Natural Hazards, Growth and Risk-Transfer

An Empirical Comparison between Risk-Transfer-Mechanisms in Europe and the USA

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Motivation

2002 flooding in Germany and Austria

- A low penetration of flood insurance coverage (among private homeowners) ($\approx$ 10%)
- Governments (ad-hoc, catastrophe fund) incapable of providing sufficient relief
  - Austria: $\approx$ 50% of damages covered by federal relief
  - Austria: average time span between damage and transfer of funds: 85 days
- Provision of federal relief is influenced by discretionary decisions by politicians - *Rubber-boots-policies*
  - Germany: "Schroeder-Rule" financed by postponing a tax reform.
  - Austria: Reduction of public spending in other areas.

Motivation

Public discussion about implementing alternative (ex-ante) insurance systems

- Imperfections on market for flood insurance
- Various forms of existing mandatory insurance schemes
- Proposition: Ex-ante risk transfer mechanisms (e.g. mandatory insurance) are more efficient than ex-post policies (e.g. ad hoc governmental relief) (Kunreuther & Pauly 2006)
- "Case study evidence" - Limitation on demand side (e.g. claim processing)
- Empirical evidence missing

Outline

- Panel-econometric analysis of the effects of floods on income
- Compare the effects of existing societal risk-transfer mechanisms against flood

Europe	**USA**
212 NUTS II - regions	3,085 counties
Mandatory Insurance	U.S. NFIP
Ad-hoc governmental intervention	Ad-hoc governmental intervention

- Presentation of results structured by sample

Summary of Results

- Floods have a negative impact on income in flood year
- Floods have a positive impact on income in the year after the flood
- Mitigating effects of ex-ante risk-transfer mechanisms in the flood year (Europe & USA)
- Negative effects of ad-hoc governmental intervention in flood year (Europe & USA)
- NFIP counties follow a less volatile growth path in years following a flood (USA)

Natural Hazards and Economic Development

Impact on Economic Growth

- + (Skidmore & Toya 2002)
  - Destruction of old (less productive) technology
  - Increase in total factor productivity
- - (Rasmussen 2004 - Caribbean)

Drawbacks of existing empirical studies

- Space:
  - Analysis so far: Country-level
  - Comparing a flood with the same spatial extent in the USA and Austria
  - Assuming same absorptive capacity (e.g. infrastructure)

⇒ "The smaller, the better" - regional units

- Time:
  - Analysis so far: Long-run
  - Effect of x of disasters over n years
  - Omitted variables that account for dynamics over time (e.g. economic freedom, degree of federalism)
  - Higher frequency of disasters in the future? (IPCC 2007)

⇒ Analysis of short-run effects

Disasters in an endogenous growth model

- Solow growth model and
- Economics of disaster management (Tol & Leek 1999)
- Derivation of panel-econometric growth function (Islam 1995)
- Negative effect of disaster
- Mitigating effect of risk-transfer (depending on level of coverage)
- Costs of risk-transfer (depending on coverage)

Economic data

- 199 European regions (NUTSII) (EU15 + CZ, H, N, PL & CH)
- Yearly data 1980-2004
- European Regional Database, Cambridge Econometrics
- Eurostat

- 3,050 U.S. counties
- Yearly data 1970-2003
- Regional Economic Information System, BEA, U.S. Department of Commerce

Hazard data

1. Historical flood events:

1. Europe:
   - Major flood events
   - EM-DAT, CRED Brussels
2. U.S.A:
   - Flood events on county level (Damage: >$ 50.000)
   - Sheldus database, University of South Carolina

Hazard data

Flood dummy:

1. "Economic damages" inaccurate, inconsistent collection methods
2. Disaster damages are endogenous
3. Exogenous variables on magnitude !?
4. Effects of an *average* flood

Hazard data

2. **Flood hazard distribution: (Robustness test)**
   - Magnitude of flood might differ between regions
   - Controlling for regional exposure
   - GIS-data on flood areas
   - Calculation of regional (NUTSII or county) mean
   - Cross section data! - Interaction term
   - Worldbank and Columbia University (Dilley et. al. 2005)

