

The Short-Run, Dynamic Employment Effects of
Natural Disasters: New Insights
ONLINE APPENDIX

February 2022

This appendix contains some supplementary material not inserted (due to space constraints) in the main text of Barattieri, Borda, Brugnoli, Pelli and Tschopp (2022).

A Hurricanes Used in the Baseline Specification

In this Section, we report the names of the 23 hurricanes and storms we use in our baseline specification, together with the year and month when they hit Puerto Rico and the maximum category they reached according to the Simpson and Riehl scale. We also report the number of people that these hurricanes have affected overall, the number of fatalities and the estimated damages. Blanks correspond to missing values.

Table A.1: **Hurricanes**

Name	Year	Month	Category	People affected	Total fatalities	Total damages
Luis	1995	9	4	98,000		339,684,000
Marilyn	1995	9	4		1	169,842,000
Bertha	1996	7	2-3			
Hortense	1996	9	4	57,315	18	825,028,000
George	1998	9	3			2,778,505,000
José	1999	10	TS			
Lenny	1999	11	4		1	233,058,000
Debby	2000	8	1			
Keith	2000	10	3			
Dean	2001	8	1			
Jeanne	2004	9	3	3,500	2	137,022,000
Frances	2004	9	4			
Dean	2007	5	5			
Olga	2007	12	TS			
Omar	2008	10	4		1	
Earl	2010	8	4			
Irene	2011	8	3	2,271	1	575,291,000
Karen	2013	10	TS			
Gonzalo	2014	10	4			
Danny	2015	8	3			
Erika	2015	8	TS			
Irma	2017	9	5		2	
Maria	2017	9	5	750,000	64	71,798,241,000

Note: *Category* refers to the category corresponding to the maximum windspeed reached by the hurricane according to the Saffir-Simpson wind scale. *TS* stands for tropical storm. Data on *People affected*, *Total fatalities*, and *Total damages* come from the EM-DAT database (<https://public.emdat.be>).

B Summary Statistics of Hurricane Exposures

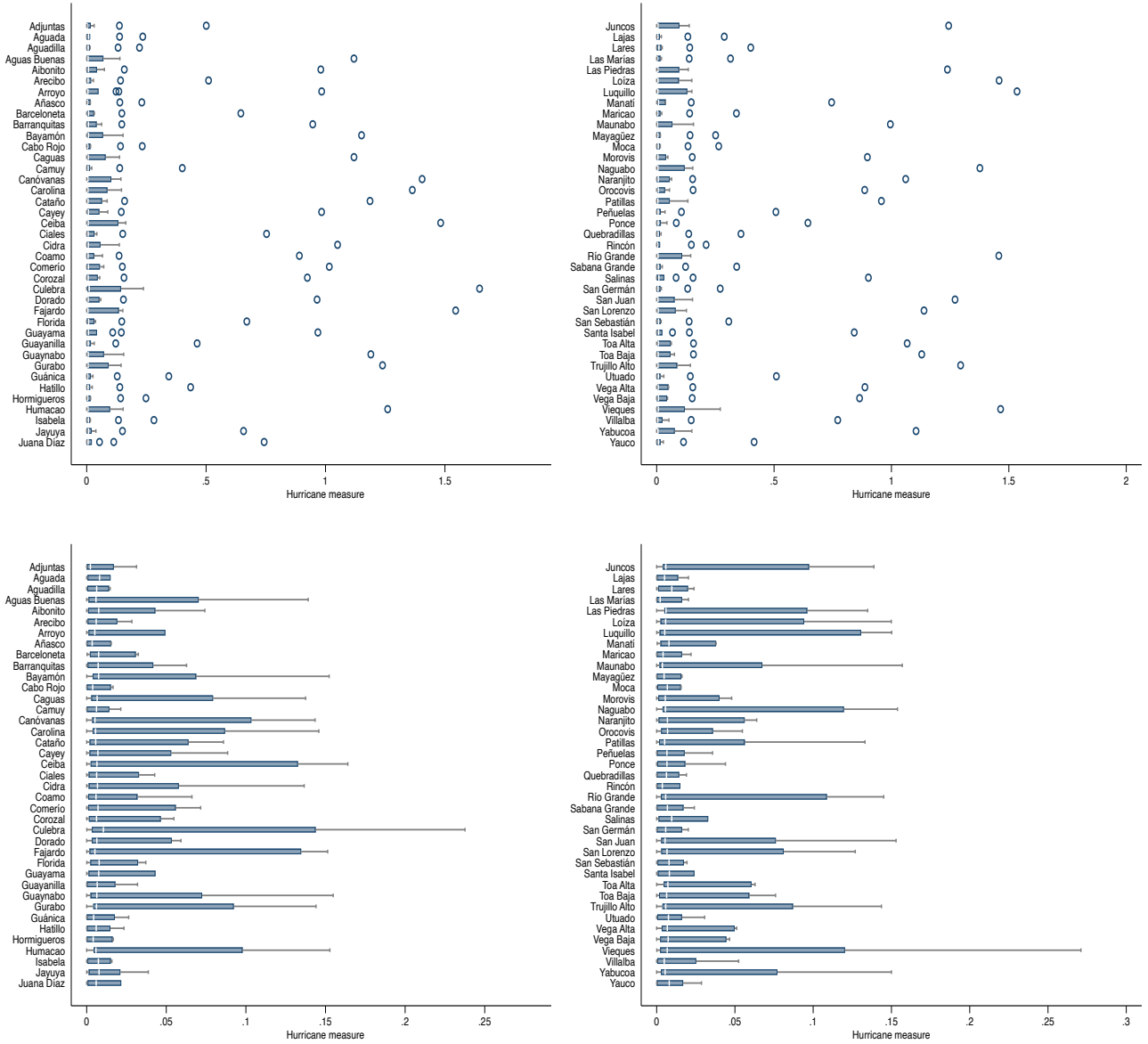
Table B.2 presents summary statistics of the exposure index, S_{ct} , across Puerto Rican counties and for the period 1995-2017 using monthly (top panel) and quarterly (bottom panel) data. Not surprisingly, when zero exposures are accounted for, monthly exposures exhibit a smaller average. When computed using positive exposures only, the average monthly and quarterly exposures are similar.

