Cyclone damage & agriculture in India

Income Smoothing, Risk Diversification and Cyclone Damage in India

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EC501 Work-in-Progress Seminar
20.10.2009

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    - The exogenous variation in cyclone tracks
  - During 1949-2007, a cyclone on average affected 1.4 million people & caused $US290 million in damages (EM-DAT 2009)
- Since the 1960s, the costs of natural disasters has increased 14-fold (Munich Re 1995) due to
  - Economic development
  - Population growth in risky areas
  - Climate change (Emanuel 1995, 2005)

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- Moreover, HHs might not correctly anticipate these low probability events

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And more generally,

- Does living in a disaster-prone area translate into a long-run growth disadvantage?

Note: I will not be able to address migration due to data limitations

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- Tests for the persistence of cyclone shocks
- Tests for potential adaptation to these cyclone shocks

This paper (2/2)

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- This effect does not persist over time
- However, the capital stock remains significantly lower even 5 years after the shock suggesting the presence of liquidity constraints
- There is some income smoothing/risk diversification across crop types

Related Literature

- Nascent literature on natural disasters & aid
  - Cross-country studies on natural disasters (Yang 2008; Khan 2005, Anbarci et al. 2005, Toya and Skidmore 2002 & 2007, Cuaresma, Hlouskova, and Obersteiner 2008)
  - Sub-national studies on natural disasters (Pugatch & Yang 2008, Bluedorn & Cascio 2005, Foster 1995)
  - Sub-national studies on determinants of aid (Besley & Burgess 2002, Cole et al. 2008, Eisensee & Stroemberg 2007)

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- Literature on Climate Change (Deschenes & Greenstone 2007; Guiteras 2007, Dell et al. 2008)

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- Literature on Climate Change (Deschenes & Greenstone 2007; Guiteras 2007, Dell et al. 2008)
- [Literature on choice under uncertainty - does not seem that relevant in this case]

Cyclone damage & agriculture in India (1/5)

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  - Drown human beings & livestock
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$\Longrightarrow$ The primary sector will be most exposed to these effects

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- There are cyclone shocks all year round, but the two main cyclone seasons in India are
  - May-June
  - September-November
- There are two main cropping seasons in India (excluding Tamil Nadu)
  - Kharif crops are sown in spring & harvested in autumn
  - Rabi crops are sown in late autumn & harvested the following spring
  - Two season crops have varieties that can be grown in both seasons

Cyclone damage & agriculture in India (3/5)

- The farmer will face three states of the world
  - a cyclone shock in the Kharif season, which occurs with probability pr_k and causes damage d_{ki} to output/input i
  - a cyclone shock in the Rabi season, which occurs with probability pr_r and causes damage d_{ri} to output/input i
  - no cyclone shock, which occurs with probability $(1 - pr_k - pr_r)$

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Cyclone damage & agriculture in India (4/5)

If the farmer has full information about the event probabilities, she will maximize expected profits

$$\max_{q_k,q_r,K,L} E(\Pi)=pr_k[p_k(q_k-d_{kk})+p_r q_r-r(K\text{-}d_{kK})-w(L\text{-}d_{kL})]+ pr_r[p_k q_k+p_r(q_r-d_{rr})-r(K\text{-}d_{rK})-w(L\text{-}d_{rL})]+ (1\text{-}pr_k\text{-}pr_r)[p_k q_k+p_r q_r-rK-wL] \quad (1)$$

Subject to production functions $q_k = f_k(K, L)$ and $q_r = f_r(K, L)$

Cyclone damage & agriculture in India (5/5)

If the farmer has incomplete information I about the event probabilities, she will maximize expected profits

$$\max_{q_k, q_r, K, L} E(\Pi|I) = pr_k(I)[p_k(q_k - d_{kk}) + p_r q_r - r(K\text{-}d_{kK}) - w(L\text{-}d_{kL})] + pr_r(I)[p_k q_k + p_r(q_r - d_{rr}) - (K\text{-}d_{rK}) - w(L\text{-}d_{rL})] + (1\text{-}pr_k(I)\text{-}pr_r(I))[p_k q_k + p_r q_r - rK - wL] \quad (2)$$

