Insuring Growth: The Impact of Disaster Funds on Economic Development

Alain de Janvry, Alejandro del Valle, and Elisabeth Sadoulet

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Natural disasters have negative and persistent effects on economic development

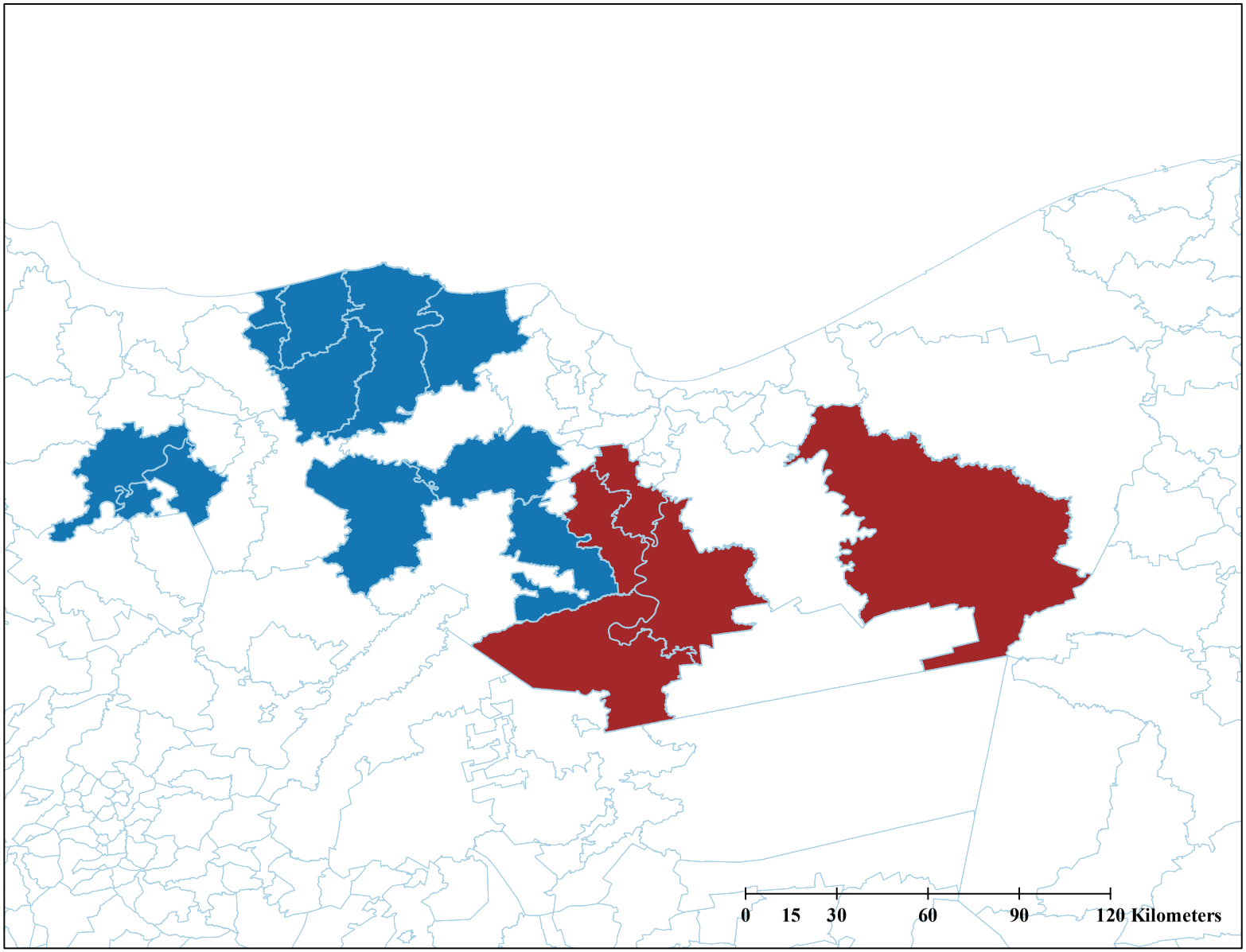
- In *developing economies*, natural disasters have particularly large and persistent effects on economic performance
  - In the long run: a single percentile 90 hurricane can undo 3.7 years of average economic growth, Hsiang and Jina (2014)
  - In the medium run: Anttila-Hughes and Hsiang (2013) argue that damage created by west pacific hurricanes one year after the event is 15 times larger than the immediate damages

Can Disaster Funds provide a cost effective way of mitigating these losses ?

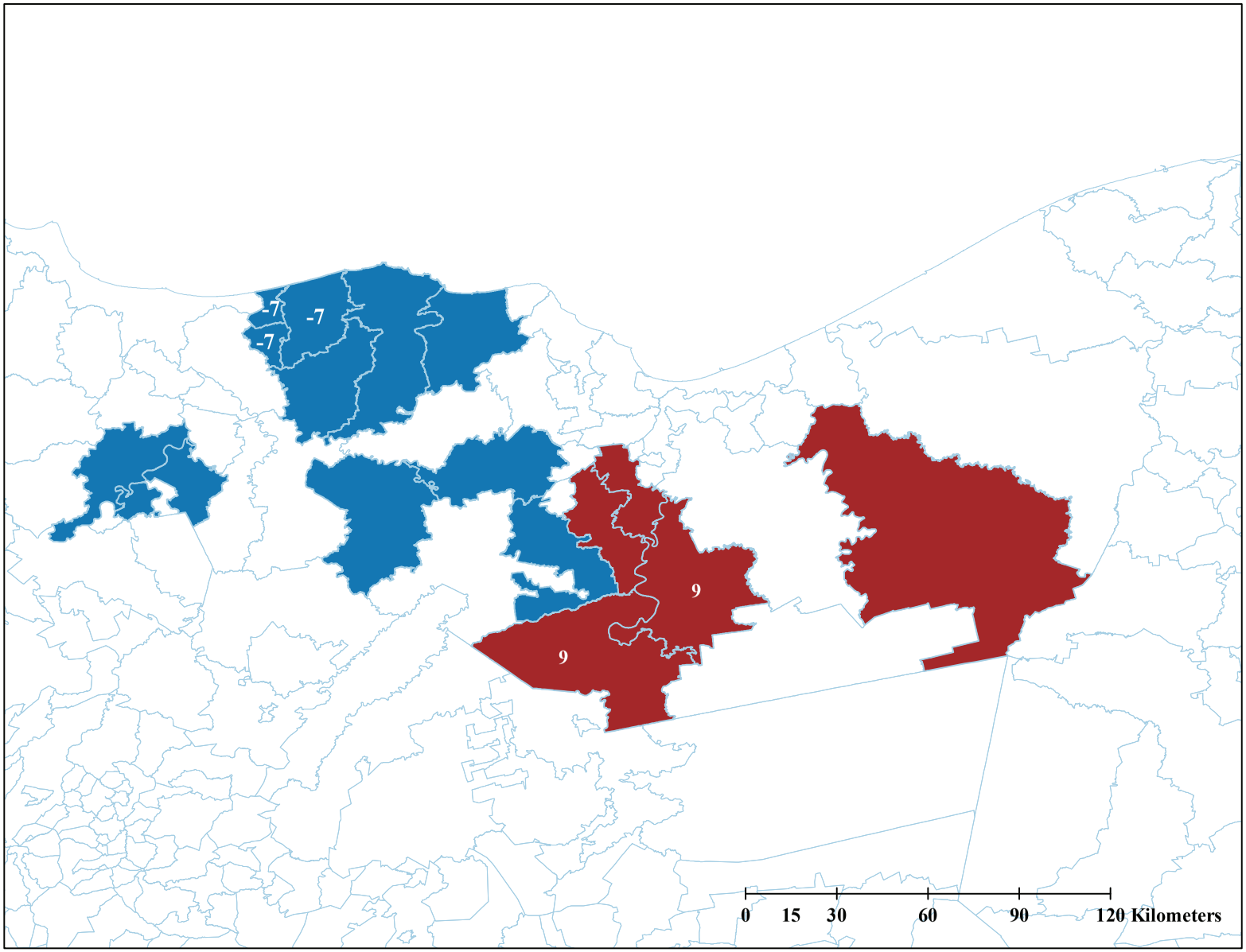
- Disaster Funds: ex-ante budgeting allocations for post-disaster reconstruction
- Disaster Funds provide a double gain:
  - Reduce the opportunity cost of reconstruction
  - Allows firms and households to better manage risk by knowing in advance the government response

