“Gone with the Storm: Rainfall Shocks and Household Wellbeing in Guatemala”

Javier E. Baez (World Bank)
Leonardo Lucchetti (World Bank)
Mateo Salazar (World Bank)
Maria E. Genoni (World Bank)

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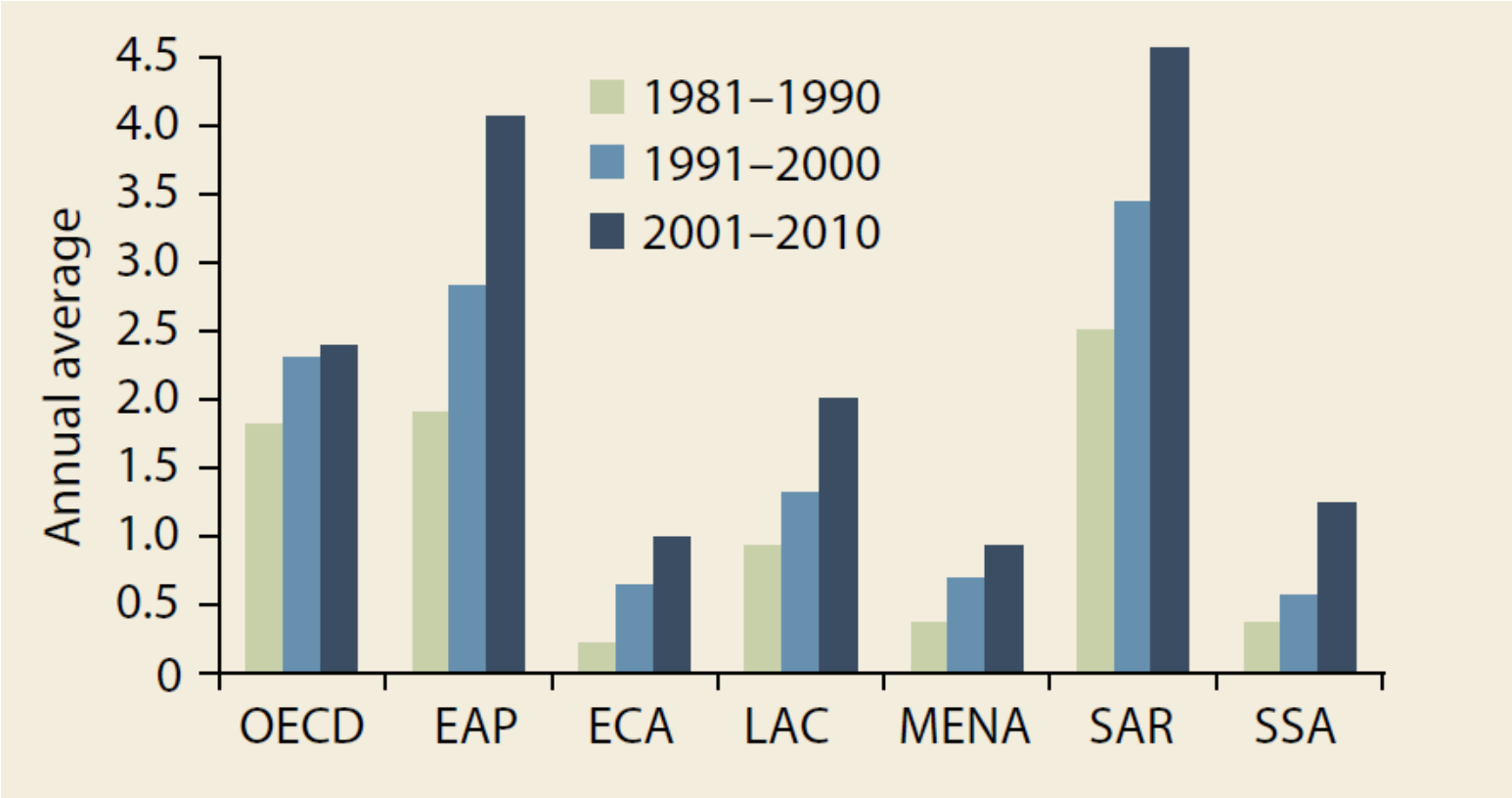
Why should we care?

Incidence of natural disasters



Note: natural disasters include droughts, floods, earthquakes and storms
Source: World Development Report 2014

Uninsured risks from natural disasters hinder (current and future) economic wellbeing

- Apart from death and destruction, extreme weather events found to
  - Reduce **income, consumption** and **productive assets** (e.g. Burkina Faso [Kazianga and Udry 2006]; Ethiopia [Dercon 2004])
  - Reduce **school participation** (e.g. India [Jacoby & Skoufias 1997]; Ivory Coast [Jensen, 2000])
  - Increase **child labor** (e.g. Thailand [Townsend, 1995]; El Salvador [Kruger et al 2004]) and the **incidence of malnutrition** (Bangladesh [Foster 1995])
- Effects could persist over time and be quite regressive (Indonesia [Maccini and Yang 2009]; Zimbabwe [Hoddinott & Kinsey 2001])

This paper

- Estimates the medium-term impacts of a Tropical Storm on
  - **Household wellbeing** (consumption, poverty indicators)
  - **Children's human capital** (school enrollment and health)
  - **Labor force supply responses** (adults and children)

- **Tropical Storm Agatha**: Hit Central America in May 25-30, 2010; Guatemala the hardest hit – largest rainfall since records are kept

- Guatemala is highly vulnerable: one of the poorest countries in LAC; 12th in the list of countries most affected by extreme weather events between 1991-2000

How?