Figures B.1 and B.2 present boxplots of the exposure index computed using monthly and quarterly data, respectively. In both figures, the bottom panels exclude outliers. The boxplots highlight that there is substantial variation in exposures both across counties and over time.

Table B.2: **Summary Statistics of Hurricane Exposures**

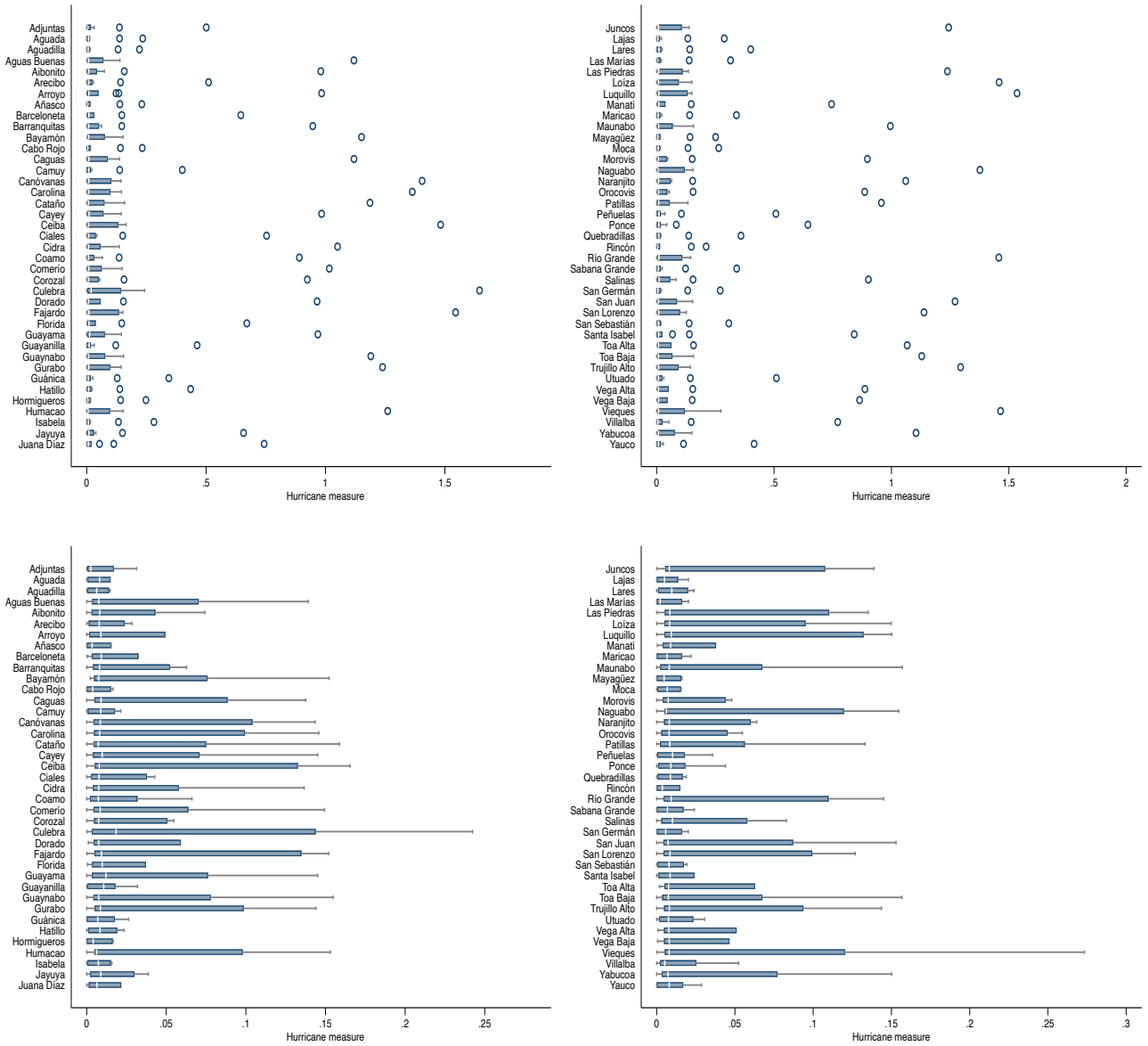
Variable	Mean	Std. Dev.	Min.	Max.	N
<i>Monthly data:</i>					
S_{ct}	0.004	0.057	0	1.645	21294
S_{ct} if $S_{ct} > 0$	0.084	0.242	0	1.645	1063
<i>Quarterly data:</i>					
S_{ct}	0.013	0.098	0	1.645	7098
S_{ct} if $S_{ct} > 0$	0.092	0.253	0	1.645	961

Figure B.1: Storm Exposure by County for $S_{ct} > 0$, Monthly Data, 1995-2019



Note: The boxplots describe S_{ct} by county using monthly data for the period 1995-2017. Counties with $S_{ct} > 0$ between 1995 and 2017 are listed in the alphabetical order. The top (bottom) panels include (exclude) outliers. The white line is the median. The bottom of the box is the first quartile (Q_1 or 25th percentile) and the top the third quartile (Q_3 or 75th percentile). The end of the left (right) whisker is the 1st percentile (99th percentile). Circles without box mean that all observations are clustered around the median. The circles outside of the box capture outliers.

Figure B.2: Storm Exposure by County for $S_{ct} > 0$, Quarterly Data, 1995-2019



Note: The boxplots describe S_{ct} by county using quarterly data for the period 1995-2017. Counties with $S_{ct} > 0$ between 1995 and 2017 are listed in the alphabetical order. The top (bottom) panels include (exclude) outliers. The white line is the median. The bottom of the box is the first quartile (Q_1 or 25th percentile) and the top the third quartile (Q_3 or 75th percentile). The end of the left (right) whisker is the 1st percentile (99th percentile). Circles without box mean that all observations are clustered around the median. The circles outside of the box capture outliers.

C Puerto Rico

In this Section, we report the structure of Puerto Rico private employment using NAICS 2-digits industries (Table C.1.1) and the structure of Puerto Rican private manufacturing employment using NAICS 3-digits industries (Table C.1.2). We present average figures across our sample period. In Figures C.1.1 and C.1.2 we report instead the dynamics over time of employment in selected industries. Finally, in Table C.2.1 we show the labor force for each county in Puerto Rico in 1995, its share in the total labor force, and the percentage change of labor force in each county over the period 1995-2019.