Subject to production functions $q_k = f_k(K, L)$ and $q_r = f_r(K, L)$

Note: I is assumed to increase with the exposure to recent cyclone shocks

Predictions (1/2)

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  - Cyclones after September should
    - Destroy Kharif crops (harvest & storage)
    - Have an ambiguous effect on Rabi crops (destruction vs. income smoothing)
    - Destroy two-season crops

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- If HHs have updated their expectations, we should observe permanent changes in
  - The crop mix
  - Input choices
  - Area planted
- If expected profits are lower than the outside option, the farmer should migrate

Empirical strategy (1/2)

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- Use a fixed effects specification to control for
  - Time-invariant district-level characteristics
  - Macroeconomic shocks & region-specific time trends with year FE and either (distance to sea)*year FE or state*year FE
- Control for other exogenous factors influencing agricultural production, namely precipitation & temperature shocks (Guiteras 2007, Schlenker & Roberts 2008)

Empirical strategy (2/2)

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- To estimate direct economic cost of cyclone exposure include
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  - Lags of the cyclone exposure variable to estimate the persistence of the cyclone shock
- Main problem with including lags: cannot isolate potential change in expectations from effect of past shocks on current agricultural production
  - To estimate effect on expectation use cyclone exposure of neighboring districts
  - This is ONLY valid, if can show that neighboring districts do not affect local markets through prices

Regression specification for cyclone impact

Various LHS variables, e.g. $ln(revenue\_tot)_{dt}$ for district d, year t

$$\ln\left(y_{dt}\right) = \alpha + \beta_0 shock_{dt} + \\ + \sum_{m=4}^{12} \theta_{1m} rainshock_{dmt} + \sum_{m=1}^{3} \theta_{2m} rainshock_{dmt+1} \\ + \sum_{m=4}^{12} \theta_{3m} tempshock_{dmt} + \sum_{m=1}^{3} \theta_{4m} tempshock_{dmt+1} \\ + \delta_d + \mu_{it} + \varepsilon_{dt} \tag{4}$$

- Standard errors clustered at the district level

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- Standard errors clustered at the district level
- Variable for cyclone impact $shock_{dt}$ for district d in year t
- δ_d district FE, μ_{it} region $i*$year t interactions, ε_{dt} error term
- weather shocks $rainshock_{dmt,dmt+1}$ & $tempshock_{dmt,dmt+1}$ for district d in month m of year t and $t+1$

Regression specification for cyclone impact, by season

Various LHS variables, e.g. $ln(revenue\_tot)_{dt}$ for district d, year t

$$
\begin{aligned}
\ln\left(y_{dt}\right) = {} & \alpha + \beta_{0k} shock_{dt} * karif_t + \beta_{0r} shock_{dt} * rabi_{t,t+1} \\
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- Standard errors clustered at the district level
- Dummy for Kharif season $kharif_t = 1$ if cyclone in year t occurs in month $m = [4, 8]$, $= 0$ otherwise
- Dummy for Rabi season $rabi_{t,t+1} = 1$ if cyclone in year t occurs in month $m = [9, 12]$ or cyclone in year $t = +1$ occurs in month $m = [1, 3]$, $= 0$ otherwise

Regression specification for persistence

Various LHS variables, e.g. $ln(revenue\_tot)_{dt}$ for district d, year t

$$\ln(y_{dt}) = \alpha + \beta_0 shock_{dt} + \beta_1 shock_{dt-1} + \beta_2 shock_{dt-2} + \ldots + \beta_5 shock_{dt-5} + \sum_{m=4}^{12} \theta_{1m} rainshock_{dmt} + \sum_{m=1}^{3} \theta_{2m} rainshock_{dmt+1} + \sum_{m=4}^{12} \theta_{3m} tempshock_{dmt} + \sum_{m=1}^{3} \theta_{4m} tempshock_{dmt+1} + \delta_d + \mu_{jt} + \varepsilon_{dt} \quad (6)$$