- It employs a standard double-difference analysis

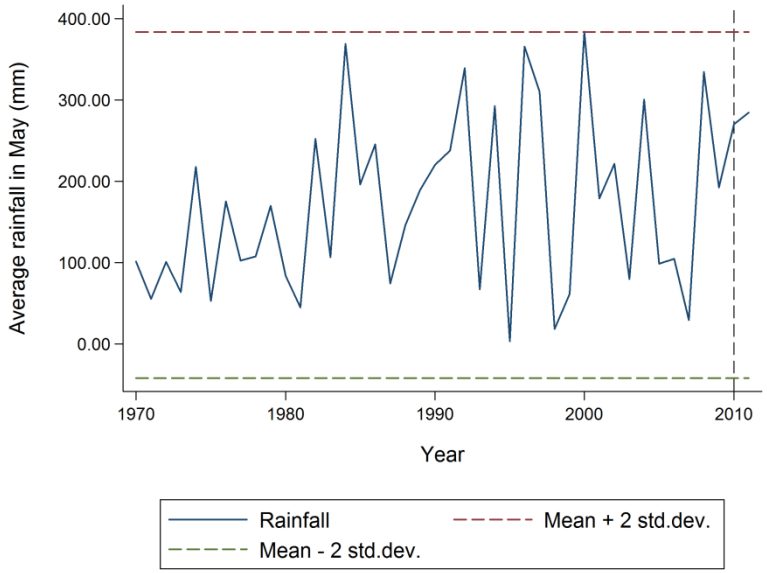
$$Y_{imt} = \alpha_m + 2011_t + \beta Storm_{mt} + X_{imt}{}'\gamma + \varepsilon_{imt}$$

- Using cross-sectional household survey data from 2006 (pre-shock) and 2011 (post-shock)
- Exploits quasi-exogenous variation in the intensity of the shock (monthly and daily rainfall data from 73 weather stations - unbalanced panel for the period 1963-2013)
- Performs several robustness checks
- Examines the possible mechanisms at play

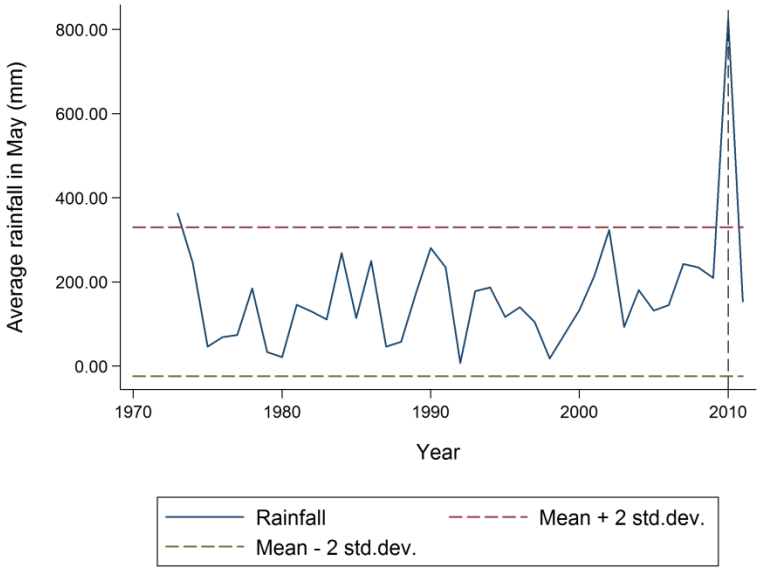
Precipitation anomalies

- A station, i.e. matched municipality, heavily affected if rainfall recorded in May of 2010 is at least two standard deviations above its historical mean

Puerto Barrios station: Not affected

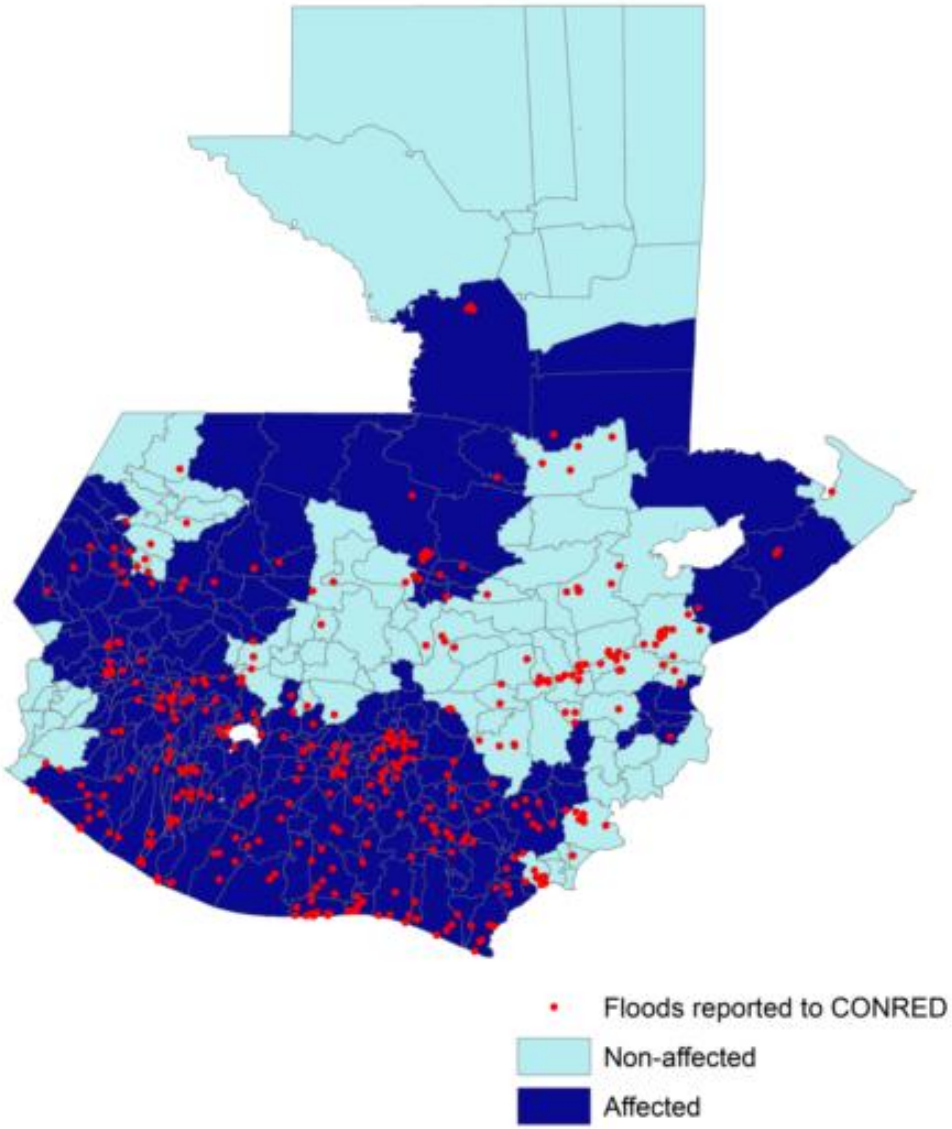


Montufar station: Affected



Source: INSIVUMEH and World Bank.