C.1 Puerto Rico Private Employment

Table C.1.1: **Private Employment Structure**

NAICS2	Sector Name	Av. Employment (count)	Empl. Share
11	Agriculture, forestry, fishing and hunting	12,560	1.86%
21	Mining, quarrying, and oil and gas extraction	1000	0.15%
22	Utilities	240	0.04%
23	Construction	48,130	7.13%
30	Manufacturing	116,020	17.20%
42	Wholesale trade	30,420	4.51%
44-45	Retail trade	123,740	18.34%
48-49	Transportation and warehousing	16.58	2.46%
51	Information	16,810	2.49%
52	Finance and insurance	29,570	4.38%
53	Real estate and rental and leasing	13,040	1.93%
54	Professional and technical services	24,880	3.69%
55	Management of companies and enterprises	12,230	1.81%
56	Administrative and waste services	59.11	8.76%
61	Educational services	23,900	3.54%
62	Health care and social assistance	65.83	9.76%
71	Arts, entertainment, and recreation	3,360	0.50%
72	Accommodation and food services	61.40	9.10%
81	Other services, except public administration	15,220	2.26%
99	Unclassified	690	0.10%
	TOTAL	674,800	100.00%

Table C.1.2: **Manufacturing Employment Structure**

NAICS3	Industry Name	Av. Employment (count)	Empl. Share
325	Chemical manufacturing	25,360	21.9%
311	Food manufacturing	14,840	12.8%
315	Apparel manufacturing	14,820	12.8%
339	Miscellaneous manufacturing	12,280	10.6%
334	Computer and electronic product manufacturing	10,430	9.0%
335	Electrical equipment and appliance mfg.	6,700	5.8%
332	Fabricated metal product manufacturing	5,070	4.4%
327	Nonmetallic mineral product manufacturing	3,390	2.9%
312	Beverage and tobacco product manufacturing	3,250	2.8%
316	Leather and allied product manufacturing	3,020	2.6%
326	Plastics and rubber products manufacturing	2,930	2.5%
323	Printing and related support activities	2,320	2.0%
333	Machinery manufacturing	2,310	2.0%
337	Furniture and related product manufacturing	2,200	1.9%
336	Transportation equipment manufacturing	1,820	1.6%
322	Paper manufacturing	1,780	1.5%
324	Petroleum and coal products manufacturing	1,210	1.0%
314	Textile product mills	960	0.8%
331	Primary metal manufacturing	650	0.6%
321	Wood product manufacturing	420	0.4%
313	Textile mills	230	0.2%
TOTAL		116,020	100.0%

Figure C.1.1: Private Employment Dynamics (in thousands)