We use a unique dataset and natural experiment to provide some of the first estimates of the impact of disaster funds on local economic activity

We exploit a nearly ideal research enviroment: Mexico's FONDEN

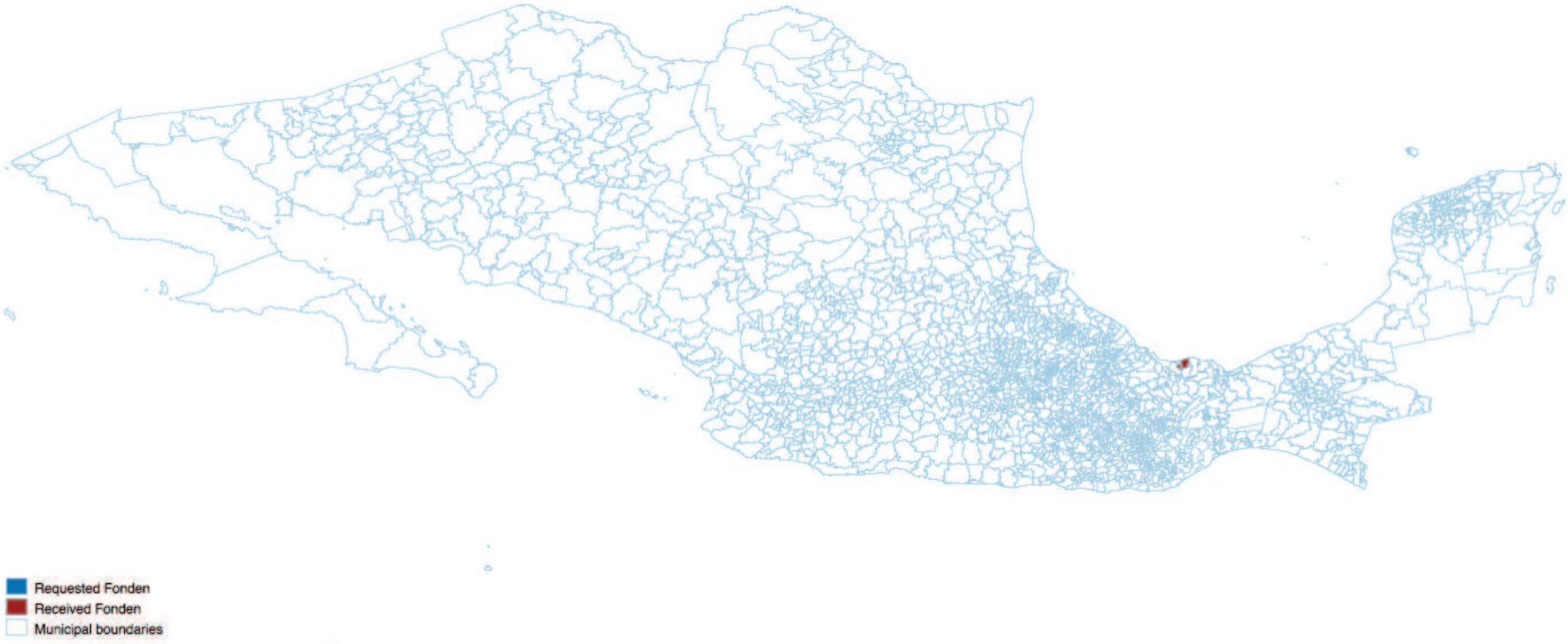


Our source of variation is created by Fonden disaster thresholds

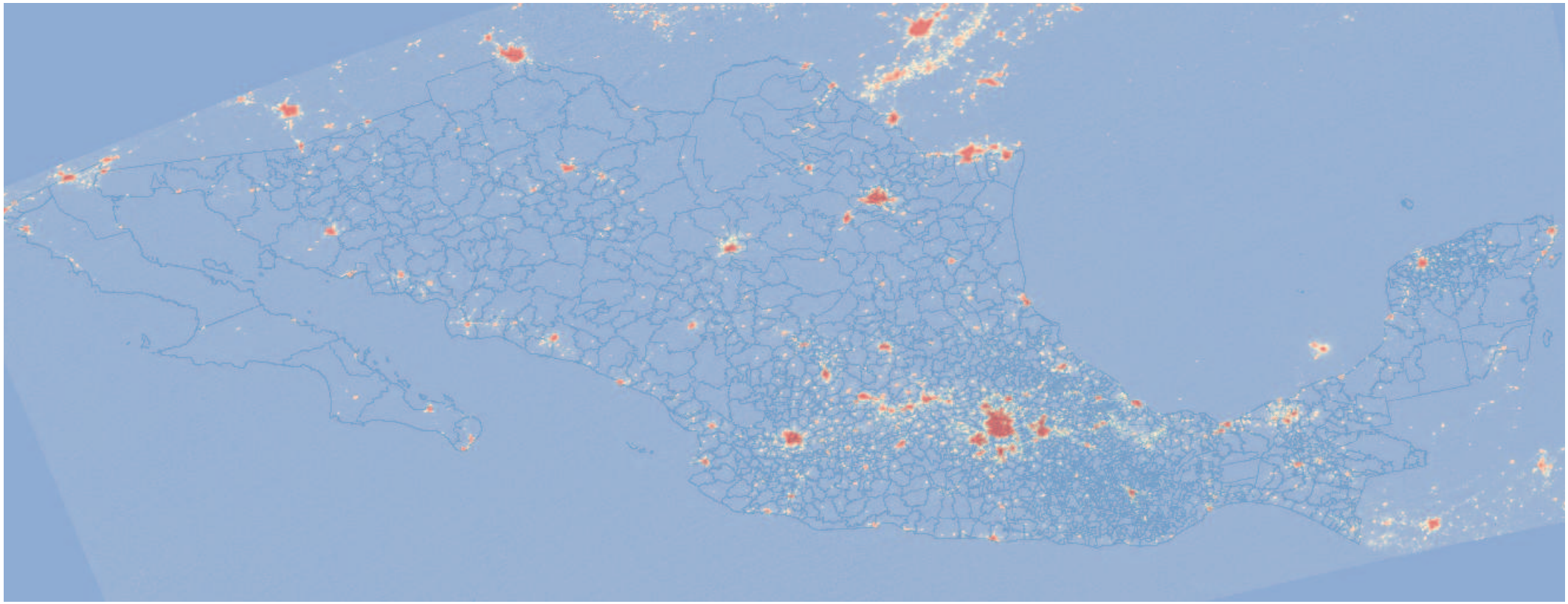


Heavy Rain Events (2004-2013)