Precipitation anomalies due to Agatha strongly associated with actual floods

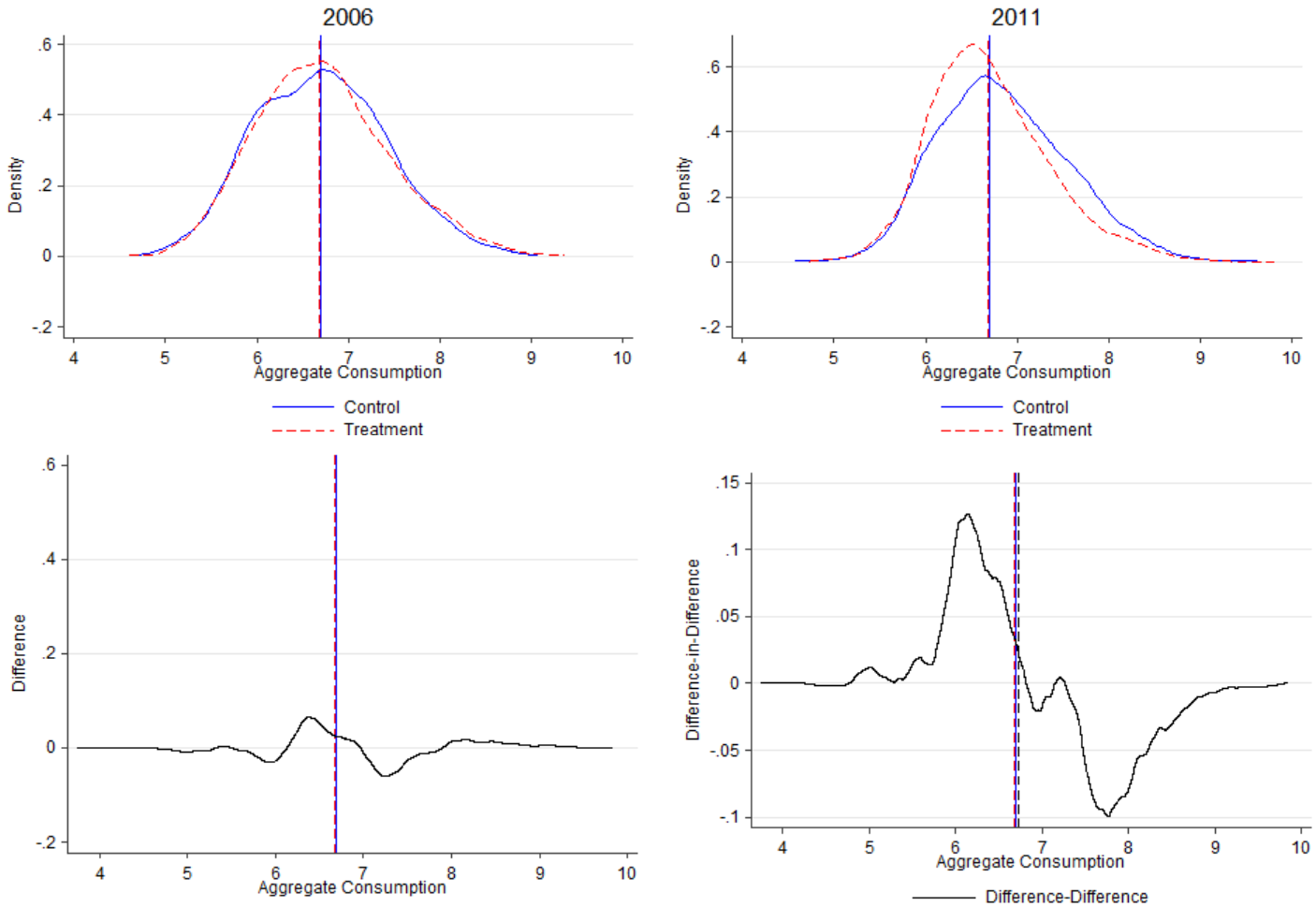


Was the shock really exogenous?

- In principle, the path of storms and hurricanes is exogenous
- In reality, trajectories may hit harder some regions than others in a non-random fashion
- Differences between "treated" and "comparison" units in pre-shock observable characteristics (e.g., age, gender, education, race)
- We condition on cross-sectional time-invariant covariates and municipality fixed effects

Raw DD shows a fall in consumption among affected households

Distribution of consumption per-capita for control and treatment groups (pre- and post-shock)

