UNIVERSITÀ DEGLI STUDI FIRENZE

DISEI
Dipartimento di scienze per l'economia e l'impresa

Modeling Acreage, Production and Yield Supply Response to Domestic Price Volatility

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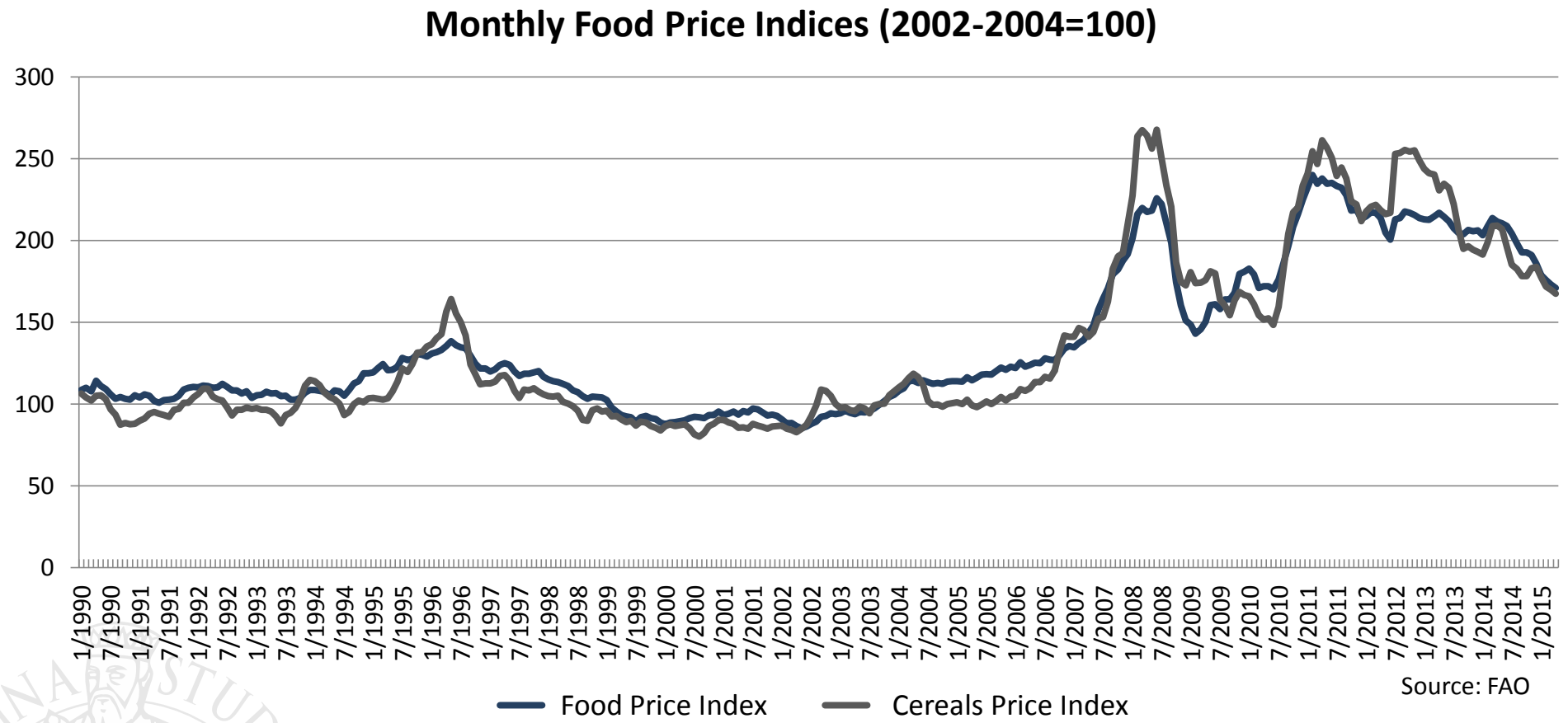
The starting point