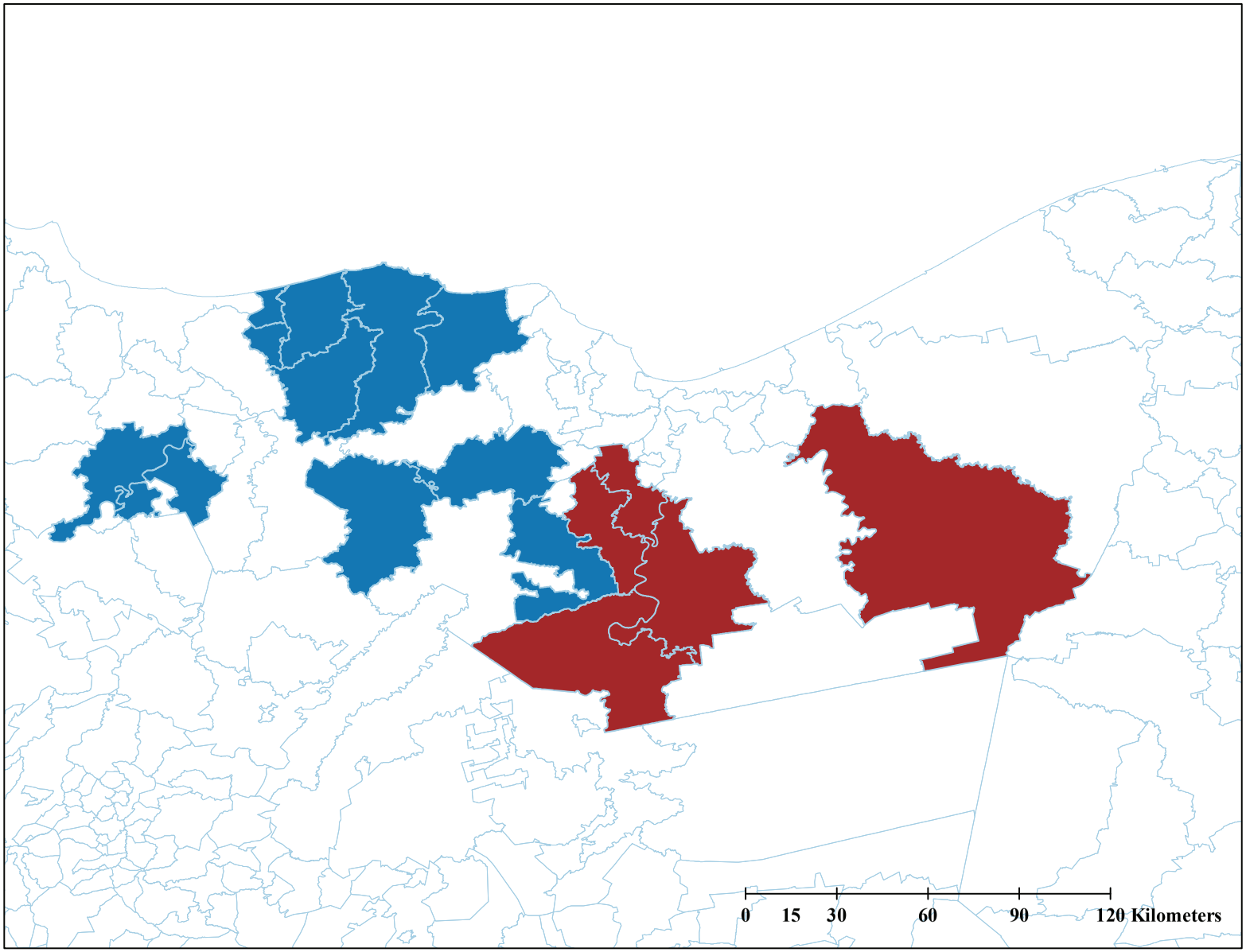
74% of municipalities will request Fonden funding



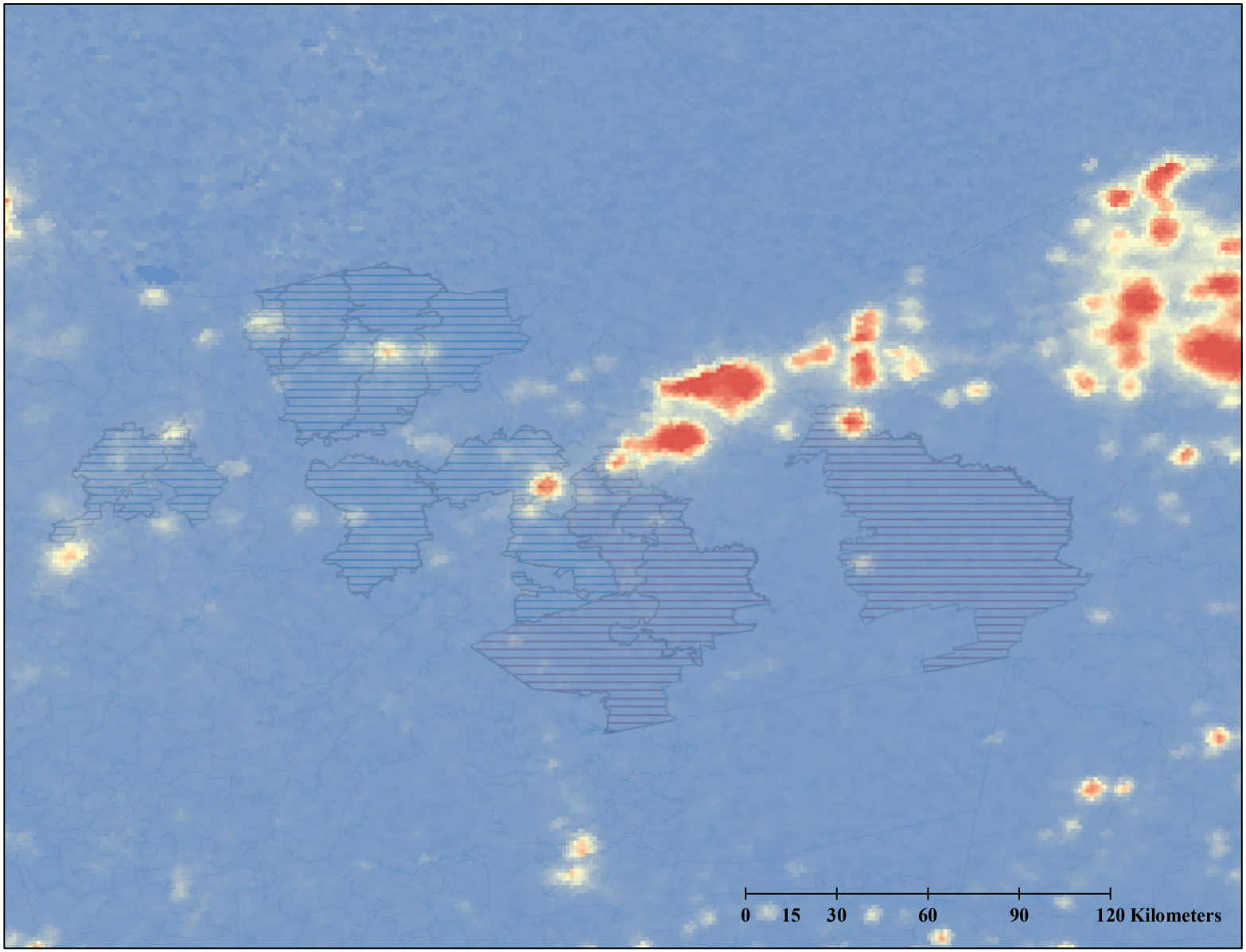
We measure economic activity using *night lights* imagery



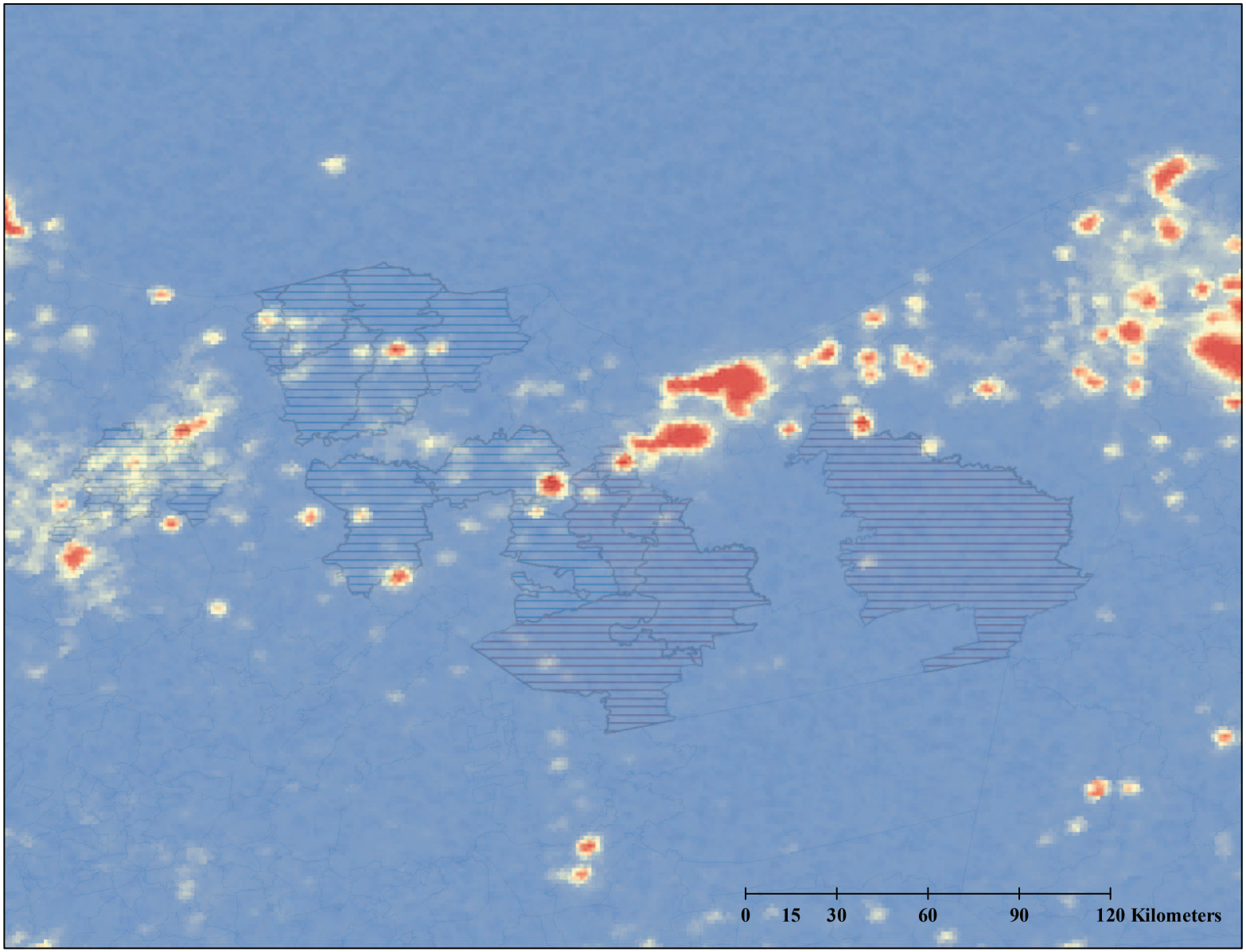
We measure LOCAL economic activity using night lights