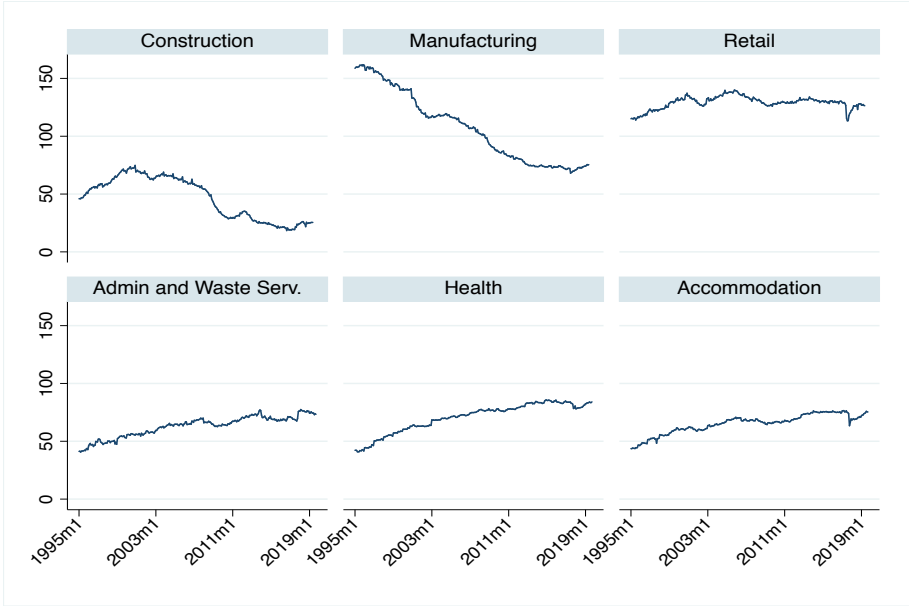
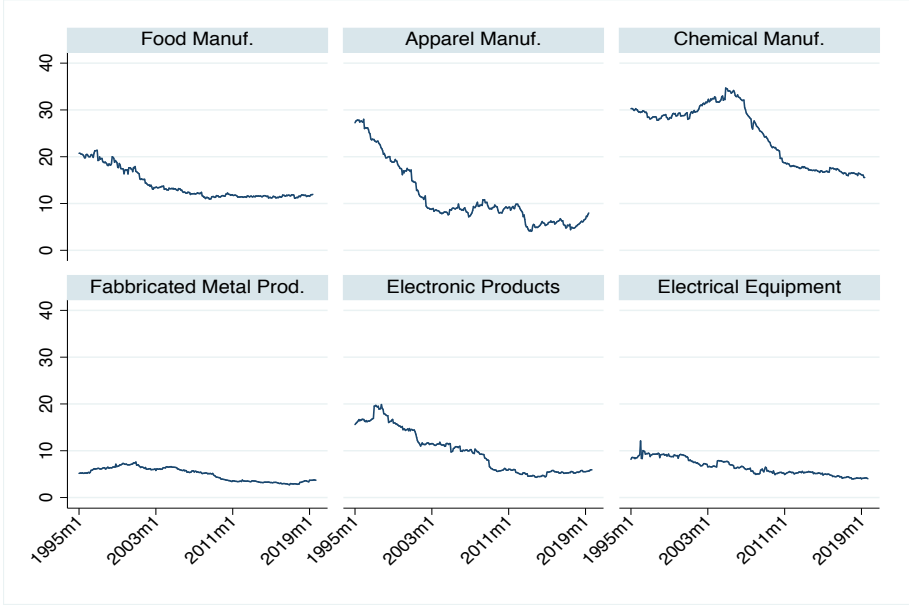


Figure C.1.2: Manufacturing Employment Dynamics (in thousands)