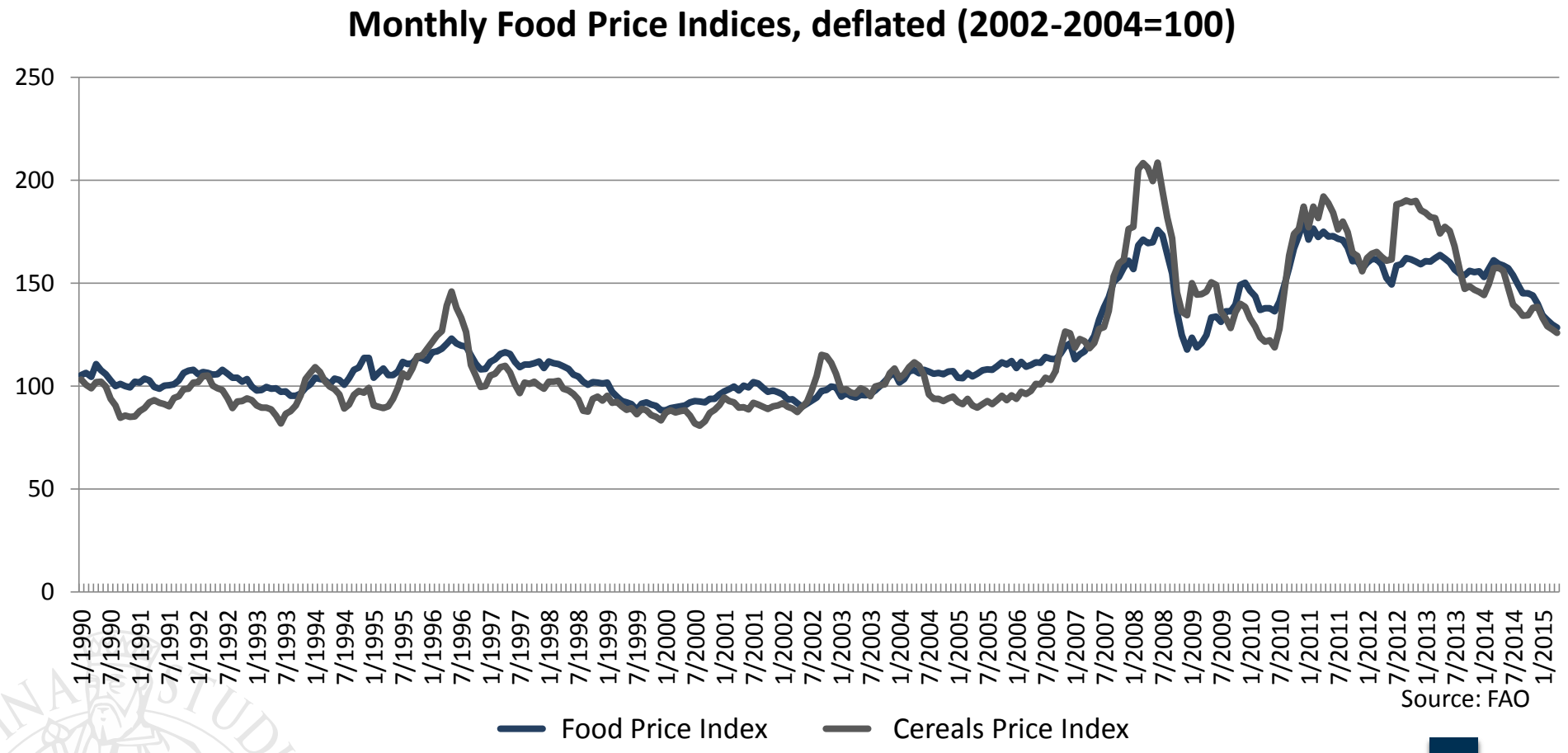
The price crisis: level and volatility



Source: FAO

The starting point

The price crisis: level and volatility



A rapidly increasing literature

- Determinants of price spikes

  Abbott et al. (2009), Piesse and Thirtle (2009), Timmer (2010), Headey and Fan (2010), Gilbert and Morgan (2010), Trostle (2010), Abbott and De Battisti (2011), OECD-FAO (2011), FAO-IMF-UNCTAD (2011)

  - structural factors: supply (productivity slow-down, adverse ToT change) vs. demand (food-feed, food-fuel)
  - non-structural factors: weather, oil spikes, financial crisis, financial speculation, policy response

A rapidly increasing literature

- Impact on the poor and food insecure

  Zezza et al. (2008)

  FAO-WFP-IFAD (2008, 2009)

  - SSA and Asia, poorest, landless, female-headed
  - at least 930 mln food insecure (2007)

- Prospects

  OECD-FAO (2013)

  - volatility slow-down
  - … but agricultural production expansion slow-down in the incoming years

Our viewpoint

- The analysis of speed and magnitude of global supply response and of its determinants is important to understand price instability
  - the more inelastic the agricultural supply, the stronger the degree that harvest and demand shocks translate into price spikes

Research questions

- To what extent domestic food commodity prices and their volatility influence supply response of wheat, rice and maize?
- Do non-price factors, namely inputs use, financial deepening and climatic factors, have an incidence on agricultural supply response?
- What is the role played by financial deepening in a context of domestic price volatility?