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- Standard errors clustered at the district level
- Variable for cyclone impact $shock_{dt}$ & associated lags $shock_{dt-i}$ for $i = 1, 2, .., 5$

Regression specification for persistence, by season

Various LHS variables, e.g. $ln(revenue\_tot)_{dt}$ for district d, year t

$$\begin{aligned}\ln(y_{dt}) = {} & \alpha + \beta_{0k} shock_{dt} * kharif_t + \beta_{1k} shock_{dt-1} * kharif_t + \\ & \beta_{2k} shock_{dt-2} * kharif_t + \ldots + \beta_{5k} shock_{dt-5} * kharif_t + \\ & \beta_{0r} shock_{dt} * rabi_{t,t+1} + \beta_{1r} shock_{dt-1} * rabi_{t,t+1} + \\ & \beta_{2r} shock_{dt-2} * rabi_{t,t+1} + \ldots + \beta_{5r} shock_{dt-5} * rabi_{t,t+1} + \\ & + \sum_{m=4}^{12} \theta_{1m} rainshock_{dmt} + \sum_{m=1}^{3} \theta_{2m} rainshock_{dmt+1} \\ & + \sum_{m=4}^{12} \theta_{3m} tempshock_{dmt} + \sum_{m=1}^{3} \theta_{4m} tempshock_{dmt+1} \\ & + \delta_d + \mu_{jt} + \varepsilon_{dt}\end{aligned} \tag{7}$$

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Cyclone Data

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  - Cyclones (33-47 knots/60-88kmph)
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- Advantage of meteorological measurements:
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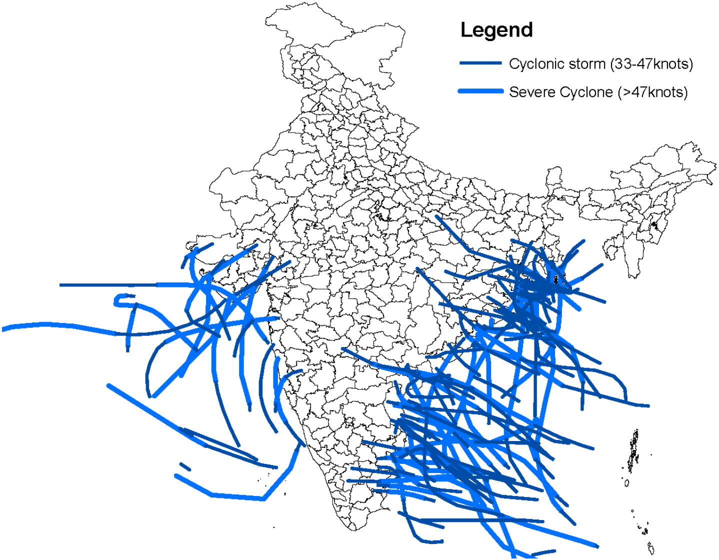
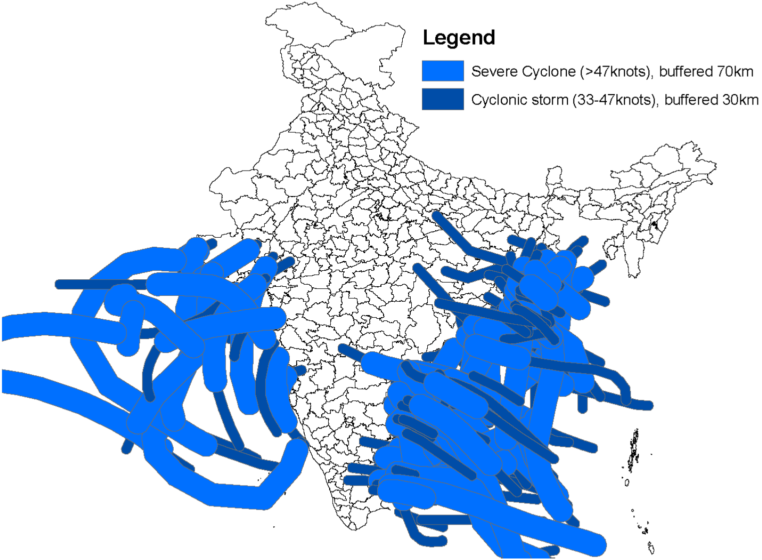
- Two variables constructed:
  - $cyclone\_hit_{dt} = 1$ if cyclone passed over district d in year t, 0 otherwise
  - $percent\_affected_{dt} = \frac{area\_affected_{dt}}{total\_area_{d}}$

