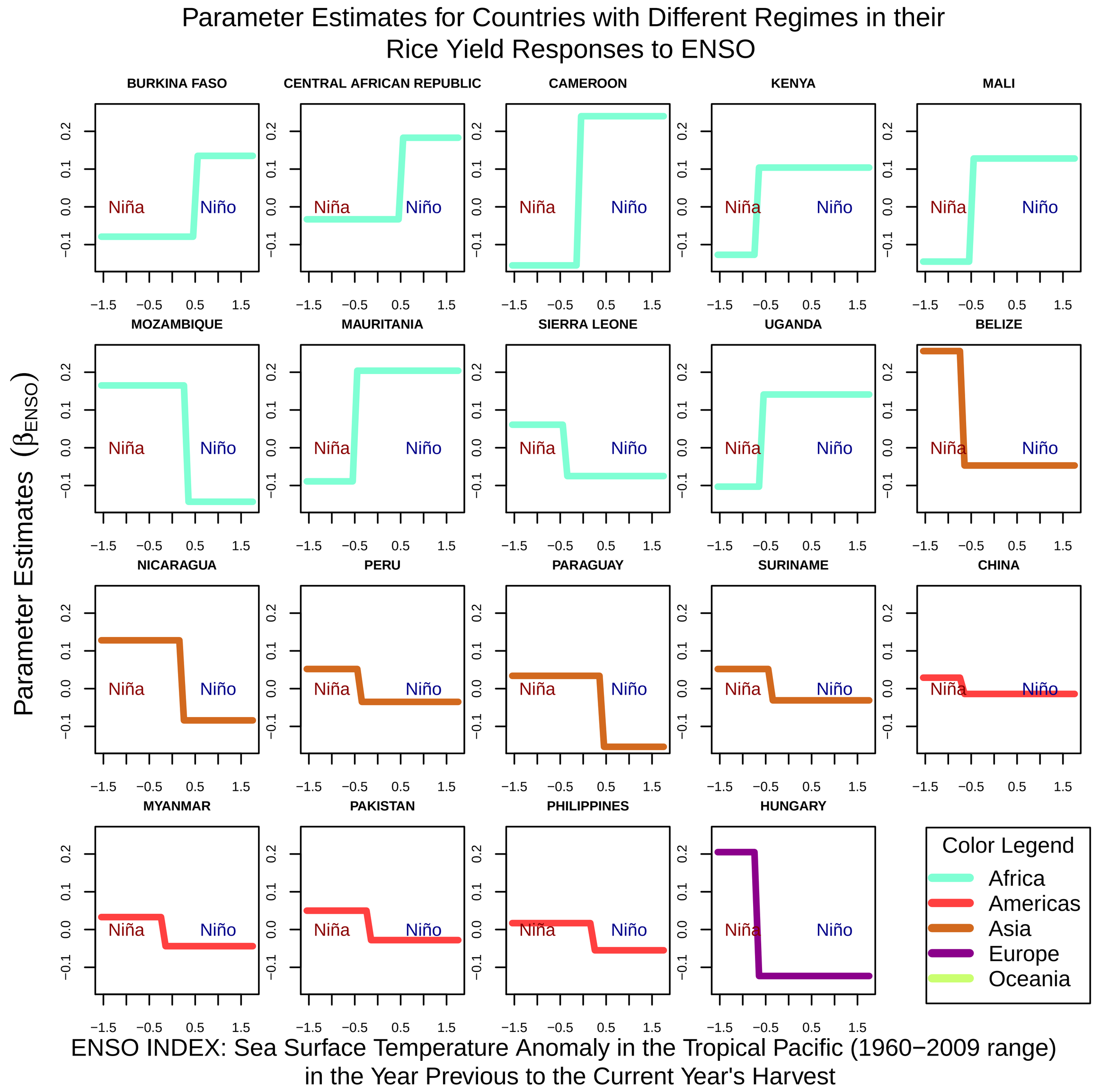
Research Question: Does the ENSO phenomenon synchronize the global harvest of main staples?