Features of our study

- only few works focused on supply response to prices at global level (Subervie, 2008; Haile, 2013)
- none of them make use of domestic price volatility

Variables		This Paper	Subervie (2008)	Haile (2013)
Prices	International prices		■	■
	Domestic prices: level and volatility	■		
	Price of inputs	■		■
Dependent	Acreage	■		■
	Yield	■		■
	Production	■	■	
Crops	Wheat	■		■
	Maize	■		■
	Rice	■		■
	Soybean			■
	Aggregate		■	
Non-Price	Financial deepening	■	■	
	Agricultural value added (%GDP)	■		
	Yield shock	■		■
	Inputs usage	■		

Features of our study

- Specification
  - System - Generalized Method of Moments (GMM-sys): GMM-sys more asymptotically efficient than the GMM-diff, as it explores much more moment conditions
- Robustness
  - instruments over-identifications: Sargan test, H_0: "instruments are valid"
  - GMM-sys performance: AR(1) and AR(2) Arellano-Bond tests
  - autocorrelation of residuals (Arellano-Bond, 1991; Blundell-Bond, 1998)

Econometric model

- Specification
  - data availability and the meaningfulness of some variables largely determined our selection of variables

Variable name	label	Unit	Range	Source	Level
$lnArea_{ij}$	Area Harvested	Ha/Year	1961-2012	FAO-STAT	CC
$lnYld_{ij}$	Yield	Hg/Ha/Year	1961-2012	FAO-STAT	CC
$lnProd_{ij}$	Production	Tonnes/Year	1961-2012	FAO-STAT	CC
$VOL_{ij,t}$	SDLOG Annual Volatility	Unit Free Measure	2005-2013	FAO-GIEWS WFP-VAM FEWS.NET	CC
$E(P_{ij,t})$	Expected Price	USD/Kg	2005-2013	FAO-GIEWS WFP-VAM FEWS.NET	CC
$\omega_{ij,t-1}$	Yield Risk	Jackknifed residuals of deviation from trend	1961-2012	FAO-STAT	CC
$FTC_{i,t}$	Fertilizers consumption	Ion Metric Tonnes of N nutrients per year	2000-2012	FAO-STAT	C
FTP_t	Intl. Prices of Fertilizers	USD/Kg	2000-2012	World Bank Pinksheet	C
$FiDe_{i,t}$	Domestic credit to private sector by banks (% of GDP)	Unit Free Measure	1961-2012	WDI	C
$AGDP_{i,t}$	Agriculture, value added (% of GDP)	Unit Free Measure	2000-2012	WDI	C

C = Country
CC = Country-Commodity

Econometric model

- Specification
  - panel econometric estimation based on a standard version of the Nerlove model (Nerlove, 1956, 1971; Askari and Cummings, 1977)

$$ln\Gamma_{ij,t} = \gamma_i ln\Gamma_{ij,t-1} + \delta_i VOL_{ij,t} + \beta_1 lnE(P_{ij,t-p}) + \beta_2 \omega_{ij,t-1} + \mathbf{Z}'_{A,t} + \eta_i + u_{ij,t}$$

with $ln\Gamma_{ij,t} = lnYld_{ij,t} = lnArea_{ij,t} = lnProd_{ij,t}$

with $\mathbf{Z}'_{A,t} = \beta_3 FTC_{i,t} + \beta_4 FTP_t + \beta_5 FiDe_{i,t}$

Unit root tests

- Two tests
  - LLC (Levin-Lin-Chu, 2002) H_0 (unit root)
  - Hadri (2000) H_0 (no unit root)
- Results
  - LLC-lev: H_0 (unit root) not rejected for almost all the series under examination (whether or not a trend is included generates different results)
  - LLC-diff: H_0 rejected
  - Hadri-lev: H_0 (no unit root) rejected
  - Hadri-diff: H_0 not rejected

