

Climatic shocks and Food Security in Developing Countries

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Outline

- Objective & Motivation
- Literature Review
 - Determinants of food security
 - Effects of climatic shocks on Food Security
- Empirical analysis
- Conclusion

Objective

The paper aims:

- To analyze the effects of climatic shocks on food security (Food supply, undernourished population)
- Identify mechanisms
- We use aggregated panel data over 1960-2008 for 77 developing countries
- We apply modern econometric methods

Motivations

- Regain and importance of the climate change debate
- MDGs: (Goal 1: MDG Report(2011), Chen et Ravallion (2010), FAO, (2009a))
- Prev studies (Climate change and Agr) are:
 - theoretical papers (Christensen et al. (2007), Ringler, Zhu, et al.(2010)
 - Few Empirical papers (Lee, Nadolnyak, et Hartarska 2012, von Braun (1991)

- Originality :
 - empirical and macroeconomic: 77 developing countries
 - mechanisms climatic shocks food security
 - Climatic variability data from 2 sources

Literature review (1)

▪ **Determinants of food security**

➤ **Definition of food security (FAO 1996)**

“when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”.

➤ **Microeconomic Causes**

-Low rate of agricultural production (FAO, 2004)

-Low access to food supply

-infrastructures and local markets

-environment health

Literature review (2)

➤ *Macroeconomic Causes*

- Economic performance (Pritchett & Summers, 1996 Wiesmann, 2006)
- Population growth (Birdsall & Sinding (2001)
- Trade policy (Merrick (2002)
- Political institutions (Sen (1999), Sen (2000); Wiesmann (2006))
- **Effects of climatic shocks on Food Security**
- Effect on Agriculture Production (Dorward and Kydd (2002))

Literature review (3)

- Effect on Households incomes (ILO (2007))
- Effect on food prices (food availability and accessibility)
- Effect on economic growth and resources (Dell and al. (2008))
- Effect on the risk of civil conflicts

Empirical analysis (1)

Analyze effects of climatic shocks on food security

Estimation method

$$Y_{i,t} = \alpha_i + \beta CS_{i,t} + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

With X : { income pc, rainfall, pop growth, democratic institutions }, $\varepsilon_{i,t}$ error term, γ_t time effect and α_i country fix-effects.

$Y_{i,t}$: two complem measures food security

Empirical analysis (2)

- Food supply
- Proportion of undernourished population

CS_{it} :rainfall instability

Heterogeneities between CS and food security:

- the impact conditional on the civil conflicts
- climatic vulnerability of countries
- A context of food prices vulnerability

Estimation strategy : OLS, FE and RE

Empirical analysis (3)

Sources

- World Development Indicators (2011): pop growth, income pc, undernourished people
- Democratic institutions (Polity IV (2010)), civil conflicts (M.G. Marshall (2010)), climatic vulnerability (D Wheeler (2011))
- Rainfall volatility (Guillaumont and Simonet (2011)) and food supply (FAOSTAT (2011): wheat, rice, maize, sorghum, soybean, sugar)

Independent variable	Food Supply					
	OLS		FE		RE	
	(1)	(2)	(3)	(4)	(4)	(6)
Volatility	-0.0716*** (-2.749)	-0.0912*** (-3.722)	-0.417*** (-8.506)	-0.365*** (-7.532)	-0.0716** (-2.536)	-0.0912*** (-3.333)
	-0.0764*** (-3.282)	-0.0630*** (-2.909)	-0.417*** (-9.408)	-0.339*** (-7.552)	-0.0764*** (-3.997)	-0.0630*** (-3.304)
Per capita	0.0178*** (3.395)	0.0165*** (3.572)	0.0172*** (5.095)	0.0162*** (4.984)	0.0178*** (5.916)	0.0165*** (5.684)
Population growth	-9.688** (-2.190)	-7.001* (-1.807)	-2.827 (-0.979)	-2.630 (-0.914)	-9.688*** (-3.301)	-7.001** (-2.404)
Political institutions	0.778 (0.862)	0.409 (0.497)	-0.219 (-0.196)	-0.462 (-0.426)	0.778 (0.687)	0.409 (0.378)
	454.0*** (12.87)	414.3*** (11.91)	872.1*** (15.67)	757.5*** (13.28)	454.0*** (15.46)	414.3*** (13.96)
Control dummies	No	Yes	No	Yes	No	Yes
Observations	626	626	626	626	626	626
Clusters	71	71	71	71	71	71
Adjusted R ²			0.216	0.289		