Year the disaster takes place



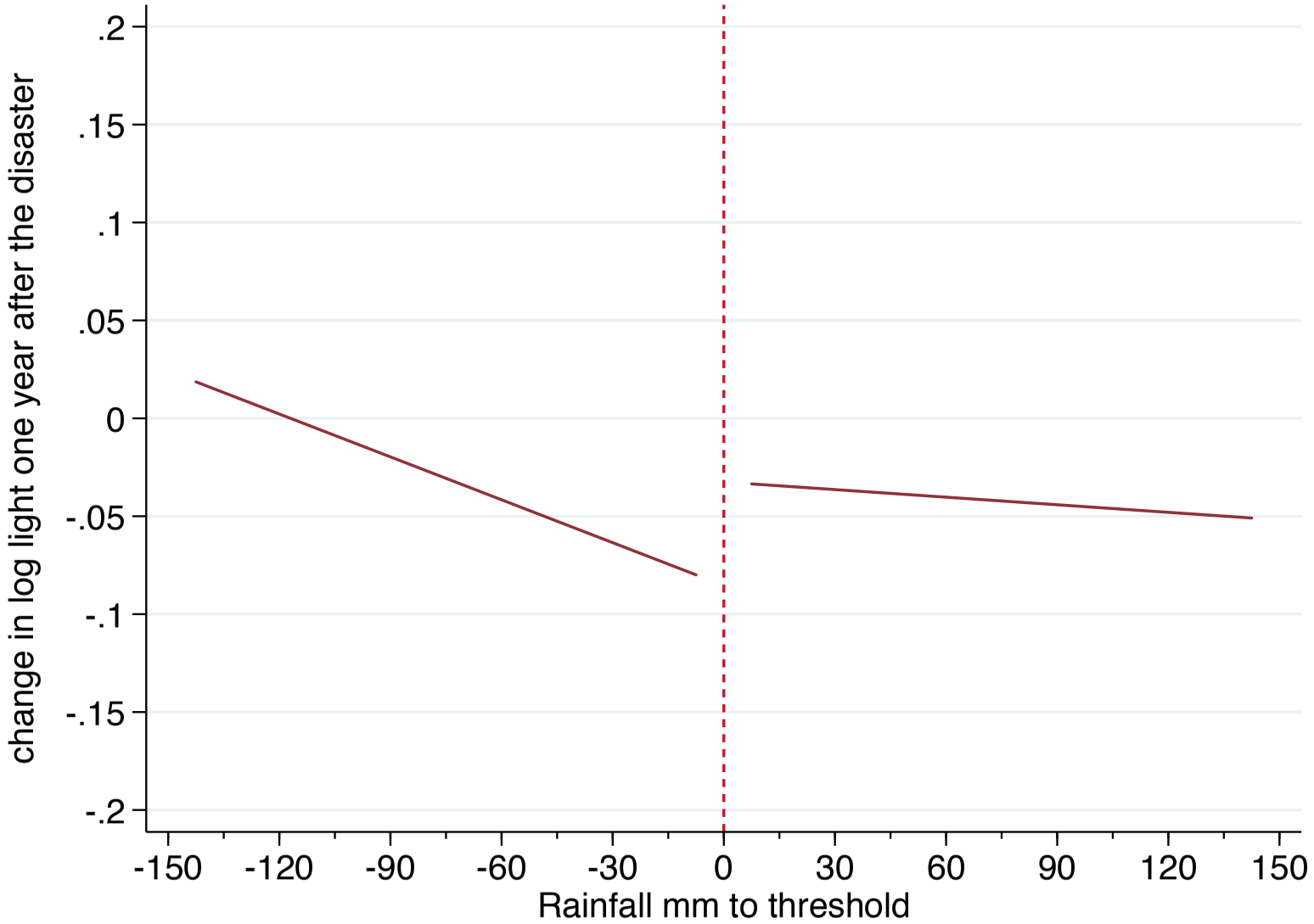
One year after the disaster occurs



Night lights are good proxies of local economic activity

- We Following Henderson et al. (2011) and calculate for every municipal year observation:
  - $log\_light = ln\left(\frac{\sum_{p=1}^{P} DN_p}{\sum_{p=1}^{P} Area_p}\right)$
- Our log light measure explains up to 43% of the variation in state level GDP.
- Strongly correlated to municipal level proxies of economic activity.

We expect Fonden to mitigate the impact of Natural Disasters

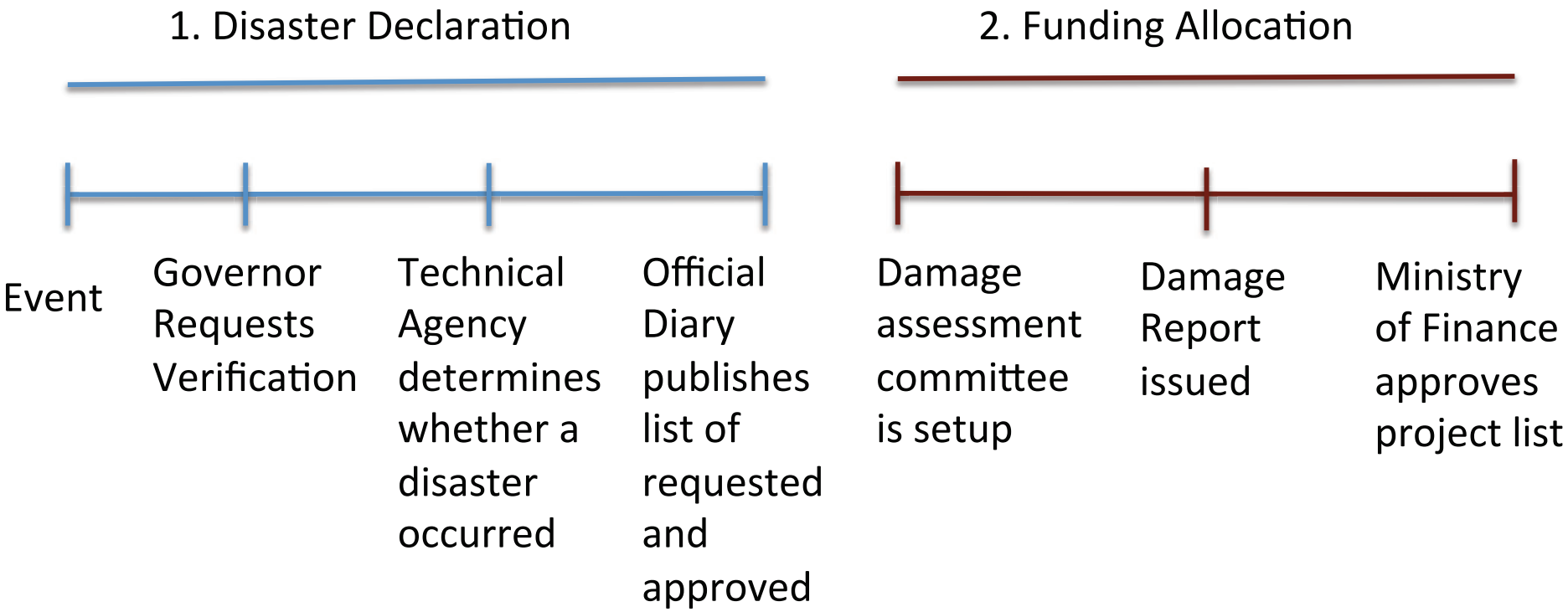


Mexico's Natural Disaster Fund: Fonden

- Program by the government of Mexico began operating in 1999
- Financed by a protected budget allocation, and through the placement of CAT-Bonds
- Provides rapid reconstruction funds for low-income housing and public infrastructure
  - Rebuild roads, hydraulic, health, and educational infrastructure
  - Roads account for 56% of overall expenditures, and for more than 70% of expenditures in some years

Fonden may operate by enabling municipalities to quickly rebuild their road network following a disaster.