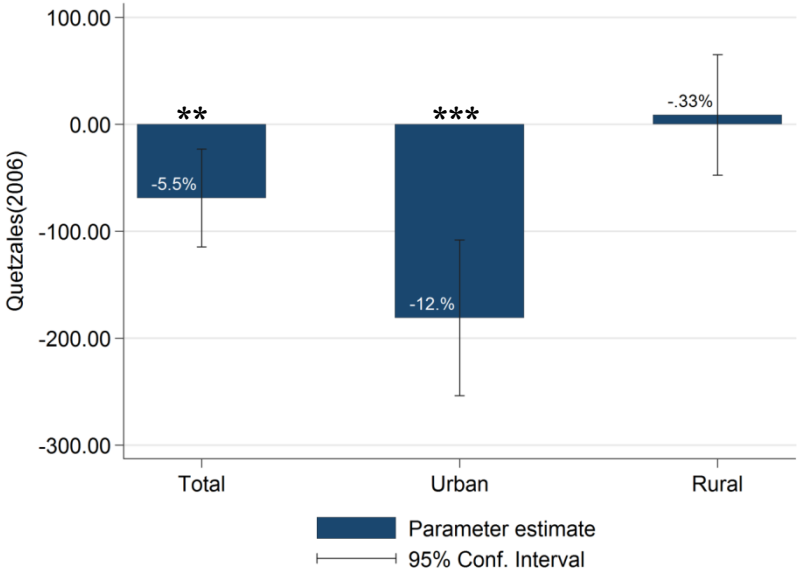


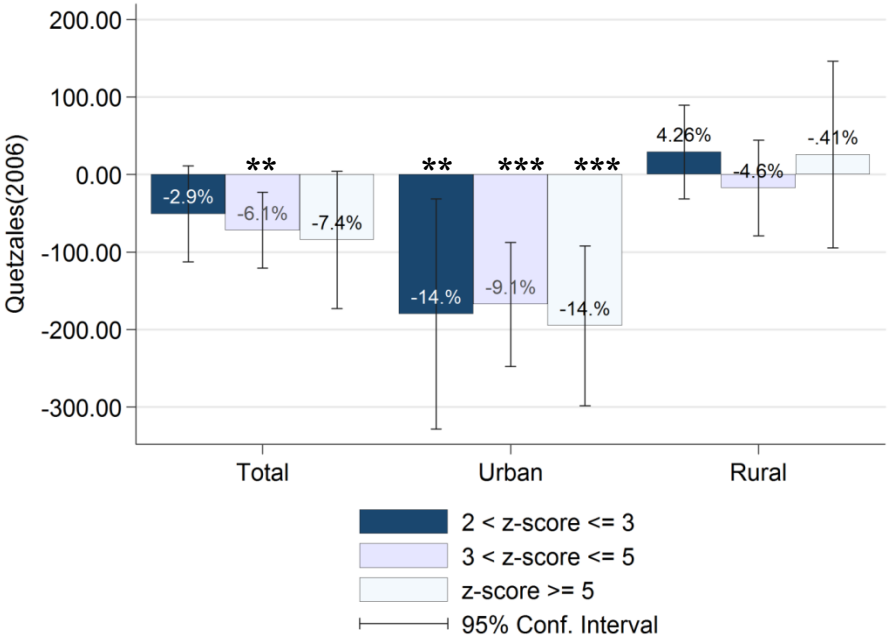
Source: LSMS 2006 and 2011 and World Bank calculations

Conditional DD models confirm that consumption fell, mostly in urban areas

- Overall consumption fell by 5.5% among affected households, 12% among urban households

Impact estimates of the effect of Agatha on household per capita consumption

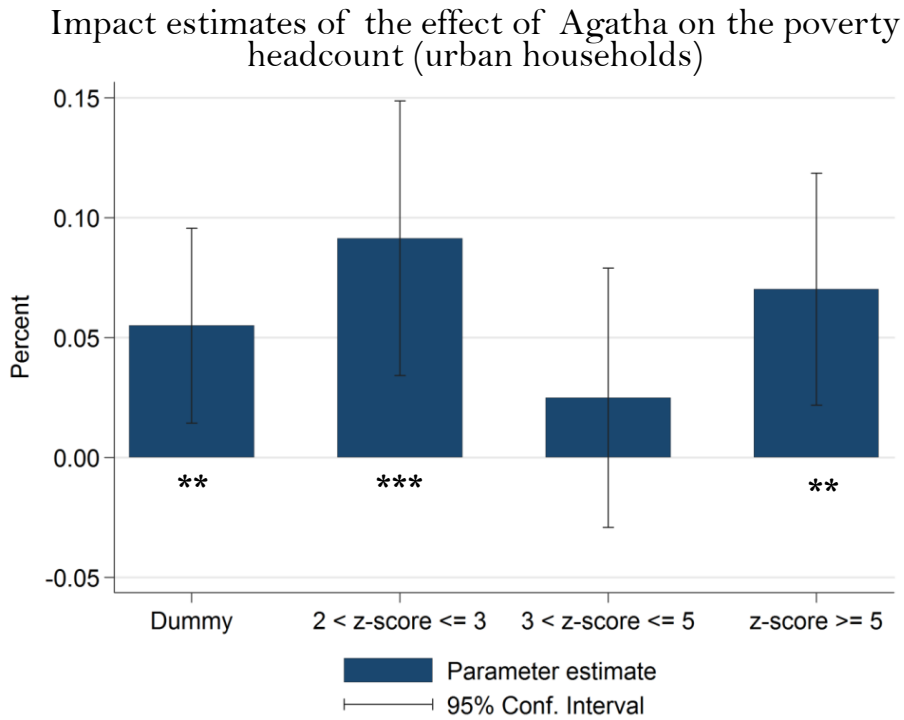




Note: Parameter estimates of the effect of the shock on household consumption per capita from diff-in-diff models. Results in Panel A derived from a binary definition of the treatment while results from Panel B use a treatment intensity specification. Robust standard errors clustered at the municipality level. Estimates significant at 90(*), 95(**), 99(***) percent confidence

The fall in consumption pushed some affected households back into poverty

- The shock increased poverty by 5.5 percentage points (18%)



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Expenditures in food among the most heavily compromised by the shock

- Food expenditures fell by 10%, accounting for close to 40% of the total reduction in consumption
  - A calorie-income elasticity range of 0.2-0.5 implies that consumption of **calories fell by between 43 and 108 per capita per day**