Dependent variable	Food supply				
	(1)	(2)	(3)	(4)	(5)
Rainfall volatility	-0.365*** (-7.532)	-0.336*** (-6.878)	-0.318*** (-6.395)	-0.332*** (-6.695)	-0.361*** (-7.440)
Rainfall	-0.339*** (-7.552)	-0.313*** (-6.943)	-0.296*** (-6.444)	-0.307*** (-6.682)	-0.406*** (-6.006)
Income per capita	0.0162*** (4.984)	0.0160*** (4.981)	0.0159*** (4.942)	0.0168*** (5.188)	0.0162*** (4.979)
Population growth	-2.630 (-0.914)	-2.740 (-0.961)	-1.022 (-0.355)	-2.301 (-0.804)	-2.507 (-0.871)
Democratic institutions	-0.462 (-0.426)	-0.374 (-0.347)	-0.349 (-0.325)	-0.419 (-0.388)	-0.512 (-0.472)
Cereal production land		5.46e-06*** (3.408)			
Agricultural land			2.003*** (3.683)		
Arable land				2.520*** (2.853)	
Rainfall squared					1.73e-05 (1.326)
Intercept	757.5*** (13.28)	694.2*** (11.67)	618.5*** (9.112)	681.6*** (10.88)	802.8*** (12.08)
Observations	626	626	626	626	626
Number of countries	71	71	71	71	71
R-squared	0.289	0.304	0.306	0.300	0.291

Empirical analysis (4)

Rainfall volatility reduces food supply in DC:

Why ?

- High uncertainty agr production & Households incomes
- Low Ec growth & ability to purchase food on international markets (food import)

Results are robust with additional control variables

Empirical analysis (5)

Heterogeneity on the effect of climatic shocks

➤ *The effects of rainfall shocks on food security are different for countries in conflict?*

Civil conflict reduce food supply (through active pop in agr sector)

Table 3: Effects of climatic shocks on food security: the importance of civil conflict

Dependent variable	Food supply		
	(1)	(2)	(3)
Rainfall volatility	-0.365*** (-7.532)	-0.374*** (-7.612)	-0.372*** (-7.583)
Rainfall	-0.339*** (-7.552)	-0.345*** (-7.623)	-0.344*** (-7.618)
Rainfall volatility * Civil conflict			-0.415** (-1.990)
Civil conflict		-34.67*** (-2.804)	-52.29*** (-3.445)
Income per capita	0.0162*** (4.984)	0.0155*** (4.749)	0.0153*** (4.701)
Population growth	-2.630 (-0.914)	-3.484 (-1.200)	-3.626 (-1.252)
Democratic institutions	-0.462 (-0.426)	-0.211 (-0.193)	-0.128 (-0.118)
Intercept	757.5*** (13.28)	768.8*** (13.35)	768.1*** (13.37)
Observations	626	617	617
Number of countries	71	71	71

Empirical analysis (6)

- Effects of climatic shocks on food supply are more severe with civil conflicts.

Empirical analysis (8)

The sec hyp tested is potential effect clim shocks in a context of food prices shocks vulnerability

We construct this variable using the procedure de Janvry and Sadoulet (2008); Combes et al. (2012). Countries are vuln to food price shocks if :

- (1) high food dependency
- (2) a high food import burden
- (3) low income

price shocks

Dependent variable	Food supply			
	(1)	(2)	(3)	(4)
Rainfall volatility	-0.365*** (-7.532)	-0.287*** (-5.278)	-0.210*** (-3.767)	-0.183*** (-3.132)
Price vulnerability		-0.557*** (-6.359)	-0.476*** (-5.426)	-0.467*** (-4.938)
Rainfall volatility * Price vulnerability		-0.000721* (-1.832)	-0.000901** (-2.331)	-0.00107*** (-2.714)
Rainfall	-0.339*** (-7.552)	-0.287*** (-5.974)	-0.222*** (-4.519)	-0.202*** (-3.859)
Food price			0.167*** (4.461)	0.107** (2.128)
Price volatility				0.146 (1.381)
Income per capita	0.0162*** (4.984)	0.00728** (2.134)	0.00480 (1.420)	0.00415 (1.194)
Population growth	-2.630 (-0.914)	-11.15*** (-2.684)	-7.048* (-1.692)	-6.002 (-1.373)
Democratic institutions	-0.462 (-0.426)	-0.984 (-0.891)	-0.746 (-0.690)	-0.290 (-0.269)
Intercept	757.5*** (13.28)	783.1*** (13.21)	667.0*** (10.50)	650.4*** (9.662)
Observations	626	500	500	470
Number of countries	71	69	69	69
R-squared	0.289	0.365	0.394	0.364

Empirical analysis (8)

- Countries that are more vulnerable to food prices shocks are less able to maintain food supply.
- Very little policy space, limited fiscal and administrative capacity

Robustness

- ***Alternative indicators of climatic shocks***
 - Rainfall series from Mitchell et al (2004)
 - Rainfall inst is the abs deviation of the yearly

Empirical analysis (9)

average of rainfall from its own trend (long term mean of rainfall 1960-2008): deterministic trend

Hyp: stochastic trend. We compute and rainfall volatility defined as the 5-year rolling standard deviation of the growth rate of rainfall series

Empirical analysis (10)

- ***Inertia of food supply***: lagged level of food supply) system-GMM estimation (one step and two steps
- ***Complementary indicator of food security***
proportion of undernourished people in the total population