Fonden two-step funding process



Disaster Declarations (2004-2013)

- Bulk of disaster declaration correspond to rain related events
  - Heavy rain, areal flooding, riverine flooding, landslides, hail storms, and hurricanes
  - Rain related: 305 declarations, 7200 municipal requests
  - **Heavy rain**: 226 declarations, 5126 municipal requests
- Threshold: heavy rain occurs in a municipality when rainfall is greater or equal to the percentile 90 of historic rain recorded at any of the representative weather stations

Datasets 2004-2011

- NASA-NOAA: Annual light composites
- Official Diary: Disaster Declarations
- Conagua: Daily Rainfall, mapping of weather stations to municipalities, and P90 thresholds.

We use a fuzzy regression discontinuity design

- We may still have rainfall events, like riverine flooding, misclassified as heavy rain events.
- We are unable to fully match municipalities to the set of weather stations used for verification.
- For today's presentation we restrict the sample to 1745 municipal heavy rainfall requests.
  - 25% of the sample we could possibly exploit.

Descriptive statistics

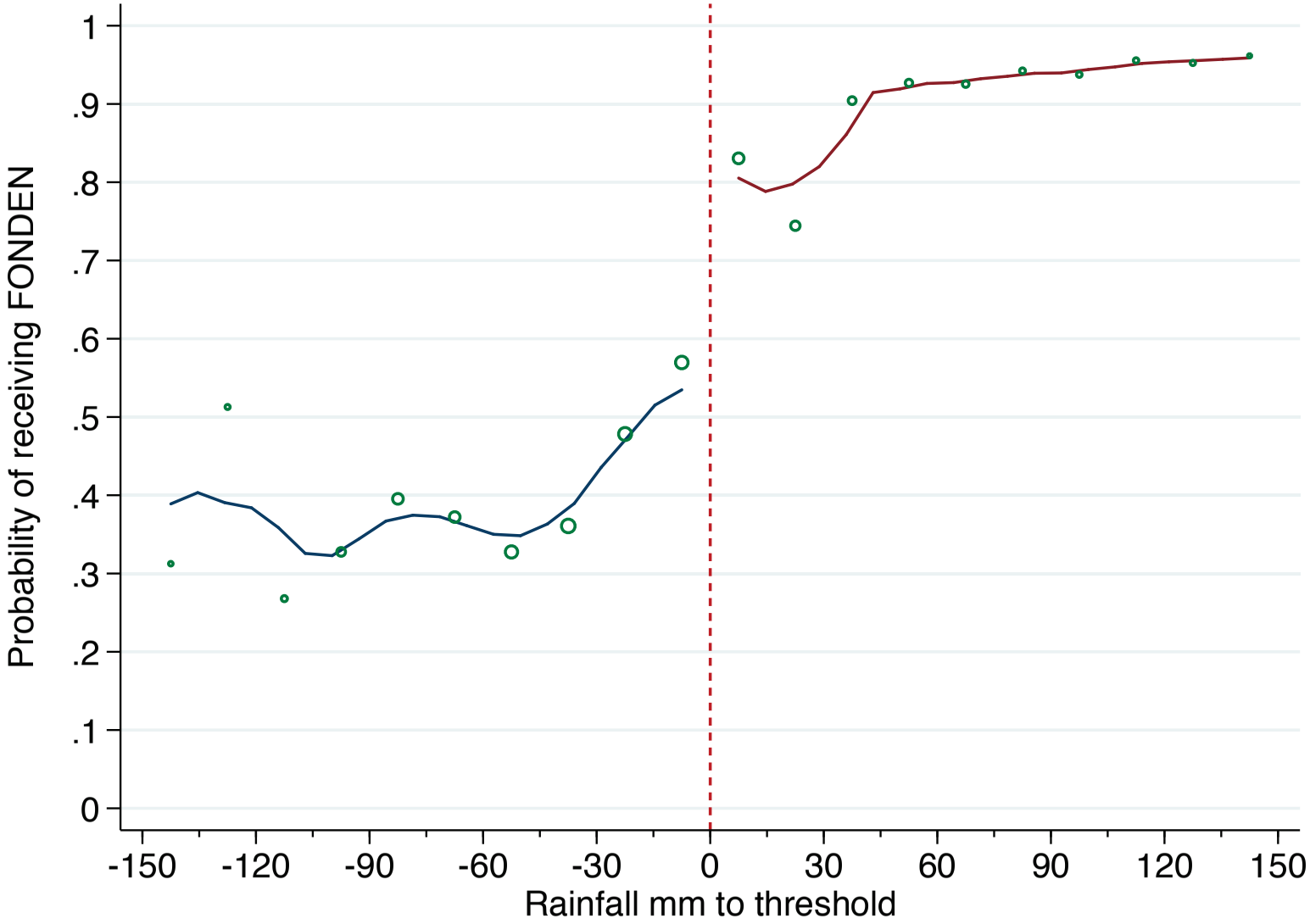
Table: Summary statistics

Variable	Obs	Mean	Std. Dev.	P5	P95
△ log light	1745	-.04	.28	-.43	.48
Fonden=1	1745	.58	.49	0	1
Above threshold	1745	.36	.48	0	1
Rainfall mm to threshold	1745	-13.09	74.94	-116.1	120.8