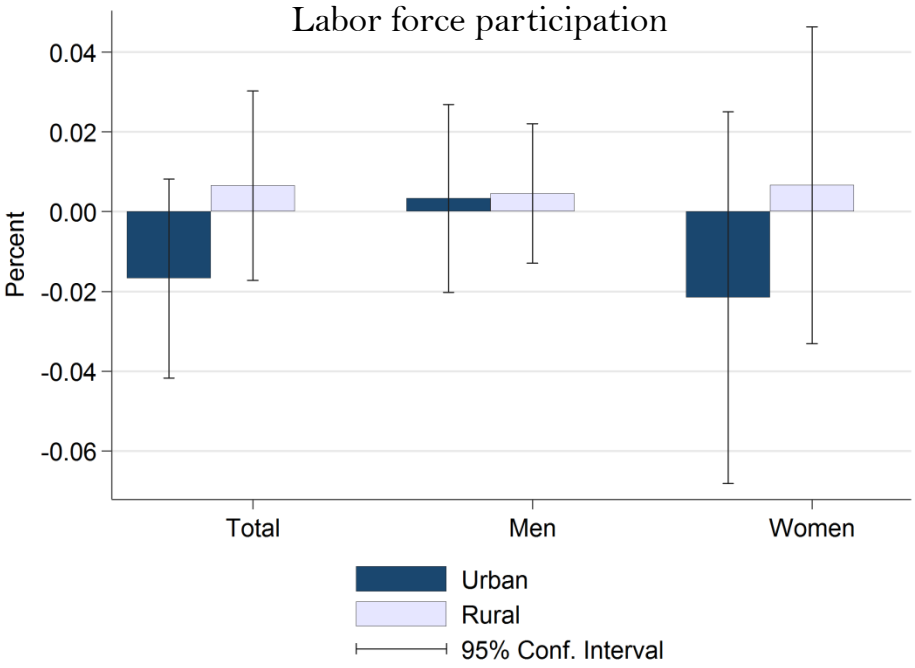
Behind the drop in consumption is a fall in labor income of around 10%

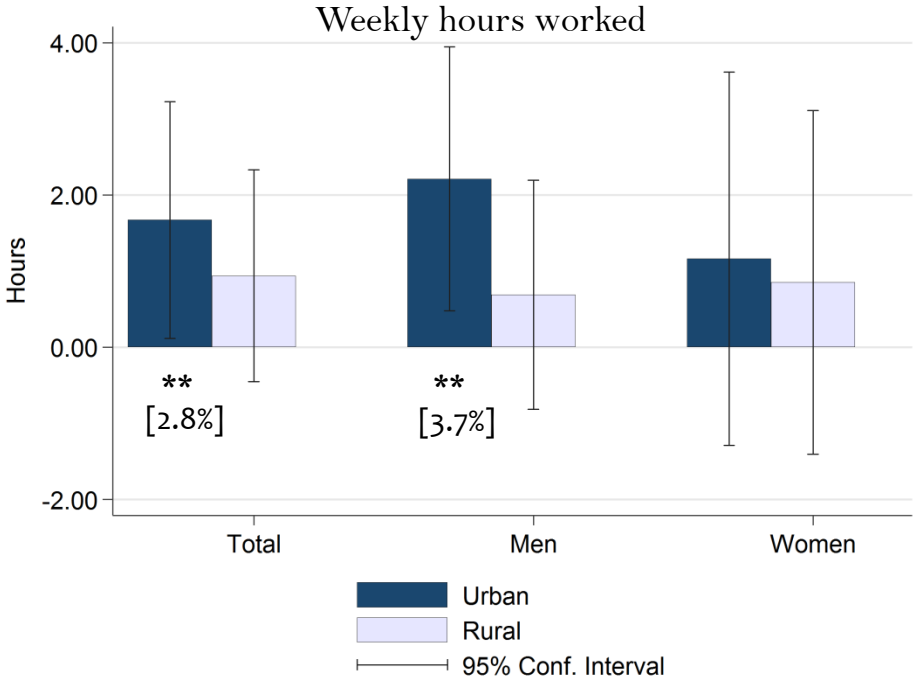
	Total Income Per Capita	*Labor Income Per Capita*	*Labor income from salary work*	*Non-wage income*	*Non-Labor Income Per Capita*	*Private Transfers Per Capita*	*Public Transfers Per Capita*	*Other non-labor income*
Measure of Shock	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Total				
t * (rainfall z-score> 2)	-44.4*	-52.4**	-33.6**	-18.8	12.4	2.9	0.6	-2.9
	[26. 2]	[21.6]	[14.4]	[12.9]	[9.0]	[6.0]	[0.9]	[11.4]
Baseline Mean/Median	566.6	391.7	198.4	46.3	20.50	69.9	10.8	78.3
				Panel B: Urban				
t * (rainfall z-score> 2)	-57.4	-51.9*	-35.7**	-16.2	23.4**	7.2	1.1	-9.6
	[40.7]	[30.4]	[18.1]	[23.1]	[12.6]	[9.5]	[1.0]	[23.6]
Baseline Mean/Median	781.7	556.3	326.2	35.4	15.740	70.8	7.2	142.7
				Panel C: Rural				
t * (rainfall z-score> 2)	-13.7	-22.1	-12.5	-9.6	6.8	2.3	-0.2	1.5
	[30.0]	[23.4]	[16.0]	[14.7]	[10.4]	[7.6]	[1.3]	[6.9]
Baseline Mean/Median	438.6	289	126.5	50.1	23.4	69.2	13.4	31.8

Note: Observations: 26,163 Total; 10,905 Urban; 15,258 Rural. Notes: Results from diff-diff regression. Robust standard errors in brackets clustered at the municipality level. Total Consumption is the monthly expenditure p.c. of a household. Quetzales of 2006. Moderate poverty means that the p.c. expenditure is under the moderate poverty line. Extreme poverty means that the p.c. expenditure is under the extreme poverty line. The poverty gap represents the distance from the household to the poverty line. The Z-scores indicates the number of standard deviations above the rainfall mean (since 1980). t is the before-after dummy.***p<0.01,**p<0.05,*p<0.1