Cyclones & Severe Cyclones, 1946-1987



Cyclones & Severe Cyclones, 1946-1987 - buffered



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- Source: India Agricultural & Climate dataset of the World Bank (Sanghi, Kumar & McKinsey, 1998)
- Time period: 1956-1987 (annual)
- Agricultural year $t \equiv$April $t-$March $t+1$
- Number of districts: 259 (1966 boundaries, excl. Tamil Nadu)

Outcome Data (1/2)

- Source: India Agricultural & Climate dataset of the World Bank (Sanghi, Kumar & McKinsey, 1998)
- Time period: 1956-1987 (annual)
- Agricultural year $t \equiv$April $t-$March $t+1$
- Number of districts: 259 (1966 boundaries, excl. Tamil Nadu)
- Agricultural data on prices, output & area planted by crop

Kharif crop		Rabi crop		Two season crop	
major crop	minor crop	major crop	minor crop	major crop	minor crop
bajra	cotton	wheat	barley	jowar	other pulses
maize	groundnut		gram	rice	soy
	sesame		jute	sugar	sunflowers
	tobacco		potato		
	ragi		rapeseed & mustard		
	tur				

Outcome Data (2/2)

- Agricultural data on (cont.)
  - Number of agricultural labourers & cultivators, real wages
  - Number & price of tractors & bullocks
  - Usage & price of fertilizer

Outcome Data (2/2)

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  - Number of agricultural labourers & cultivators, real wages
  - Number & price of tractors & bullocks
  - Usage & price of fertilizer
- Main outcome variables (in natural logs):
  - Revenue variables (in MM 1980 INR): total revenue, revenue of 6 major crops, revenue of Kharif crops, revenue of Rabi crops, revenue of two-season crops
  - Input data: agricultural labourers (in 1000), cultivators (in 1000), real wage, # of bullocks (in 1000), # of tractors, fertilizer used (in tons)

Weather Data

- Source: Terrestrial Air Temperature & Precipitation dataset (Version 1.02)

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- Time period: 1956-1988 (monthly)
- Number of weather stations: 352
- Construct monthly weather shocks (following Duflo & Pande, 2007):
  - Interpolated b/n weather stations w/in 100km radius
  - Calculate mean temperature & precipitation at the district level for each month & year
  - Calculate % deviation of the district-level weather variable from the district mean 1956-1988

Summary statistics: main outcome variables (year=1956)

	total rev (MM)	rev 6 major (MM)	rev kharif (MM)	rev. rabi (MM)	rev both (MM)
mean coast	800.61	680.35	123.99	24.00	652.63
sd coast	638.22	610.26	180.82	33.94	631.23
mean inland	530.43	371.33	100.88	139.77	289.78
sd inland	342.66	291.67	115.99	165.31	301.33
mean total	553.36	397.55	102.84	129.95	320.58
sd total	382.48	340.02	122.53	161.67	354.67

	agri L (1000)	cult (1000)	fertilizer (tons)	tractors	bullocks (1000)
mean coast	87.49	205.17	852	208.28	30.96
sd coast	77.29	134.54	1159.55	139.53	33.21
mean inland	56.60	212.667	336.57	206.37	62.61
sd inland	53.08	132.51	574.64	120.34	110.76
mean total	59.22	212.03	380.32	206.53	59.92
sd total	56.02	132.45	657.54	121.80	106.73