Probability of treatment by forcing variable

5mm

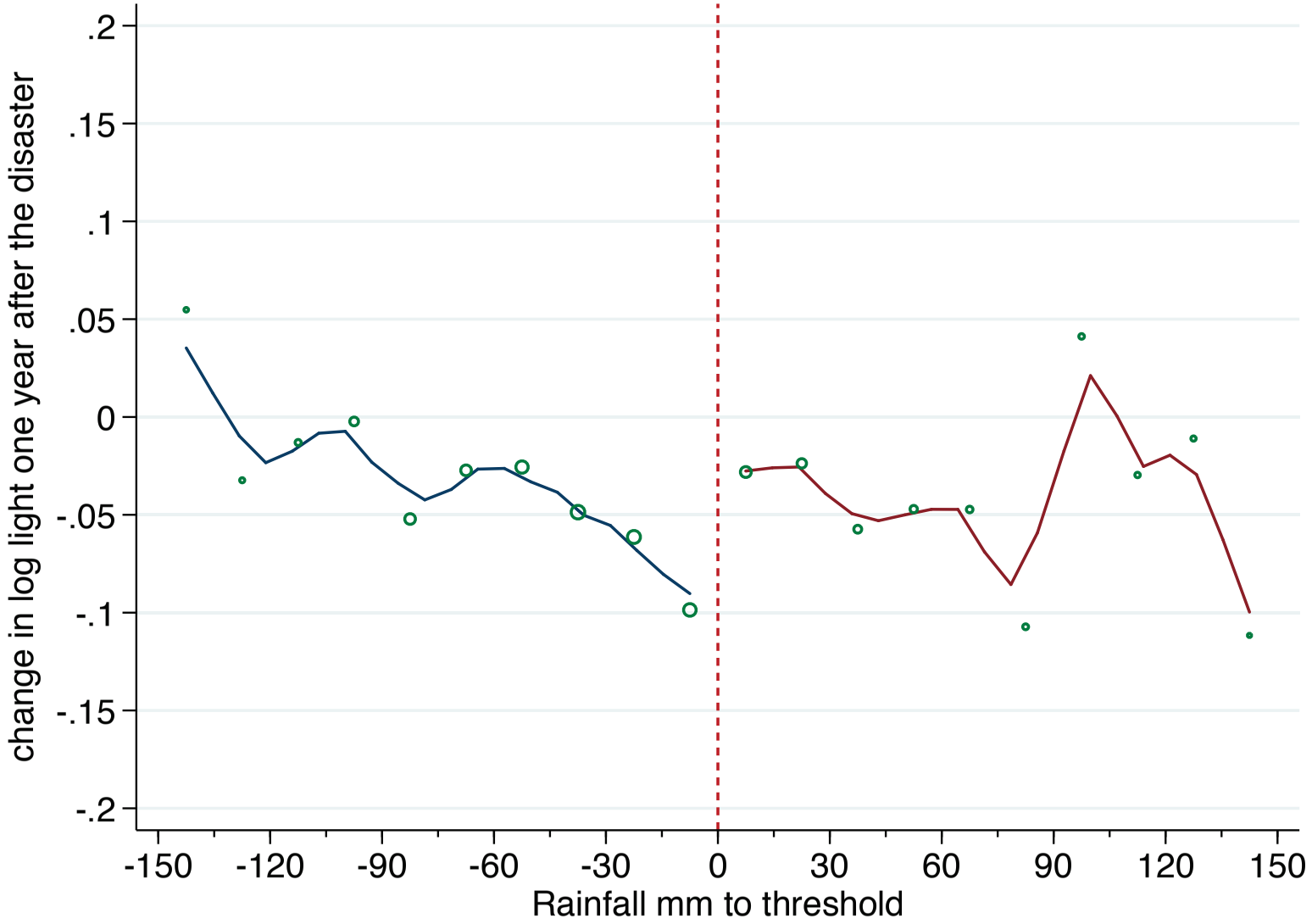
15 mm bins



Change in lights by forcing variable

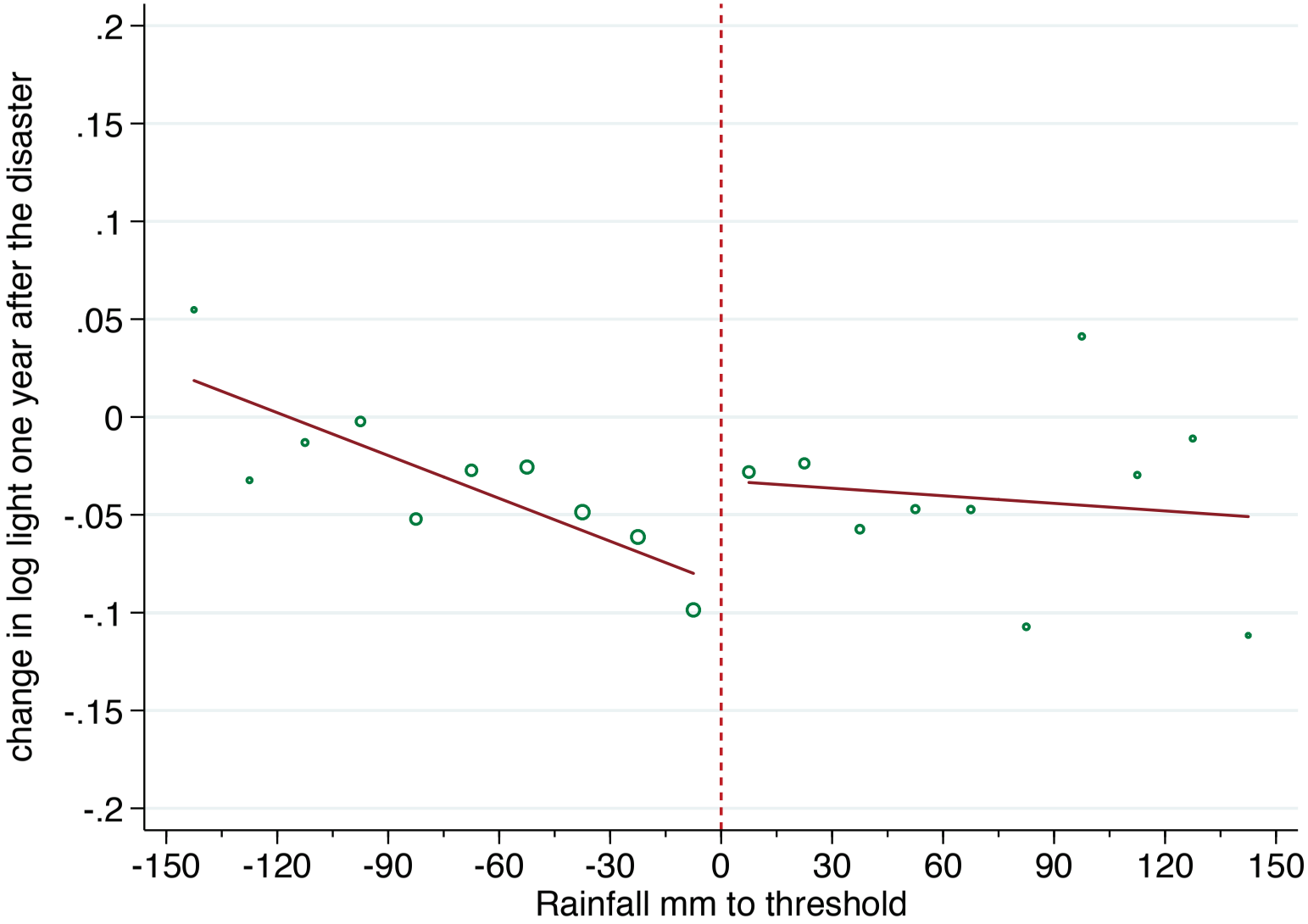
15 mm bins

▸ 5mm ▸ obs



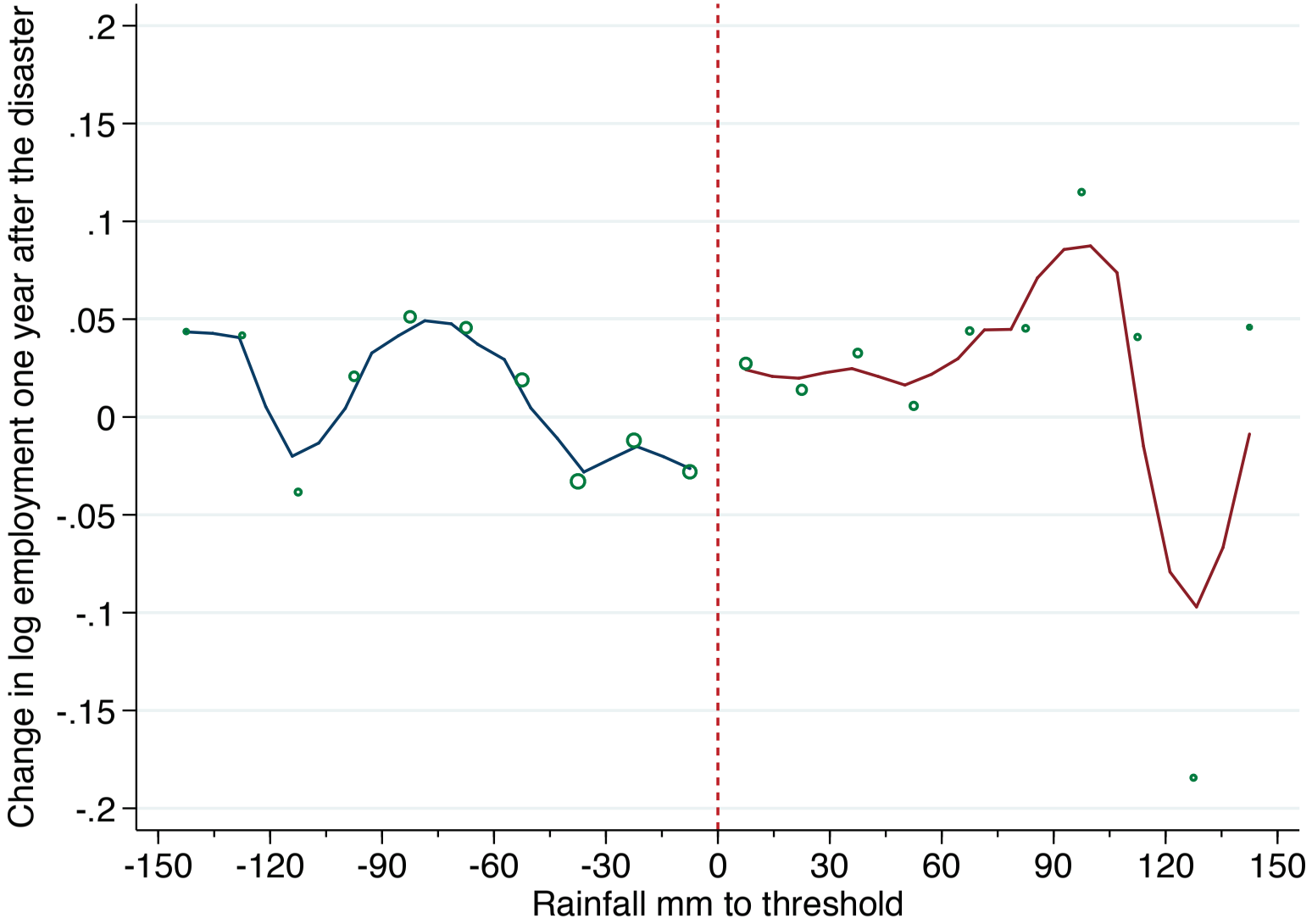
Change in lights by forcing variable

15 mm bins, linear fit



Change in log employment by forcing variable

15 mm bins



Estimation: Fuzzy Regression Discontinuity

- First Stage:

$$f_{mt} = \gamma_0 + \gamma_1 z_{mt} + \gamma_2 g(r_{mt} - c_{mt}) + \gamma_3 g(r_{mt} - c_{mt}) * z_{mt} + \theta_t + v_{mt}$$

- Reduced Form:

$$y_{mt} = \beta_0 + \beta_1 z_{mt} + \beta_2 g(r_{mt} - c_{mt}) + \beta_3 g(r_{mt} - c_{mt}) * z_{mt} + \theta_t + \varepsilon_{mt}$$

- Fonden Impact:

$$\hat{\pi}_1 = \frac{\hat{\beta}_1}{\hat{\gamma}_1}$$

- Estimation 2 ways:
  - Full Sample model $g(\cdot)$ as quadratic or cubic
  - Optimal Bandwidth sample, linear $g(\cdot)$
    - Imbens and Kalyanaraman (2012); Calonico et al. (2014)

	(1)	(2)	(3)	(4)
Dep. Variable	Fonden=1	Fonden=1	Fonden=1	Fonden=1
First Stage				
Above threshold	0.194***	0.140***	0.129**	0.157***
	(0.042)	(0.0510)	(0.0530)	(0.0506)
Dep. Variable	△ log light	△ log light	△ log light	△ log light
Reduced Form				
Above threshold	0.038**	0.0382	0.0481**	0.0439**
	(0.018)	(0.0235)	(0.0235)	(0.0222)
2SLS				
$\widehat{Fonden}$	0.196*	0.272	0.372	0.280*
	(0.104)	(0.199)	(0.238)	(0.167)
Impact on local GDP %	1.36	1.88	2.57	1.93
Observations	1,745	1,745	922	1,016
Specification	quadratic	cubic	linear	linear