Which prompted a labor supply response of adults on the extensive margin

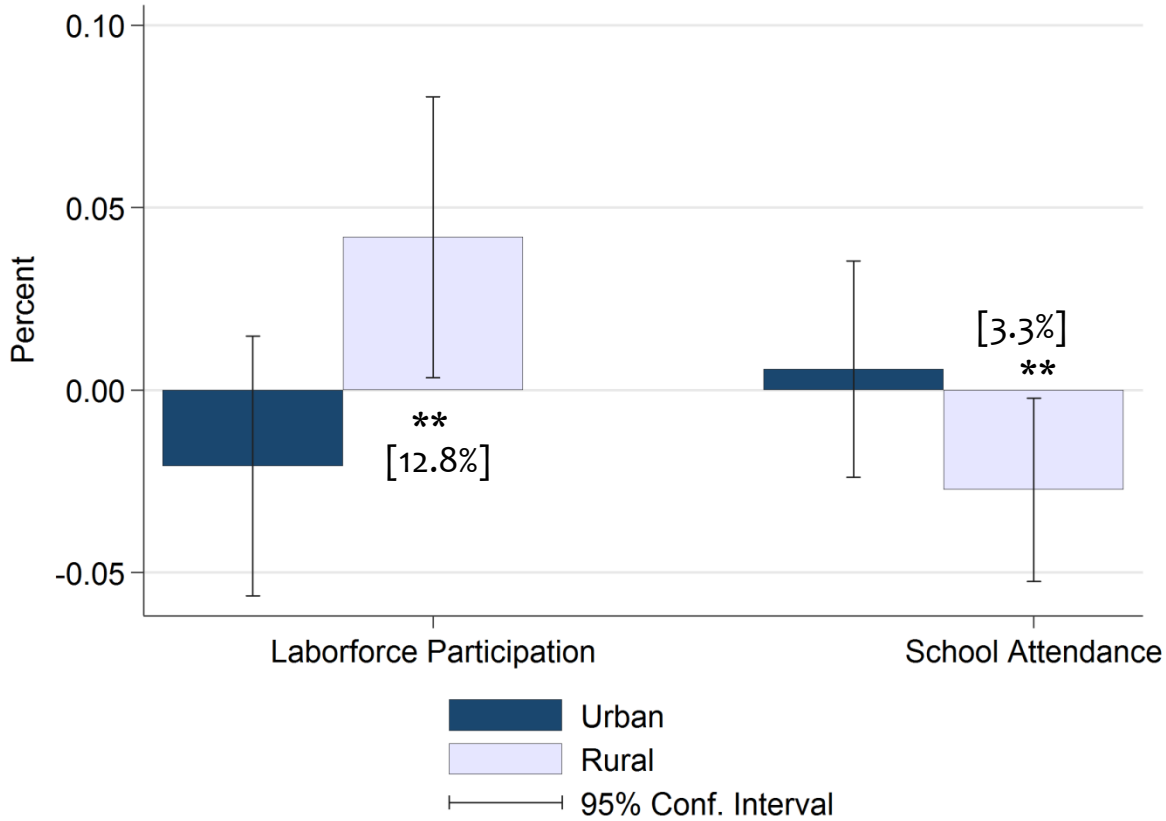
Effects of the shock on adult labor supply





Rural households relied more on the labor supply of their children, reducing school participation

Effects of the shock on labor force and school participation of children



Robustness (I): No placebo treatment effects

- Base results robust to "fake" treatments in pre-shock period, ruling out pre-treatment differential trends

Placebo test: Impact estimates of the effect of Agatha on consumption and poverty on pre-shock period

	Total Consumption	**Moderate Poverty**	**Poverty Gap**
Measure of Shock	(1)	(9)	(11)
t * (rainfall z-score> 2)	-36.633	-0.023	0.002
	[41.047]	[0.030]	[0.015]
Observations	20,788	20,788	20,788
Number of municipalities	322	322	322
Baseline Mean	957.0	0.459	0.174

Note: Parameter estimates from a placebo test of the effect of the shock based on a diff-in-diff analysis using pre-shock data (2000 and 2006)
Source: LSMS 2000 and 2006 and World Bank calculations

Robustness (II): No placebo treatment effects

- Base results robust to "fake" treatments on time-invariant variables in post-shock period, ruling out endogenous compositional changes

Placebo test: Impact estimates of the effect of Agatha on pre-determined variables

Measure of Shock	**Education** (1)	**Age** (2)	**Gender** (3)	**Area of residence** (4)	**Single-married** (5)
t * (rainfall z-score> 2)	-0.238	-0.086	0.014	0.013	0.009
	[0.154]	[0.378]	[0.011]	[0.024]	[0.011]
Observations	23,320	23,500	23,500	23,500	23,498
Number of municipalities	327	327	327	327	327
Baseline Mean	3.966	45.47	0.788	0.424	0.792

Note: Parameter estimates from a placebo test of the effect of the shock based on a diff-in-diff analysis using post-shock data (2006 and 2011)
Source: LSMS 2000 and 2006 and World Bank calculations

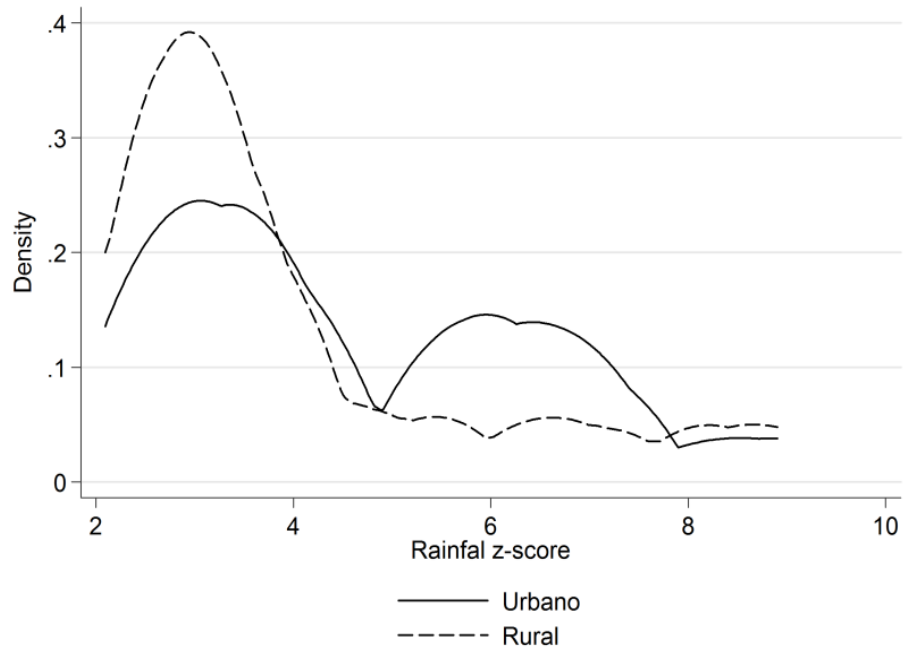
Robustness (III)