C.2 Puerto Rico Labor Force

Table C.2.1: Labor Force, by County

County Name	Labor Force 1995	Labor Force Share	Δ Labor Force 1995-2017
San Juan Municipio	155752	12.70%	-14.87%
Bayamun Municipio	82662	6.74%	-23.86%
Carolina Municipio	74477	6.07%	-19.28%
Ponce Municipio	57516	4.69%	-23.38%
Caguas Municipio	53565	4.37%	-11.16%
Guaynabo Municipio	39202	3.20%	-5.66%
Mayagez Municipio	35054	2.86%	-45.33%
Toa Baja Municipio	32573	2.66%	-10.85%
Arecibo Municipio	30831	2.51%	-26.92%
Trujillo Alto Municipio	26903	2.19%	-0.85%
Aguadilla Municipio	21250	1.73%	-36.09%
Humacao Municipio	19350	1.58%	-10.70%
Vega Baja Municipio	18018	1.47%	-30.23%
Toa Alta Municipio	17819	1.45%	40.25%
Rio Grande Municipio	16599	1.35%	3.13%
Cayey Municipio	15825	1.29%	1.99%
Canuvas Municipio	15594	1.27%	2.72%
Cabo Rojo Municipio	15133	1.23%	-9.44%
Cidra Municipio	14295	1.17%	6.68%
Aguada Municipio	14134	1.15%	-18.04%
Isabela Municipio	14118	1.15%	-11.96%
San Sebastian Municipio	13541	1.10%	-26.33%
San German Municipio	13417	1.09%	-32.17%
Fajardo Municipio	13102	1.07%	-13.43%
Juana Diaz Municipio	12901	1.05%	14.93%
Yauco Municipio	12774	1.04%	-24.31%
Manati Municipio	12763	1.04%	-9.14%
Moca Municipio	12375	1.01%	-16.04%
Yabucoa Municipio	11830	0.96%	-27.20%
Juncos Municipio	11605	0.95%	6.79%
San Lorenzo Municipio	11105	0.91%	6.96%
Guayama Municipio	10985	0.90%	4.75%
Hatillo Municipio	10960	0.89%	18.48%
Vega Alta Municipio	10791	0.88%	-9.94%
Aibonito Municipio	10685	0.87%	-46.35%
Gurabo Municipio	10338	0.84%	53.70%
Aoasco Municipio	10236	0.83%	-15.13%
Las Piedras Municipio	9780	0.80%	14.57%
Dorado Municipio	9763	0.80%	27.56%
Catano Municipio	9490	0.77%	-19.59%
Camuy Municipio	9477	0.77%	-0.87%
Corozal Municipio	9308	0.76%	-2.76%
Coamo Municipio	9184	0.75%	8.99%
Morovis Municipio	9173	0.75%	-13.56%
Lajas Municipio	8779	0.72%	-48.87%
Aguas Buenas Municipio	8373	0.68%	-23.54%
Sabana Grande Municipio	8363	0.68%	-30.23%
Salinas Municipio	8363	0.68%	-14.19%
Loiza Municipio	8133	0.66%	3.09%
Utua Municipio	8115	0.66%	-19.10%
Lares Municipio	8083	0.66%	-12.60%
Quebradillas Municipio	7579	0.62%	-22.58%
Barranquitas Municipio	7439	0.61%	0.84%
Barceloneta Municipio	7408	0.60%	-22.96%
Guayanilla Municipio	7342	0.60%	-39.62%
Naranjito Municipio	7030	0.57%	1.43%
Pequeñas Municipio	7009	0.57%	-18.66%
Hormigueros Municipio	6791	0.55%	-21.16%
Naguabo Municipio	6528	0.53%	22.00%
Luquillo Municipio	6163	0.50%	3.29%
Santa Isabel Municipio	6029	0.49%	47.95%
Orocovis Municipio	5801	0.47%	-12.25%
Gunica Municipio	5738	0.47%	-35.09%
Villalba Municipio	5715	0.47%	25.96%
Rincon Municipio	5630	0.46%	-18.59%
Ceiba Municipio	5584	0.46%	-37.13%
Patillas Municipio	5559	0.45%	-20.01%
Adjuntas Municipio	5501	0.45%	-22.17%
Arroyo Municipio	5208	0.42%	-7.76%
Comerlo Municipio	5147	0.42%	-4.90%
Ciales Municipio	4889	0.40%	-24.96%
Jayuya Municipio	3834	0.31%	13.43%
Maunabo Municipio	3100	0.25%	-8.02%
Las Marias Municipio	3043	0.25%	-10.85%
Vieques Municipio	2609	0.21%	4.86%
Florida Municipio	2573	0.21%	25.70%
Maricao Municipio	2143	0.17%	-9.44%
Culebra Municipio	746	0.06%	13.64%
TOTAL	1226600	100.00%	-11.1%

D Industry Heterogeneity

Table D.1 reports for each of the 70 NAICS industries included in our analysis the classification into Strengthened (“S”), Neutral (“N”), or Weakened (“W”) for different time horizons (2,6,12,18,24 months). The second column report the results obtained with our baseline specification, while columns 3, 4 and 5 report different robustness (see appendix *E*, *F* and *G*)