$\Rightarrow$ All series are *I*(1) processes

GMM-sys estimates of world yield response

	Wheat (W1)	Wheat (W2)	Wheat (W3)	Maize (M1)	Maize (M2)	Maize (M3)	Rice (R1)	Rice (R2)	Rice (R3)
$\ln Y_{j,t-1}$	-0.091	-0.078	0.134***	-0.079	0.458***	0.440***	0.015	0.005	0.212***
	(0.106)	(0.102)	(0.034)	(0.158)	(0.057)	(0.041)	(0.051)	(0.058)	(0.047)
VOL_j	0.603	1.047	-0.685***	-0.511**	1.316	-0.830**	-0.582***	-0.532	0.067
	(1.104)	(1.487)	(0.170)	(0.191)	(0.702)	(0.280)	(0.139)	(1.959)	(0.594)
$\ln E(P_{t-p})$	-0.210	-0.177	-0.034	0.241	0.023	0.039	0.248***	0.245***	0.243***
	(0.126)	(0.110)	(0.018)	(0.160)	(0.052)	(0.072)	(0.019)	(0.022)	(0.027)
$\ln(FTC)$	0.055***	0.058***	0.056**	0.144***	0.060**	0.028	0.053***	0.059***	0.016***
	(0.012)	(0.010)	(0.016)	(0.031)	(0.020)	(0.020)	(0.004)	(0.005)	(0.005)
$\ln(FTP_t)$	0.046	0.051	-0.059**	-0.228*	-0.082*	0.046	-0.128***	-0.160***	-0.031
	(0.097)	(0.094)	(0.018)	(0.116)	(0.038)	(0.076)	(0.019)	(0.026)	(0.033)
$\ln(FiDe_{it})$	0.351*	0.325*	-0.045	0.390***	0.229***	0.135***	0.191***	0.132	0.019
	(0.136)	(0.138)	(0.044)	(0.054)	(0.059)	(0.037)	(0.016)	(0.122)	(0.056)
$\ln(FiDe_{it})*VOL_j$		-0.021	0.022***		-0.020	0.032**		0.041	-0.006
		(0.032)	(0.006)		(0.016)	(0.011)		(0.076)	(0.016)
$\ln(AGDP_{it})$			-0.208**			-0.261**			-0.286***
			(0.057)			(0.083)			(0.021)
_cons	8.549***	8.518***	8.274***	9.653***	4.464***	6.170***	9.864***	10.206***	8.927***
	(0.587)	(0.562)	(0.469)	(1.577)	(0.509)	(0.491)	(0.516)	(0.815)	(0.572)
N	195	195	180	276	276	261	239	239	232
AR(1):p-val	0.004	0.002	0.003	0.005	0.006	0.000	0.000	0.001	0.000
AR(2):p-val	0.249	0.534	0.669	0.301	0.318	0.689	0.943	0.675	0.665
Sargan test: p-val	0.374	0.443	0.104	0.694	0.124	0.077	0.162	0.080	0.101
F test: p.val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

GMM-sys estimates of world acreage response

	Wheat (W1)	Wheat (W2)	Wheat (W3)	Maize (M1)	Maize (M2)	Maize (M3)	Rice (R1)	Rice (R2)	Rice (R3)
$\ln Y_{j,t-1}$	0.992***	0.992***	1.000***	1.040***	0.956***	0.946***	0.689***	0.694***	0.670***
	(0.014)	(0.011)	(0.012)	(0.052)	(0.018)	(0.022)	(0.087)	(0.083)	(0.083)
VOL_j	-0.143	-0.610*	-0.654*	-1.157	-0.469	-0.362	1.682	2.554	-0.316
	(0.392)	(0.289)	(0.259)	(1.440)	(1.825)	(1.753)	(1.064)	(2.440)	(2.088)
$\ln E(P_{t-p})$	-0.018	-0.026	0.013	0.566*	0.463*	0.397*	0.088	0.086	0.176*
	(0.079)	(0.058)	(0.052)	(0.247)	(0.218)	(0.199)	(0.108)	(0.109)	(0.084)
$\omega_{j,t-1}$	0.035*	0.032*	0.033*	-0.015	0.027	-0.016	0.123*	0.125*	0.044
	(0.014)	(0.012)	(0.012)	(0.085)	(0.076)	(0.079)	(0.059)	(0.059)	(0.041)
$\ln(FTC_{it})$	0.001	0.002	-0.000	-0.011	0.074*	0.088**	0.137***	0.137***	0.152***
	(0.011)	(0.009)	(0.010)	(0.063)	(0.034)	(0.032)	(0.038)	(0.038)	(0.041)
$\ln(FTP_t)$	0.009	0.024	-0.012	-0.675*	-0.334	-0.270	-0.141*	-0.149*	-0.172**
	(0.077)	(0.058)	(0.038)	(0.284)	(0.185)	(0.172)	(0.065)	(0.066)	(0.054)
$\ln(FiDe_{it})$	0.008	-0.021	0.003	0.507	-0.235	-0.189	0.235**	0.265*	0.179
	(0.027)	(0.024)	(0.019)	(0.351)	(0.161)	(0.165)	(0.071)	(0.122)	(0.112)
$\ln(FiDe_{it})*VOL_j$		0.011*	0.014*		0.050	0.048		-0.019	0.056
		(0.004)	(0.006)		(0.052)	(0.051)		(0.058)	(0.055)
$\ln(AGDP_{it})$			0.010			0.065			0.013
			(0.019)			(0.052)			(0.159)
_cons	-0.003	-0.006	0.051	2.596	2.891*	2.108	2.319***	2.185**	2.787*
	(0.401)	(0.297)	(0.263)	(1.336)	(1.251)	(1.211)	(0.627)	(0.697)	(1.203)
N	195	195	180	276	276	261	204	204	232
AR(1):p-val	0.005	0.005	0.007	0.000	0.000	0.000	0.000	0.000	0.000
AR(2):p-val	0.049	0.038	0.047	0.329	0.930	0.867	0.035	0.047	0.077
Sargan test: p-val	0.159	0.123	0.088	0.104	0.041	0.036	0.213	0.259	0.044
F test: p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