- Endogenous migration?
  - Agatha did not push systematically more (or less) households to migrate
- Measurement error?
  - Rainfall variability for the period 1970-2009 does not differ systematically between T and C weather stations
  - Statistically significant association between the continuous shock measure and the occurrence of floods in a village
  - Results robust to alternative definitions of the shock based on different thresholds

Interpretation: Why urban? (I)

- Effects concentrated in urban areas partly explained by the nature of the shock

Standard precipitations anomalies in May 2010 with respect from the long-term mean (1980-2010) for affected households



Source: World Bank calculations

Discussion: Why urban? (II)

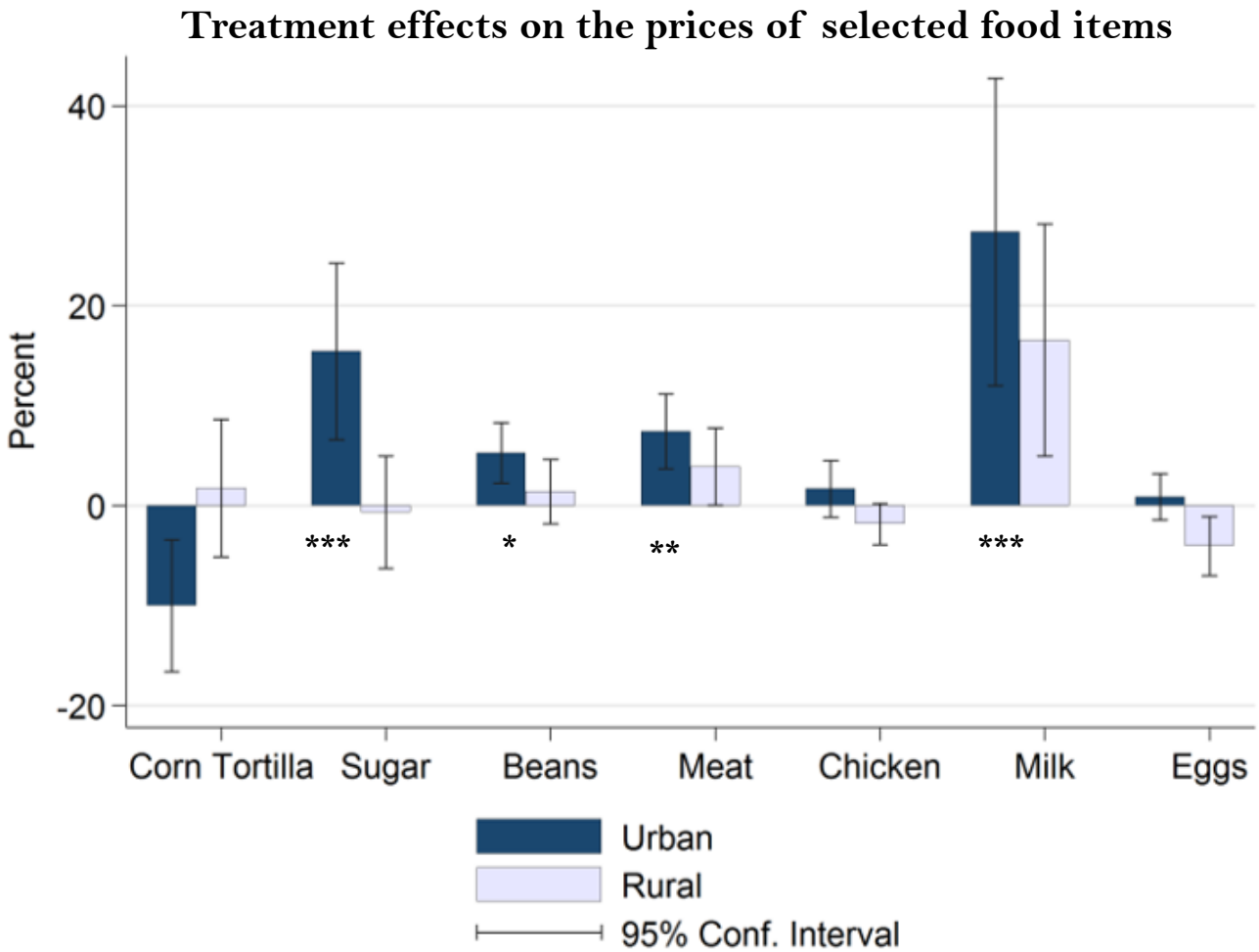
- Food prices began to rise just before the shock and continued that trend during the 10 months following Agatha

Evolution of prices of different consumption items

Source: World Bank calculations

Discussion: Why urban? (II)

- Survey implicit food prices show steep increases in treated areas



Source: World Bank calculations

Discussion: Why urban? (III)

- The "unharmful" timing of Agatha with respect to local agricultural cycles

Agricultural Cycle of Main Crops in Areas Affected by the Shock

	Agricultural land in affected areas	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize	38%					P			H				
									p			h	
Beans						P			H				
										p			h
Coffee	22%		H							H			
Sugar Cane	18%		H and P									H	