Summary statistics: cyclone variables (1946-1986)

	mean	sd	min	max
% affected coast	6.63	19.84	0	100
% affected inland	.081	6.69	0	100
% affected total	1.31	8.77	0	100
prob cyclone hit coast	0.016	0.022	0	0.086
prob cyclone hit inland	0.0018	0.0072	0	0.052
prob cyclone hit total	0.0030	0.0103	0	0.086

Cyclone impact: shock dummy

	(1)	(2)	(3)	(4)	(5)
LHS in ln	total rev	rev 6 major	rev kharif	rev. rabi	rev both
cyclone_hit	-0.128*	-0.125*	0.200	-0.273	-0.0399
	(0.0655)	(0.0706)	(0.177)	(0.438)	(0.0747)
district FE	yes	yes	yes	yes	yes
dsea*yr FE	yes	yes	yes	yes	yes
weather shocks	yes	yes	yes	yes	yes
Obs	8288	8288	8288	8288	8288

Cyclone impact: shock dummy (cont.)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	agri L	cult	fertilizer	tractors	bullocks
cyclone_hit	0.00643	-0.0194	-0.229	-0.0708	-0.0843*
	(0.0655)	(0.0132)	(0.269)	(0.115)	(0.0493)
district FE	yes	yes	yes	yes	yes
dsea*yr FE	yes	yes	yes	yes	yes
weather shocks	yes	yes	yes	yes	yes
Obs	8288	8288	8288	8288	8288

Cyclone impact: % damage

	(1)	(2)	(3)	(4)	(5)
LHS in ln	total rev	rev 6 major	rev kharif	rev. rabi	rev both
% affected	-0.00158*	-0.00179**	0.00651**	0.00359	8.05e-05
	(0.000876)	(0.00101)	(0.00326)	(0.00333)	(0.00121)
district FE	yes	yes	yes	yes	yes
dsea*yr FE	yes	yes	yes	yes	yes
weather shocks	yes	yes	yes	yes	yes
Obs	8288	8288	8288	8288	8288

Cyclone impact: % damage (cont.)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	agri L	cult	fertilizer	tractors	bullocks
% affected	0.000132	-0.000104	-0.00143	-0.00141	-0.00112
	(0.000928)	(0.000217)	(0.00334)	(0.00227)	(0.000702)
district FE	yes	yes	yes	yes	yes
dsea*yr FE	yes	yes	yes	yes	yes
weather shocks	yes	yes	yes	yes	yes
Obs	8288	8288	8288	8288	8288

Cyclone impact by season: shock dummy

	(1)	(2)	(3)	(4)	(5)
LHS in ln	total rev	rev 6 major	rev kharif	rev. rabi	rev both
cyclone_hit*kharif	-0.130*	-0.116	0.0971	0.0459	-0.0238
	(0.0776)	(0.0835)	(0.169)	(0.151)	(0.0867)
cyclone_hit*rabi	-0.116	-0.166*	0.645	-1.644	-0.109
	(0.0750)	(0.0890)	(0.536)	(2.031)	(0.122)
district FE	yes	yes	yes	yes	yes
dsea*yr FE	yes	yes	yes	yes	yes
weather shocks	yes	yes	yes	yes	yes
Obs	8288	8288	8288	8288	8288

Cyclone impact by season: shock dummy (cont.)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	agri L	cult	fertilizer	tractors	bullocks
cyclone_hit*kharif	0.0434	-0.0274**	-0.439	-0.0868	-0.0423
	(0.0271)	(0.0129)	(0.311)	(0.137)	(0.0353)
cyclone_hit*rabi	-0.153	0.0150	0.671***	-0.00194	-0.265
	(0.252)	(0.0418)	(0.228)	(0.159)	(0.180)
district FE	yes	yes	yes	yes	yes
dsea*yr FE	yes	yes	yes	yes	yes
weather shocks	yes	yes	yes	yes	yes
Obs	8288	8288	8288	8288	8288