Table D.1: Classification of Industries at Different Horizons

NAICS	Industry	Baseline Model	64-Knots Threshold	Deppe Formula	Non-weighted Centroids
		Classification at month 3.6.12.18.24	Classification at month 3.6.12.18.24	Classification at month 3.6.12.18.24	Classification at month 3.6.12.18.24
111	Crop production	WWWWW	WWWWW	WWWWW	WWWWW
112	Animal production and aquaculture	WWWWW	WWWWW	WWWWW	WWWWW
221	Utilities	WNNWW	WNNWW	WNNWW	WNNWW
236	Construction of buildings	SSSSS	SSSSS	SSSSS	SSSSS
237	Heavy and civil engineering construction	SSSSS	SSSSS	SSSSS	SSSSS
238	Specialty trade contractors	SSSSS	SSSSS	SSSSS	SSSSS
311	Food manufacturing	WNNNS	WNNSS	WNNNN	WNNNS
312	Beverage and tobacco product manufacturing	NNWNN	NNWNN	NNWNN	NNWNN
315	Apparel manufacturing	NNSSS	NNSSS	NNSSS	NNSSS
321	Wood product manufacturing	WWSSS	WWSSS	WWSSS	WWSSS
322	Paper manufacturing	NNSSS	NNSSS	NNSSS	NNSSS
323	Printing and related support activities	WWNNN	WWSNN	WWNNN	WWNNN
324	Petroleum and coal products manufacturing	NNSSS	NNSSS	NNSSS	NNSSS
325	Chemical manufacturing	NSSSN	NSSSN	NSSSN	NSSSN
326	Plastics and rubber products manufacturing	SNSSS	SNSSS	SNSSS	SNSSS
327	Nonmetallic mineral product manufacturing	NNNNS	WNNNS	NNNNN	NNNNS
331	Primary metal manufacturing	WNSSS	WNSSS	WNSSS	WNSSS
332	Fabricated metal product manufacturing	SSSSS	SSSSS	SSSSS	SSSSS
333	Machinery manufacturing	NNSSS	NNSSS	NNSSS	NNSSS
334	Computer and electronic product manufacturing	NNSSS	WSSSS	NNSSS	NNSSS
335	Electrical equipment and appliance mfg.	NWNNN	NWNNN	NWNNN	NWNNN
336	Transportation equipment manufacturing	WWNSS	WWNSS	WWNSS	WWNSS
337	Furniture and related product manufacturing	WSSSS	WSSSS	WSSSS	WSSSS
339	Miscellaneous manufacturing	NNNNN	NNNNS	NNNNN	NNNNN
423	Merchant wholesalers, durable goods	WNSSS	WWSSS	WNSSS	WNSSS
424	Merchant wholesalers, nondurable goods	WNNSS	WNNSS	WNNSS	WNNSS
425	Electronic markets and agents and brokers	WWWWW	WWWWW	WWWWW	WWWWW
441	Motor vehicle and parts dealers	WVNSS	WVNSS	WVNNS	WVNSS
442	Furniture and home furnishings stores	NSSSS	NSSSS	NSSSS	NSSSS
443	Electronics and appliance stores	WWNNN	WWNNN	WWNNN	WWNNN
444	Building material and garden supply stores	NSSSS	NSSSS	NSSSS	NSSSS
445	Food and beverage stores	WVSSN	WVSSN	WVSSN	WVSSN