GMM-sys estimates of world output response

	Wheat (W1)	Wheat (W2)	Wheat (W3)	Maize (M1)	Maize (M2)	Maize (M3)	Rice (R1)	Rice (R2)	Rice (R3)
$\ln Y_{j,t-1}$	1.031***	1.006***	1.035***	0.690**	0.129	0.562***	0.283***	0.546***	0.676***
	(0.027)	(0.017)	(0.035)	(0.234)	(0.172)	(0.080)	(0.048)	(0.147)	(0.090)
VOL_j	0.283	0.215	0.628	-0.114	-1.005	-0.006	-0.902*	1.121	-0.350
	(0.529)	(0.789)	(0.969)	(1.485)	(2.426)	(1.222)	(0.413)	(0.680)	(2.658)
$\ln E(P_{j-p})$	0.363*	0.261**	0.379*	0.542*	0.477*	0.396*	0.303***	-0.050	-0.075
	(0.161)	(0.091)	(0.192)	(0.255)	(0.223)	(0.176)	(0.085)	(0.090)	(0.055)
$\omega_{j,t-1}$	0.157***	0.174***	0.180***	-0.130	0.095***	0.102***	0.175***	0.143***	0.104***
	(0.013)	(0.014)	(0.018)	(0.118)	(0.018)	(0.024)	(0.012)	(0.017)	(0.015)
$\ln(FTC_{it})$	0.000	0.019	0.002	0.261*	0.540***	0.365***	0.106**	0.220**	0.197***
	(0.015)	(0.012)	(0.020)	(0.121)	(0.102)	(0.058)	(0.032)	(0.071)	(0.053)
$\ln(FTP_t)$	-0.183	-0.367**	-0.570*	-0.060	0.046	-0.208	-0.164**	-0.092	-0.110**
	(0.127)	(0.134)	(0.263)	(0.197)	(0.177)	(0.225)	(0.050)	(0.063)	(0.037)
$\ln(FiDe_{it})$	0.112*	0.031	0.030	-0.211	-0.480	-0.011	0.420*	0.378**	0.116
	(0.045)	(0.042)	(0.047)	(0.152)	(0.330)	(0.212)	(0.182)	(0.119)	(0.227)
$\ln(FiDe_{it})$*VOL_j		0.029*	0.029		-0.027	0.044		0.000	0.127
		(0.014)	(0.016)		(0.111)	(0.038)		(0.020)	(0.109)
$\ln(AGDP_{it})$			-0.054			0.478			0.305**
			(0.056)			(0.244)			(0.087)
_cons	0.628	1.896**	3.064*	3.181	8.175***	2.423	8.362***	2.948**	1.438*
	(0.560)	(0.691)	(1.487)	(2.177)	(2.253)	(1.493)	(0.623)	(1.047)	(0.675)
N	195	195	180	276	276	261	239	239	232
AR(1):p-val	0.000	0.000	0.003	0.007	0.002	0.000	0.001	0.000	0.013
AR(2):p-val	0.505	0.283	0.015	0.090	0.772	0.750	0.087	0.330	0.762
Sargan test: p-val	0.128	0.432	0.223	0.411	0.033	0.155	0.312	0.216	0.645
F test: p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Concluding remarks

- Price volatility leaves the farmers uncertain about whether they are going to be paid a high price or not in the market, this affects investment decisions on production with relevant impacts on yields: this risk averse behaviour is evident among wheat and maize producers
- Lack of access to credit tends to exacerbate the effect of price movements on welfare of producers

Concluding remarks

- Positive relationship of financial deepening with yield responses, suggesting policy makers to improve local financial systems with well targeted policy reforms of the financial sector in order to facilitate lending and borrowing between financial institutions and poor households
- Positive impact of fertilizers use and negative impact of fertilizers prices on the dependent variables in almost all the models

Thank you

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