Persistence: shock dummy

	(1)	(2)	(3)	(4)	(5)
LHS in ln	total rev	rev 6 major	rev kharif	rev. rabi	rev both
cyclone_hit	-0.127*	-0.124*	0.207	-0.244	-0.0382
	(0.0657)	(0.0703)	(0.181)	(0.430)	(0.0757)
l1_cyclone_hit	-0.0975	-0.0771	0.0434	-0.393	-0.112
	(0.0748)	(0.0707)	(0.160)	(0.474)	(0.09241)
l2_cyclone_hit	0.0648	0.0663	0.172	0.183	0.148**
	(0.0523)	(0.0643)	(0.211)	(0.227)	(0.0650)
l3_cyclone_hit	-0.0420	-0.0362	-0.398	0.217	-0.0296
	(0.0501)	(0.0515)	(0.617)	(0.229)	(0.0603)
l4_cyclone_hit	-0.0699*	-0.0690	0.149	0.135	-0.121**
	(0.0411)	(0.0423)	(0.293)	(0.171)	(0.0563)
l5_cyclone_hit	-0.0209	-0.0180	-0.332	0.307	0.0360
	(0.0592)	(0.0579)	(0.619)	(0.197)	(0.0665)
joint sig ls (pvalue)	0.387	0.472	0.820	0.618	0.706

Persistence: shock dummy (cont.)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	agri L	cult	fertilizer	tractors	bullocks
cyclone_hit	0.00161	-0.0193	-0.202	-0.120	-0.0894*
	(0.0613)	(0.0147)	(0.265)	(0.135)	(0.0535)
l1_cyclone_hit	-0.00651	-0.0140	-0.164	-0.371**	-0.118
	(0.0623)	(0.0167)	(0.273)	(0.158)	(0.0861)
l2_cyclone_hit	-0.0452	-0.00238	0.213*	-0.395**	-0.0950*
	(0.0602)	(0.0156)	(0.127)	(0.155)	(0.0533)
l3_cyclone_hit	-0.0406	0.00282	0.130	-0.582***	-0.0519
	(0.0586)	(0.0173)	(0.104)	(0.173)	(0.0465)
l4_cyclone_hit	-0.0480	0.000648	0.243**	-0.655***	-0.0261
	(0.0608)	(0.0179)	(0.123)	(0.168)	(0.0458)
l5_cyclone_hit	-0.0560	0.0106	0.233*	-0.716***	-0.00765
	(0.0623)	(0.0200)	(0.121)	(0.218)	(0.0379)
joint sig ls (pvalue)	0.515	0.978	0.182	0.00141	0.233

Persistence by season: shock dummy (1/4)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	total rev	rev 6 major	rev kharif	rev. rabi	rev both
cyclone_hit*kharif	-0.129*	-0.115	0.131	0.0550	-0.0228
	(0.0766)	(0.0809)	(0.199)	(0.152)	(0.0852)
l1_cyclone_hit*kharif	-0.0817	-0.0455	-0.0375	-0.0151	-0.0806
	(0.0921)	(0.0862)	(0.207)	(0.214)	(0.109)
l2_cyclone_hit*kharif	0.0530	0.0578	0.206	0.0427	0.147*
	(0.0607)	(0.0759)	(0.252)	(0.199)	(0.0758)
l3_cyclone_hit*kharif	-0.0418	-0.0303	0.178	0.185	-0.0255
	(0.0596)	(0.0606)	(0.247)	(0.194)	(0.0675)
l4_cyclone_hit*kharif	-0.0509	-0.0414	0.173	0.142	-0.124**
	(0.0439)	(0.0425)	(0.309)	(0.154)	(0.0619)
l5_cyclone_hit*kharif	-0.0148	-0.0145	0.287	0.282	0.0487
	(0.0683)	(0.0678)	(0.296)	(0.237)	(0.0780)
joint sig ls (pvalue)	0.544	0.727	0.521	0.441	0.884