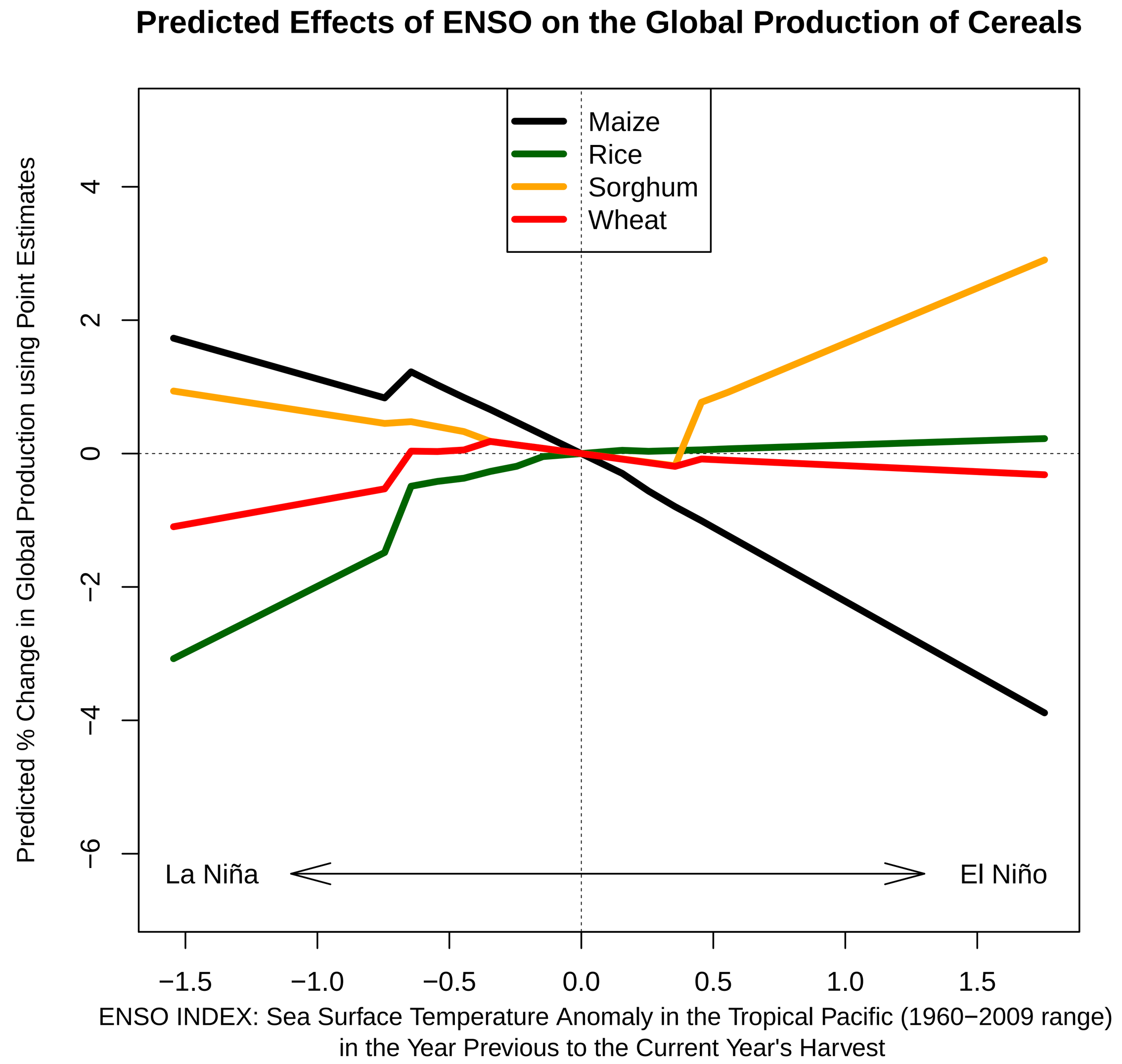
Methods & Data

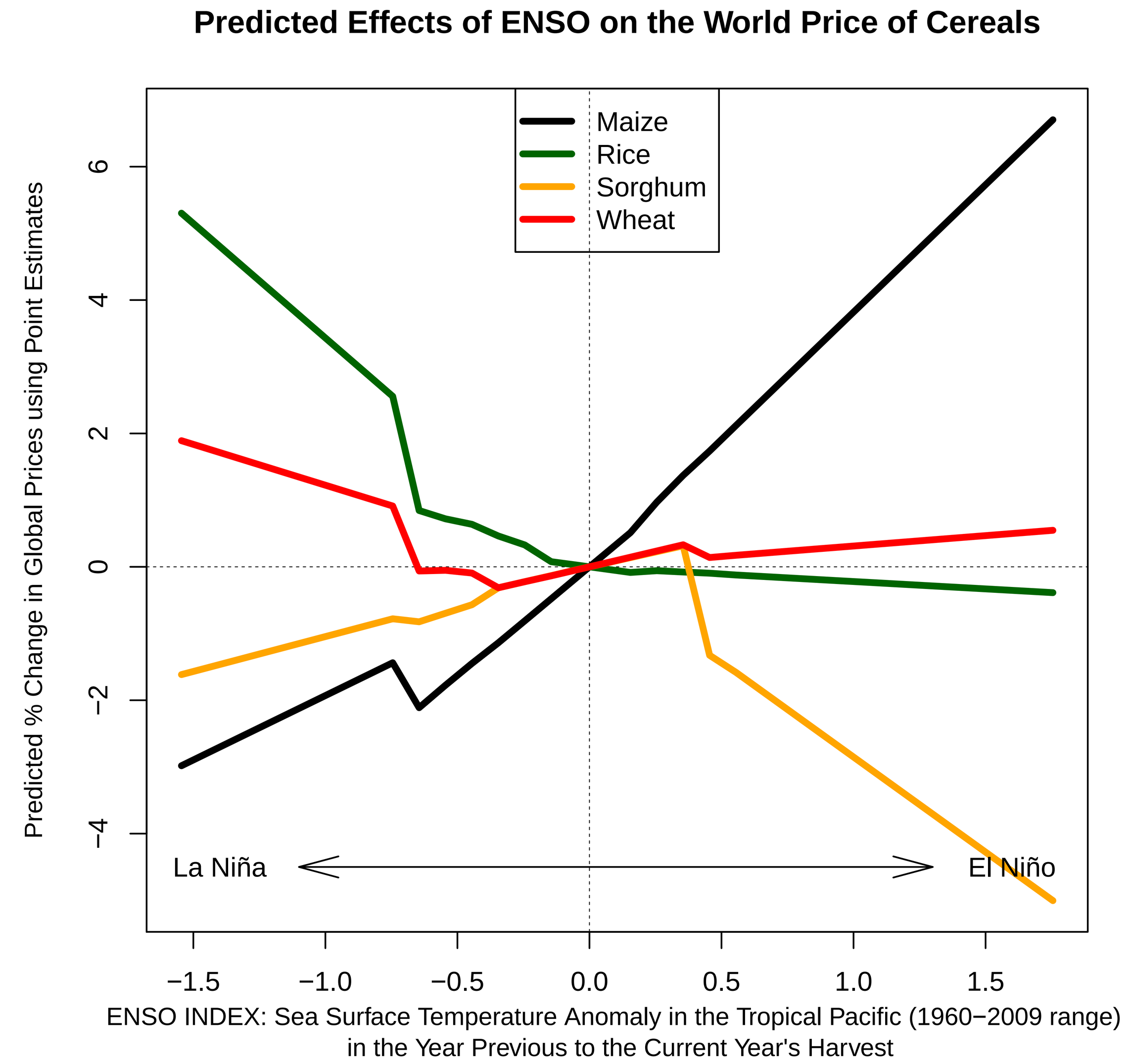
- For the period 1961-2010, we estimate country-level equations relating annual changes in the log of **maize**, **wheat**, **sorghum**, and **rice** yields (FAOSTAT) to changes in SST anomalies (*Niño 3.4* from NOAA) averaged over the period May-December previous to the harvest month in each country.
- We use Hansen's framework which allows for potentially asymmetric effects of La Niña and El Niño on yields.
- We control weather-ENSO interactions by adding country-level growing-season averages of temperature and precipitation (Monthly CRU TS3.1 averaged to crop-specific growing seasons using Sacks et al.'s crop calendars and aggregated to the country level using Monfreda et al.'s harvested areas as weights.)

Results & Discussion

We find evidence of a statistically significant relationship between changes in *Niño 3.4* and the individual yield response of countries comprising 74% of global maize production, 69% in the case of rice, 24% in the case sorghum, and 42% in the case of wheat.







- We also find that non-linear responses are important. For instance, rice yields in most of countries in the figure above (comprising 38% of global rice production) are negatively affected by La Niña and positively affected by El Niño. The only exceptions to this are Mozambique and Sierra Leone in Africa.
- The other two figures provide global output and price metrics derived from our country regressions.
- Predicted changes in aggregated output to shocks equivalent to the observed *Niño 3.4* reveals that maize is the most sensitive crop. A severe Niño could reduce global output by 4%. Meanwhile, a severe Niña could increase global output up to 2%.