446	Health and personal care stores	WWWWW	WWWWW	WWVNN	WWWWW
447	Gasoline stations	WVNNN	WVNSS	WVNNN	WVNNN
448	Clothing and clothing accessories stores	WWVNW	WWWWW	WVNNN	WWVNW
451	Sporting goods, hobby, book and music stores	WWVVN	WWWWW	WWVVN	WWVVN
452	General merchandise stores	WVNVW	WVNVW	WVNVW	WVNVW
453	Miscellaneous store retailers	WWWWW	WWWWW	WWWWW	WWWWW
454	Nonstore retailers	WVNSS	WVWSS	WVNSS	WVNSS
481	Air transportation	NWNNN	WVNNN	NWNNN	NWNNN
483	Water transportation	NNNNS	WVNNS	NNNNS	NNNNS
484	Truck transportation	NSSSN	SSSSS	NSSSN	NSSSN
485	Transit and ground passenger transportation	WVWNS	WVWNS	WVWNS	WVWNS
487	Scenic and sightseeing transportation	WVWNN	WVWNN	WVWNN	WVWNN
488	Support activities for transportation	SSSSS	SSSSS	SSSSS	SSSSS
492	Couriers and messengers	NSSSS	WSSSS	NSSSS	NSSSS
493	Warehousing and storage	SNSSS	SNSSS	SNSSS	SNSSS
511	Publishing industries, except internet	WNVWS	WNVWS	WNVWS	WNVWS
512	Motion picture and sound recording industries	WNSWW	WNSWW	WNSWW	WNSWW
515	Broadcasting, except internet	WWWWW	WWWWW	WWWWW	WWWWW
517	Telecommunications	WVNNN	WWWWW	WVNNN	WVNNN
518	Data processing, hosting and related services	WVWNN	WVWNN	WVWNN	WVWNN
522	Credit intermediation and related activities	WWWWW	WWWWW	WWWWW	WWWWW
524	Insurance carriers and related activities	WVNSS	WVNSS	WVNNS	WVNSS
531	Real estate	NNNNS	NWVNS	NNNNN	NNNNS
561	Administrative and support services	SSSSN	SSSSN	SSSSN	SSSSN
562	Waste management and remediation services	SSNNN	SSNNW	SSNNN	SSNNN
611	Educational services	WWWWW	WWWWW	WWWWW	WWWWW
621	Ambulatory health care services	WWWWW	WWWWW	WWWWW	WWWWW
622	Hospitals	NWNNN	SWNNN	NWNNN	NWNNN
623	Nursing and residential care facilities	WVWVN	WVWVV	WVWVN	WVWVN
624	Social assistance	WVWNN	WVWNN	WVWNN	WVWNN
711	Performing arts and spectator sports	WVNNN	WVWVN	WVNNN	WVNNN
712	Museums, historical sites, zoos, and parks	WVWVN	WVWVV	WVWVN	WVWVN
713	Amusements, gambling, and recreation	WVWVN	WVWVN	WVWVN	WVWVN
721	Accommodation	WWWWW	WWWWW	WWWWW	WWWWW
722	Food services and drinking places	WVWNN	WVWVN	WVWNN	WVWNN
811	Repair and maintenance	WVNSS	WVNSS	WVNSS	WVNSS
812	Personal and laundry services	WVWVN	WVWVV	WVWVN	WVWVN
813	Membership associations and organizations	WVWNN	WVWVN	WVWNN	WVWNN