Risk-Transfer mechanisms

1. **Ex-ante Risk-transfer mechanism**

Variable	Benefits	Costs	Variation
Europe:			
Mandatory insurance	+	n.a.	Countries
U.S.A:			
National Flood Insurance Program (NFIP)	+	-	Counties & Years

Risk-Transfer mechanisms

2. Ex-post discretionary political decisions

- No (comprehensive) data on governmental relief on regional level available
- **Rubber-boots-policies:**
    - Discretionary, "unbureaucratic" financial assistance
    - Generosity is higher in election years
    - $\approx$ 50% of FEMA's disaster payments are politcally motivated (Garrett & Sobel 2003)

$$\Downarrow$$

Election years as empirical proxy for discretionary federal disaster relief

Risk-Transfer mechanisms

2. Ex-post discretionary political decisions

Variable	Benefits	Costs	Variation
Europe:			
Federal Election years	+	not directly in subsequent years	Country & Year
U.S.A:			
Federal Election years	+	not directly in subsequent years	Year
Presidential Election years	+	not directly in subsequent years	Year

Empirical strategy: Europe

- Presence of lagged (endogenous) dependent variable ($\ln y_{i,t-1}$)
- Large number of N (counties, regions) vs. small number of T
- $\Rightarrow$ Dynamic panel models
- Lags of $Flood_{it}$, $Flood * Insurance_{it}$ as additional instruments for ($\ln y_{i,t-1}$)
- Judson & Owen 1999: $T = 24 \Rightarrow$ One-step GMM-Diff estimator (Arellano & Bond 1991)

Effects of flood events regional GDP in Europe, GMM-DIFF-estimator, 1980-2004

Dependent Variable $\ln y_{it}$	1.1	1.2	1.3	1.4
$\ln y_{i,t-1}$	0.438***	0.438***	0.442***	0.437***
	(9.14)	(9.20)	(9.44)	(9.11)
$\ln s_{it}$	0.182***	0.180***	0.181***	0.188***
	(6.42)	(6.37)	(6.33)	(6.57)
$Agriculture_{it}$	−0.097***	−0.096***	−0.096***	−0.098***
	(−5.71)	(−5.71)	(−5.44)	(−5.55)
$Service_{it}$	0.136**	0.137**	0.160**	0.154**
	(2.14)	(2.12)	(2.27)	(2.34)
$Flood_{it}$	−0.004*			−0.006**
	(−1.78)			(−2.36)
$Flood_{i,t-1}$		−0.000		
		(−0.08)		
$(Flood * Exposure)_{it}$			−0.001***	
			(−3.09)	
$(Flood * Insurance)_{it}$				0.007*
				(1.75)
Year FE	Yes	Yes	Yes	Yes
Number of obs.	4,277	4,277	4,277	4,277
Number of Instruments	194	194	184	205
Prob $>$Chi^2	0.000	0.000	0.000	0.000
Sargan	0.208	0.147	0.191	0.264
AR(1)	0.000	0.000	0.000	0.000
AR(2)	0.244	0.246	0.246	0.242

Marginal effects of flooding and risk-transfer mechanisms European regions

Marginal effect of flood disasters	$Flood_{it}$ M.E. (Std.Err.)	$Flood_{i,t-1}$ M.E. (Std.Err.)	$Flood * Exp_{it}$ M.E. (Std.Err.)	$Flood_{it}$ M.E. (Std.Err.)
In regions without risk-transfer	−0.004* (0.002)	−0.000 (0.002)	−0.001*** (0.000)	−0.006** (0.003)
In regions with risk-transfer				0.000 (0.003)

Marginal effects of flooding and election years in European regions

Marginal effect of flood disasters	$Flood_{it}$ M.E. (Std.Err.)	$Flood_{it}$ M.E. (Std.Err.)	$Flood_{i,t-1}$ M.E. (Std.Err.)
In years without federal elections	−0.004*	−0.003*	0.004**
	(0.002)	(0.003)	(0.002)
In years with federal elections		−0.007**	−0.009***
		(0.003)	(0.003)