Sample	All	All	Optimal bw	Optimal bw
			IK: 50.5 mm	CCT: 57.3 mm

Standard errors clustered at the municipal level in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels. All regressions include year fixed effects

Back of the Envelope: 2004-2011

Simulation 1000 draws

- The simulation takes into account both the uncertainty of estimating the impact of FONDEN as well as the uncertainty of estimating the elasticity of light to state GDP.
  - Value of economic activity generated by FONDEN
    - Mean: USD $6.38 billion
    - Std Dev: USD $ 5.63 billion
  - Cost of the program: USD $ 4.9 billion
  - Mean benefit-cost ratio: **1.29**

Conclusion

- Fonden seems to be effective at mitigating the losses created by heavy rain events one year after their occurrence
  - Fonden increases local economic activity by as much as 2.57% one year after the disaster occurs
  - We are possibly underestimating the short term impact of Fonden
    - Spillover effects
    - Ineligible municipalities may engage in reconstruction efforts of their own.
- Fonden seems to be a cost effective way of mitigating this losses
  - While noisy: Fonden average cost benefit ratio is 1.3

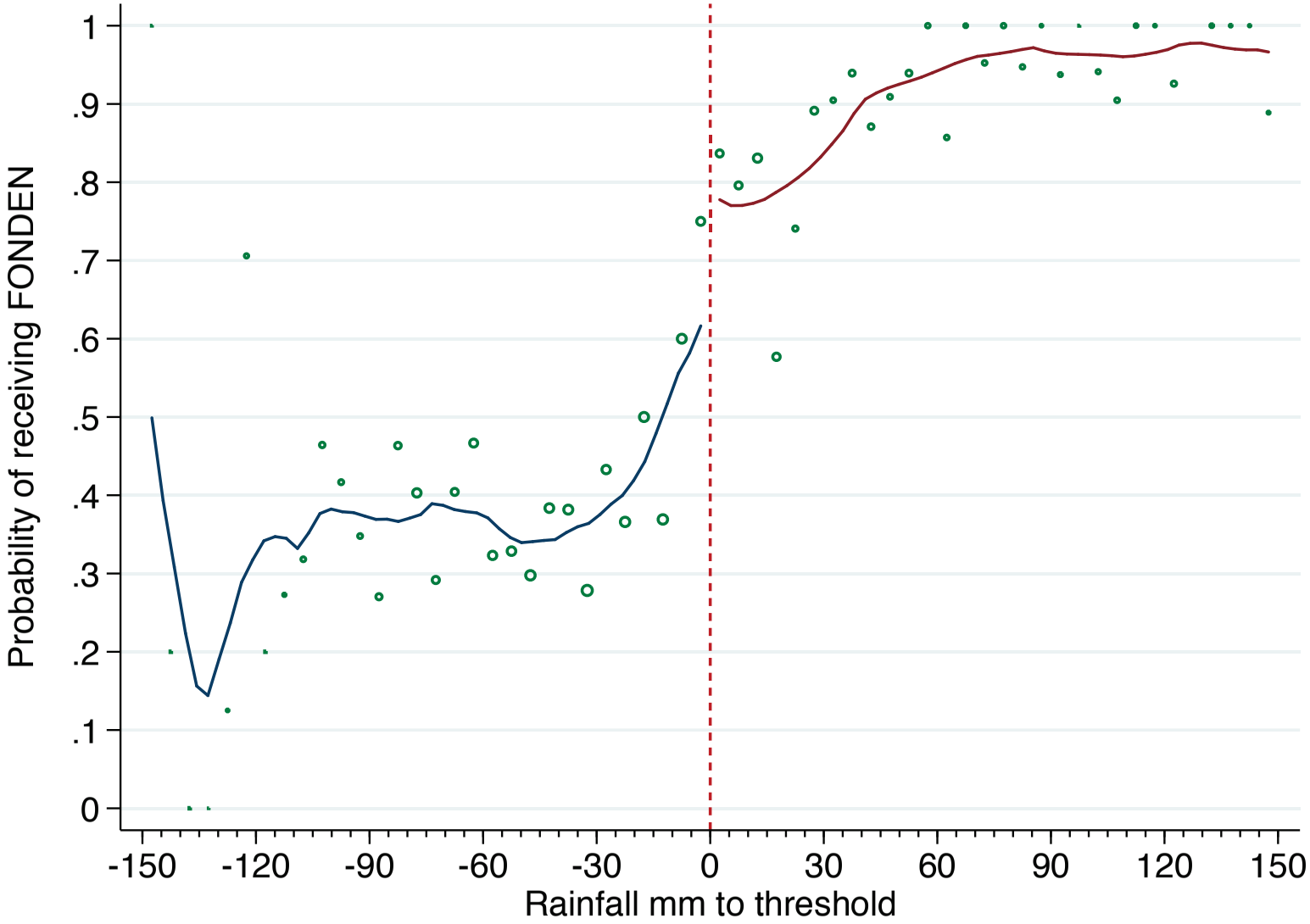
Going Forward

- Recover sharper estimates of the impact FONDEN
  - Two new datasets from Conagua
- Dynamic effects of Fonden
  - Monthly light composites covering the 2004 to 2014 period
- Test the mechanisms through which FONDEN operates
  - Ministry of finance municipal level dataset on the type of FONDEN expenditures