Persistence by season: shock dummy (cont. 2/4)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	total rev	rev 6 major	rev kharif	rev. rabi	rev both
cyclone_hit*rabi	-0.125	-0.178*	0.493	-1.655	-0.116
	(0.0773)	(0.0942)	(0.424)	(2.096)	(0.127)
l1_cyclone_hit*rabi	-0.158***	-0.207***	0.460	-2.057	-0.251
	(0.0524)	(0.0664)	(0.391)	(2.090)	(0.166)
l2_cyclone_hit*rabi	0.114	0.0975	-0.00106	0.700	0.143
	(0.104)	(0.109)	(0.122)	(0.787)	(0.116)
l3_cyclone_hit*rabi	-0.0435	-0.0700	-3.443	0.502	-0.0423
	(0.0507)	(0.0818)	(2.984)	(0.890)	(0.140)
l4_cyclone_hit*rabi	-0.177*	-0.221*	-0.413	0.167	-0.101
	(0.0975)	(0.117)	(0.391)	(0.662)	(0.105)
l5_cyclone_hit*rabi	-0.0586	-0.0451	-3.610	0.375	-0.0317
	(0.106)	(0.108)	(3.003)	(0.258)	(0.134)
joint sig ls (pvalue)	0.240	0.261	0.250	0.921	0.530

Persistence by season: shock dummy (cont. 3/4)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	agri L	cult	fertilizer	tractors	bullocks
cyclone_hit*kharif	0.0423	-0.0286**	-0.402	-0.138	-0.0425
	(0.0291)	(0.0142)	(0.306)	(0.162)	(0.0379)
l1_cyclone_hit*kharif	0.0385	-0.0279*	-0.296	-0.445**	-0.0317
	(0.0273)	(0.0149)	(0.327)	(0.184)	(0.0395)
l2_cyclone_hit*kharif	-0.0145	-0.0147	0.221	-0.467**	-0.0414
	(0.0310)	(0.0131)	(0.159)	(0.183)	(0.0389)
l3_cyclone_hit*kharif	-0.00434	-0.0125	0.158	-0.658***	-0.0119
	(0.0245)	(0.0150)	(0.118)	(0.194)	(0.0399)
l4_cyclone_hit*kharif	-0.00833	-0.0178	0.359***	-0.744***	0.0248
	(0.0275)	(0.0137)	(0.124)	(0.185)	(0.0417)
l5_cyclone_hit*kharif	-0.0252	-0.00963	0.339***	-0.823***	0.0316
	(0.0280)	(0.0149)	(0.124)	(0.242)	(0.0366)
joint sig ls (pvalue)	0.915	0.212	0.162	0.00119	0.877

Persistence by season: shock dummy (cont. 4/4)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	agri L	cult	fertilizer	tractors	bullocks
cyclone_hit*rabi	-0.183	0.0260	0.670***	-0.0161	-0.310
	(0.291)	(0.0486)	(0.209)	(0.178)	(0.201)
l1_cyclone_hit*rabi	-0.207	0.0463	0.477***	-0.0578	-0.499
	(0.291)	(0.0565)	(0.147)	(0.185)	(0.381)
l2_cyclone_hit*rabi	-0.184	0.0513	0.227	-0.0770	-0.340*
	(0.284)	(0.0556)	(0.194)	(0.179)	(0.193)
l3_cyclone_hit*rabi	-0.246	0.0898*	-0.0821	-0.145	-0.280**
	(0.317)	(0.0544)	(0.232)	(0.0987)	(0.122)
l4_cyclone_hit*rabi	-0.273	0.109*	-0.476	-0.125	-0.308***
	(0.310)	(0.0614)	(0.364)	(0.112)	(0.0709)
l5_cyclone_hit*rabi	-0.234	0.124**	-0.331	-0.132	-0.229***
	(0.314)	(0.0608)	(0.254)	(0.118)	(0.0526)
joint sig ls (pvalue)	0.450	0.130	0.863	0.339	0.0299