Empirical strategy: USA

- Presence of lagged (endogenous) dependent variable ($\ln y_{i,t-1}$)
- Large number of N (counties, regions) vs. small number of T
- $\Rightarrow$ Dynamic panel models
- Lags of $Flood_{it}$, $Flood * Insurance_{it}$ as additional instruments for ($\ln y_{i,t-1}$)
- Judson & Owen 1999: $T = 30 \Rightarrow$ First-Difference estimator Anderson & Hsiao (1981)

Empirical strategy: USA

- Income and Participation decision NFIP - subject to reversed causality
- Endogenous treatment (Heckman 1978)
  1. Probit regression on participation decision for every year
  2. Calculation of inverse Mill's ratio
  3. Mill's ratio as additional instrument for NFIP and Interaction term

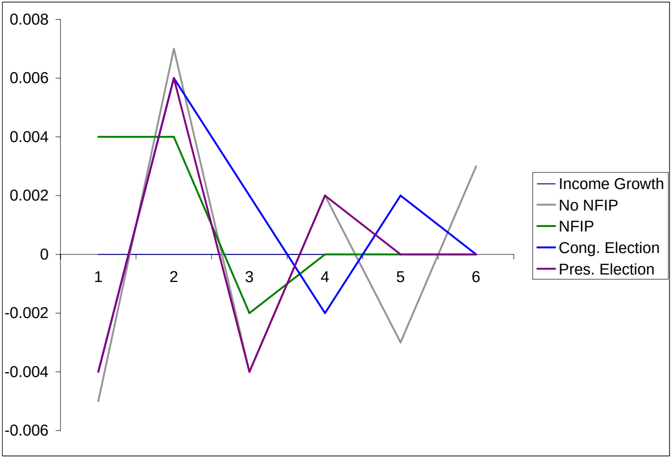
The effects of floods on personal income in U.S. counties

Dependent Variable	FE	IV-FE	AH-FD
$\ln y_{it}$	3.1	3.2	3.3
$\ln y_{i,t-1}$	0.658***	0.801***	0.127***
	(0.006)	(0.007)	(0.047)
$\ln(Agric.\ Inc._{it})$	0.025***	0.023***	0.035***
	(0.001)	(0.001)	(0.001)
$\ln(Pop.\ density)_{it}$	0.013***	−0.002	0.047
	(0.002)	(0.002)	(0.030)
$BEA\ Corr.$	0.012***	0.015***	0.009***
	(0.001)	(0.001)	(0.002)
$Flood_{it}$	−0.005***	−0.005***	−0.004***
	(0.001)	(0.001)	(0.001)
$(Flood * Insurance)_{it}$	0.003***	0.002***	0.010***
	(0.001)	(0.001)	(0.003)
$(NFIP)_{it}$	0.002**	0.002**	−0.096***
	(0.001)	(0.001)	(0.007)
County FE	Yes	Yes	No
Year FE	Yes	Yes	Yes
Number of obs.	92,407	86.444	67,350
Prob >Chi^2	0.000	0.000	0.000
R^2	0.984		
Number of Instruments		38	34
Hansen J-Stat		0.662	0.213
Kleinbergen-Paap-Stat		0.000	0.000
1stStage F-Stat. $\ln y_{i,t-1}$		121.83***	116.03***
1stStage F-Stat. $(NFIP)_{it}$			178.00***
1stStage F-Stat. $(Flood * Ins.)_{it}$			1,845.43***

Marginal effects of floodings and the NFIP in U.S. counties

Marginal effect of flood disasters	$Flood_{it}$ M.E. (Std.Err.)	$Flood_{i,t-1}$ M.E. (Std.Err.)	$Flood * Exp_{it}$ M.E. (Std.Err.)	$Flood_{it}$ M.E. (Std.Err.)
In regions without risk-transfer	−0.004*** (0.001)	0.007*** (0.001)	−0.001*** (0.000)	−0.005** (0.001)
In regions with risk-transfer				0.002*** (0.001)

Deviation from growth-path by risk-transfer system over time (U.S. sample)



Future Research

- Dynamic-Spatial-Panel estimates - Effects of a flood in neighboring regions
- Decompose benefits into:
  1. Pre-disaster: Incentives for prevention
  2. Post-disaster: More efficient relief
- Costs of ex-ante risk-transfer mechanisms - Cross section (Diff-in-Diff)

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