Probability of treatment by forcing variable

back

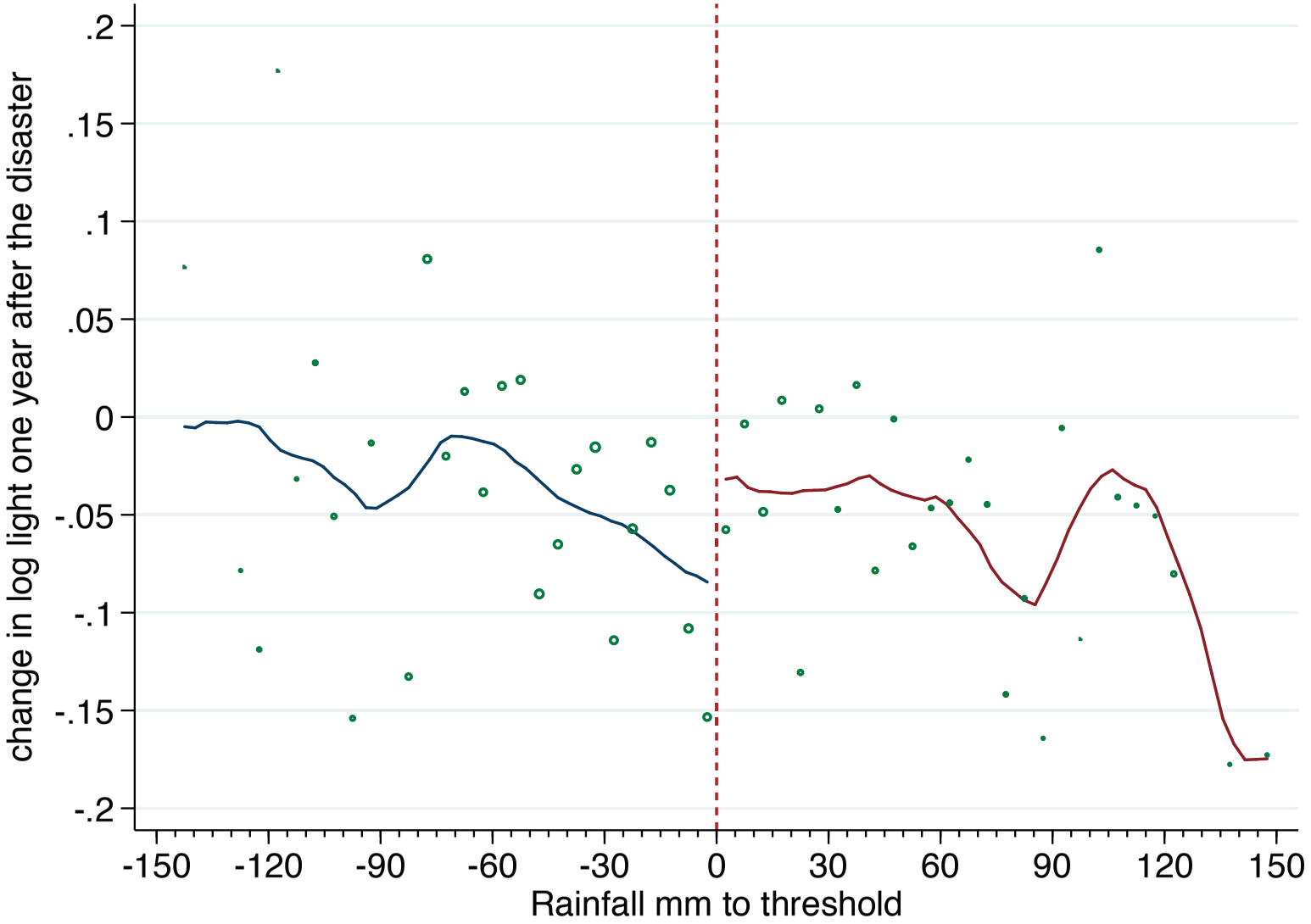
5 mm bins



Appendix: Change in lights by forcing variable

back

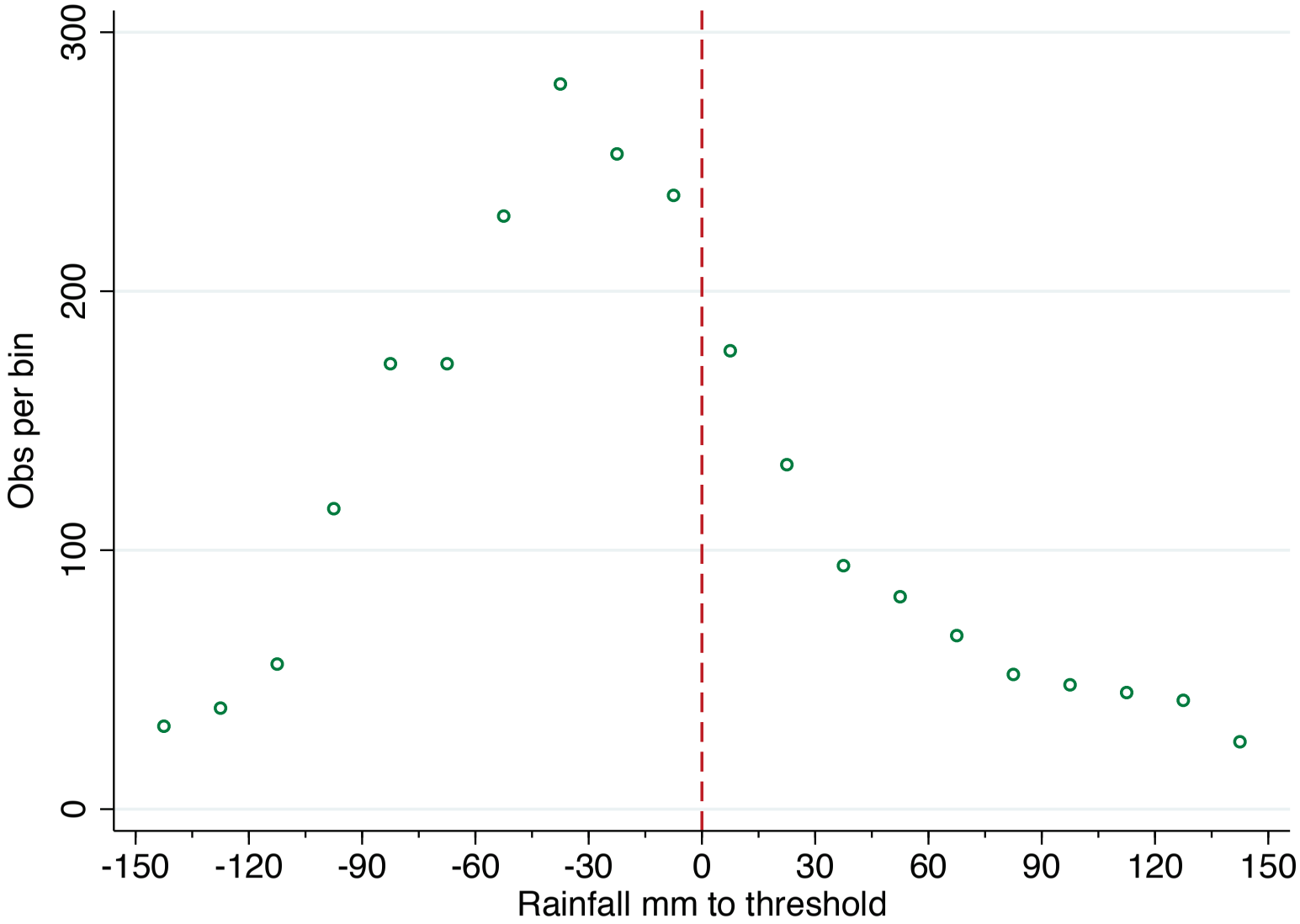
5 mm bins



Appendix: number of observations by forcing variable

back

15 mm bins



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