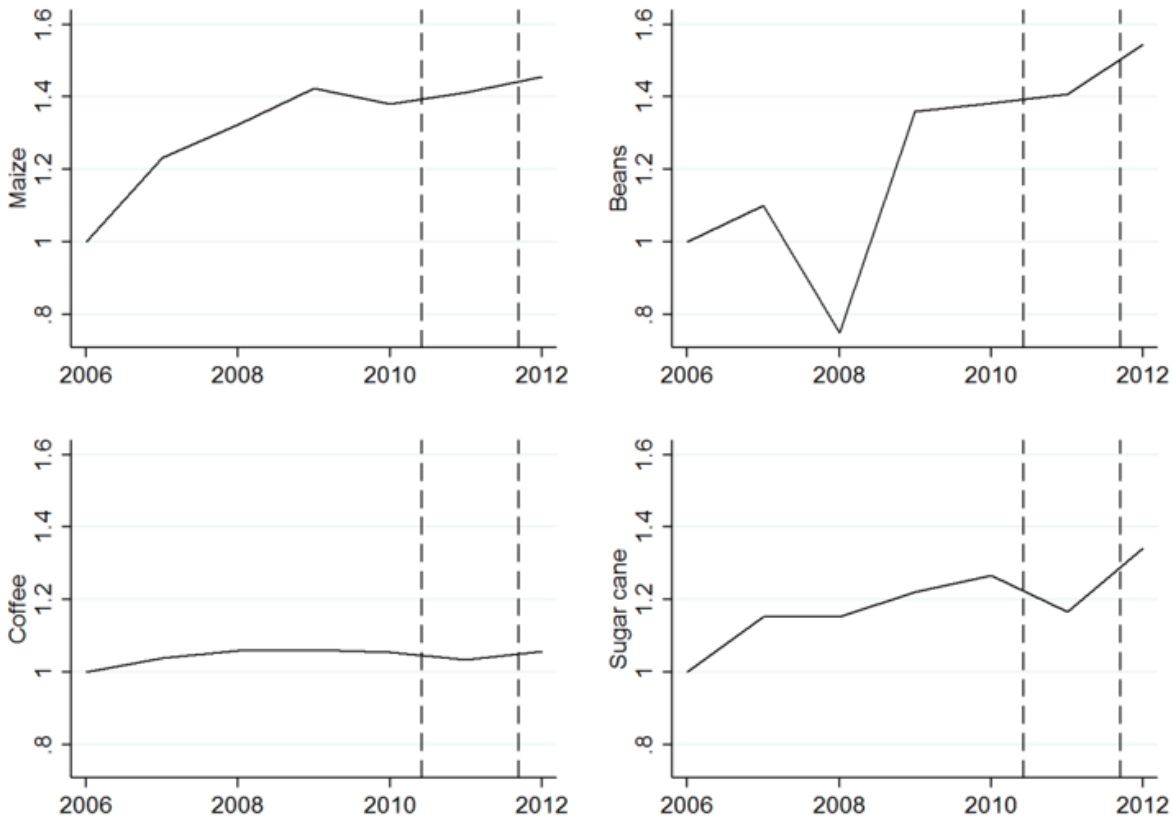
Note: H = first harvesting season; P = first planting season; h = second harvesting season; p = second planting season. Vertical gray bar corresponds to the timing of the Tropical Storm

Source: Guatemalam Department of Food Security.

Discussion: Why urban? (III)

- The "unharmful" timing of Agatha with respect to local agricultural cycles

Annual Domestic Production (2006-2012)

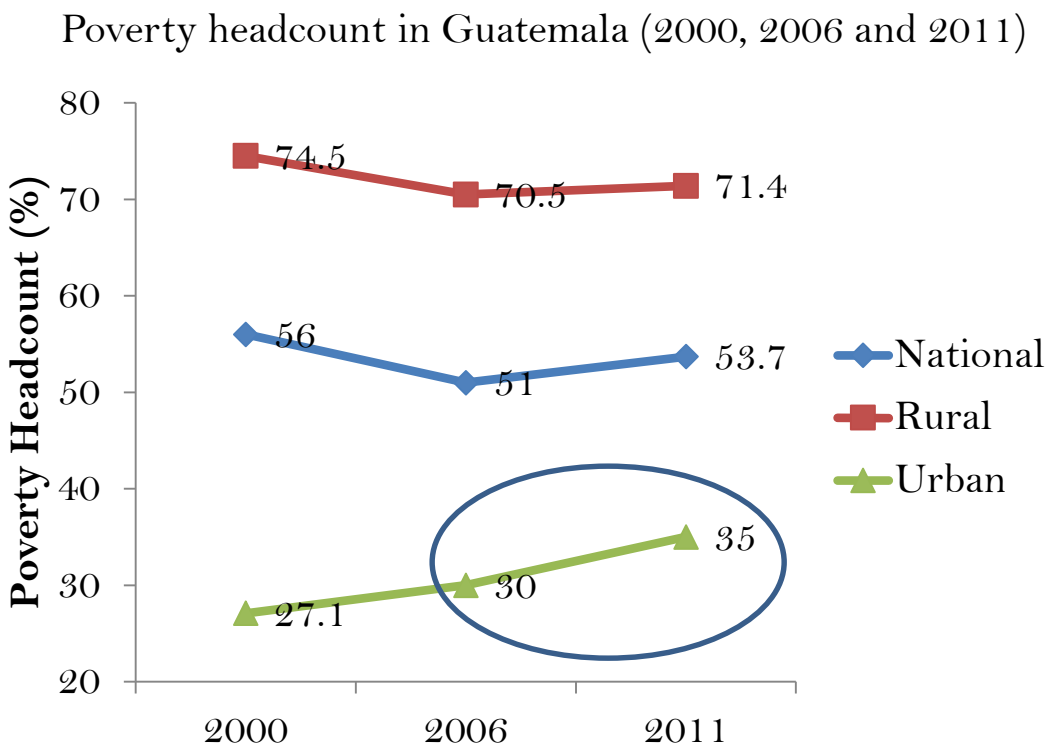


Notes: dotted line denotes the interval of time covered in the analysis
Source: Calculations by the authors based on data from Faostats (FAO).

Conclusions

- Robust evidence that Storm Agatha led to a sizable –and possibly persistent– deterioration of human welfare
- Similar impacts widely documented in the literature but often concentrated in rural areas – this paper shows that urban areas are as vulnerable
- Magnitude of the effects is not trivial:
  - 50,000-80,000 additional families fell into poverty
  - Agatha responsible for part of the increase in poverty between 2006 and 2011 –often attributed solely to the effects of the global and food price crises.
- Ignoring the detrimental consequences of shocks on human welfare will hinder the effectiveness of development policy

Poverty headcount in Guatemala



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