- The asymmetries in response are more marked for wheat and and rice which see their output reduce by 1.5% and 3.1% (respectively) under a severe Niña, but seem insensitive to the warm ENSO phase.
- Sorghum provides an interesting case with output increases in both phases of ENSO.
- We translate output changes to price changes using Roberts and Schlenker's supply/demand elasticities. Holding everything else constant, global price effects of these events are relatively large.

Conclusion

The effects of the ENSO induce positive correlation in supply shocks across vast geographic spaces. Our next step is to investigate the consequences of such correlation on the policies used to stabilize prices.

References:

- Brunner, A.D., 2002. El Nio and World Primary Commodity Prices: Warm Water or Hot Air? Review of Economics and Statistics, 84(1), pp.176183.
- Hansen, B.E., 1999. Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of Econometrics, 93(2), pp.345368.
- Hsiang, S.M., Meng, K.C. & Cane, M.A., 2011. Civil conflicts are associated with the global climate. Nature, 476(7361), pp.438441.
- Monfreda, C., Ramankutty, N. & Foley, J.A., 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global Biogeochemical Cycles, p.1:19.
- Roberts, M.J. & Schlenker, W., 2009. World Supply and Demand of Food Commodity Calories. American Journal of Agricultural Economics, 91(5), pp.12351242.
- Sacks, W.J., D. Deryng, J.A. Foley, and N. Ramankutty (2010). Crop planting dates: an analysis of global patterns. Global Ecology and Biogeography 19, 607-620.
- Ubilava, D., 2012. El Niño, La Niña, and world coffee price dynamics. Agricultural Economics, 43(1), pp.17-26.

nvillori@purdue.edu, david.ubilava@sydney.edu.au