Income smoothing & risk diversification: % affected

	(1)	(2)	(3)	(4)	(5)
LHS in ln	rev maize	rev cotton	rev gnut	rev wheat	rev gram
CROP TYPE	Kharif	Kharif	Kharif	Rabi	Rabi
% affected*kharif	0.00161	0.0120**	0.00179	0.00703	0.0112**
	(0.00891)	(0.00467)	(0.00436)	(0.00455)	(0.00527)
l1_% affected*kharif	-0.00908	0.00893**	0.00347	0.00165	0.00930*
	(0.00734)	(0.00453)	(0.00300)	(0.00506)	(0.00557)
l2_% affected*kharif	-0.00628	0.00785*	0.00577**	0.00241	0.00565*
	(0.00685)	(0.00423)	(0.00238)	(0.00443)	(0.00291)
l3_% affected*kharif	0.00119	0.00384	0.00401	0.00671	0.00661**
	(0.00461)	(0.00367)	(0.00264)	(0.00473)	(0.00307)
l4_% affected*kharif	0.00214	-0.00396	0.00481*	4.68e-05	0.00413
	(0.00508)	(0.00587)	(0.00260)	(0.00582)	(0.00684)
l5_% affected*kharif	0.00507	-0.000551	0.00491*	0.00630	0.000100
	(0.00503)	(0.00546)	(0.00288)	(0.00621)	(0.00511)
joint sig ls (pvalue)	0.689	0.313	0.0456	0.462	0.0255

Income smoothing & risk diversification: % affected (cont.)

	(1)	(2)	(3)	(4)	(5)
LHS in ln	rev maize	rev cotton	rev gnut	rev wheat	rev gram
CROP TYPE	Kharif	Kharif	Kharif	Rabi	Rabi
% affected*rabi	0.00183	-0.0197***	-0.00192	-0.00263	0.00242
	(0.00656)	(0.00667)	(0.00244)	(0.00256)	(0.00330)
l1_% affected*rabi	-0.0161***	-0.0146**	-0.00156	-0.00942**	-0.00489
	(0.00615)	(0.00592)	(0.00237)	(0.00382)	(0.00442)
l2_% affected*rabi	-0.0138**	-0.0124*	-0.00268	-0.00704**	-0.00424
	(0.00605)	(0.00745)	(0.00291)	(0.00342)	(0.00526)
l3_% affected*rabi	-0.0159*	-0.0132	-0.00509*	-0.000181	0.00356
	(0.00815)	(0.00852)	(0.00284)	(0.00406)	(0.00608)
l4_% affected*rabi	-0.00593	-0.00586	-0.00736**	-0.00120	-0.00222
	(0.00603)	(0.00495)	(0.00319)	(0.00338)	(0.00260)
l5_c% affected*rabi	-0.00418	0.000294	-0.00631*	0.00472	0.00165
	(0.00780)	(0.00437)	(0.00373)	(0.00531)	(0.00412)
joint sig ls (pvalue)	0.0224	0.0641	0.0761	0.382	0.677

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  - Dataset: National Sample Survey 38^{th} (1983–1984) to 55^{th} (1995-1996) round
- Analysis of the manufacturing sector
  - Test "creative destruction" (Gilchrist & Williams 2004) vs. "large temporary shock" hypothesis (Davis & Weinstein 2002, Miguel & Roland 2006)
  - Construct a measure of productivity (following Olley & Pakes 1996 & Pavcnik 2002)
  - Two possible datasets:
    - PROWESS dataset (1989-2003): only medium & large firms
    - Annual Survey of Industries (1980-2001): organized manufacturing sector at the district-level

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