Dependent variable	Percentage of total undernourished population						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Rainfall Volatility	0.0528*** (3.375)	0.0514*** (3.273)	0.0320** (2.124)	0.0354** (2.285)	0.0475*** (3.056)	0.0499*** (2.726)	0.0495*** (2.730)
Rainfall	0.0524*** (3.287)	0.0588*** (3.401)	0.0372** (2.245)	0.0417** (2.453)	0.0567*** (3.326)	0.0492*** (2.603)	0.0483** (2.580)
Income per capita	-0.000172 (-0.327)	-0.000125 (-0.237)	-0.000880* (-1.728)	-0.000689 (-1.323)	-0.000239 (-0.458)	-8.25e-05 (-0.151)	-0.000154 (-0.290)
Population growth	0.611* (1.657)	0.568 (1.528)	0.519 (1.496)	0.707** (1.977)	0.554 (1.514)	0.476 (1.165)	0.519 (1.313)
Democratic institutions	0.105 (0.767)	0.0957 (0.695)	0.0988 (0.769)	0.130 (0.981)	0.0884 (0.652)	0.121 (0.822)	0.0951 (0.665)
Rainfall square		-1.91e-06 (-0.956)	-1.52e-06 (-0.811)	-1.93e-06 (-1.006)	-2.32e-06 (-1.175)		
Agricultural land			-0.607*** (-5.851)				-0.0131 (-1.274)
Arable land				-0.644*** (-4.569)			-38.39* (-1.779)
Cereal production land					-1.09e-06*** (-2.792)		
Food prices						-0.00732 (-1.215)	
Food prices volatility							-0.0131 (-1.274)
Intercept	-41.52** (-2.276)	-45.24** (-2.425)	7.725 (0.393)	-14.55 (-0.762)	-35.93* (-1.923)	-38.02* (-1.753)	-38.39* (-1.779)
Observations	314	314	314	314	314	282	287
Countries	79	79	79	79	79	71	74
R-squared	0.157	0.160	0.271	0.231	0.188	0.378	0.141

Empirical analysis (11)

- Food supply is transmission channel ?

Dependent variable	Percentage of total undernourished population	
	(1)	(2)
Rainfall Volatility	0.0528*** (3.375)	0.0100 (0.581)
Rainfall	0.0524*** (3.287)	0.00561 (0.303)
Income per capita	-0.000172 (-0.327)	0.000889* (1.658)
Population growth	0.611* (1.657)	0.411 (1.158)
Democratic institutions	0.105 (0.767)	0.120 (0.947)
Food supply		-0.0728*** (-7.043)
Intercept		-38.39* (-1.779)
Observations	294	287
Countries	74	74
R-squared	0.152	0.141

Empirical analysis (12)

climatic shocks increase malnutrition through food supply

➤ *Heterogeneity for African countries*

Dependent Variable	Food Supply			
	Developing Countries (1)	(2)	African Countries (3)	(4)
Rainfall volatility	-0.358*** (-7.371)	-0.277*** (-5.048)	-0.554*** (-5.986)	-0.631*** (-4.371)
Price vulnerability		-0.562*** (-6.391)		-0.426*** (-2.919)
Rainfall volatility*Price vulnerability		- 0.000771** (-1.976)		-0.00139* (-1.805)
Rainfall	-0.336*** (-7.410)	-0.284*** (-5.837)	-0.570*** (-7.072)	-0.721*** (-7.199)
Income per capita	0.0162*** (5.004)	0.00713** (2.099)	0.0256*** (3.010)	0.00900 (0.465)
Population growth	-2.396 (-0.813)	-10.85*** (-2.614)	5.322 (1.452)	16.35** (2.467)
Democratic institutions	0.141 (0.134)	0.0768 (0.0728)	-0.00778 (-0.00474)	-0.0403 (-0.0223)
Intercept	754.1*** (13.08)	779.7*** (13.01)	772.9*** (9.689)	952.8*** (10.20)
Observations	626	500	230	164
Number of countries	71	69	25	24
R-squared	0.285	0.362	0.253	0.369

Note: t-statistics are presented in parentheses under the estimated coefficients. ***, ** and * indicate significance of the estimated coefficient at 1, 5 and 10%, respectively. Temporal dummies are included. The study period is 1960-2007.

Conclusion (1)

- Clim shocks have neg effects on food security:
 - They reduce food supply in DC (SSA)
 - Food supply is a channel by which climatic shocks increase undernourished people
 - Neg effects are exacerbated in presence of civil conflicts
 - effects are high for countries that vulnerable to food prices shocks.

Conclusion (2)

- Policies recommendation:
 - One of them is the diversification of economies that are less reliant on agriculture.
 - These countries should adopt agric techniques that optimize water use through increased and improved irrigation systems and crop development.
 - “climatic aid” : government budget or development projects for the regions adversely affected by climatic shocks