E Robustness I: 64 Knots Threshold

Figures E.1 and E.2 report the equivalent of the analysis presented in the Figures 2 and 3 of the main text. Here we change the threshold used in equation 1 from 33 to 64 knots, which defines a category 1 hurricanes according to the Simpson and Riehl scale. The results are qualitatively similar to the one presented in the main paper.

Figure E.1: **Employment Effects of Natural Disasters: Panel Results**

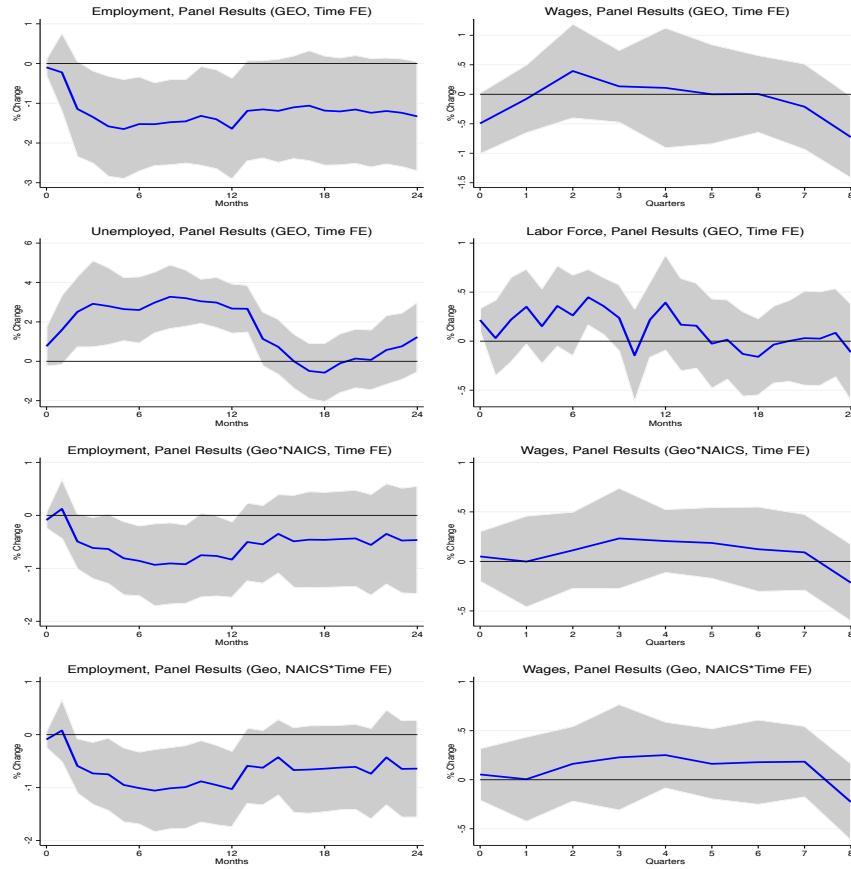
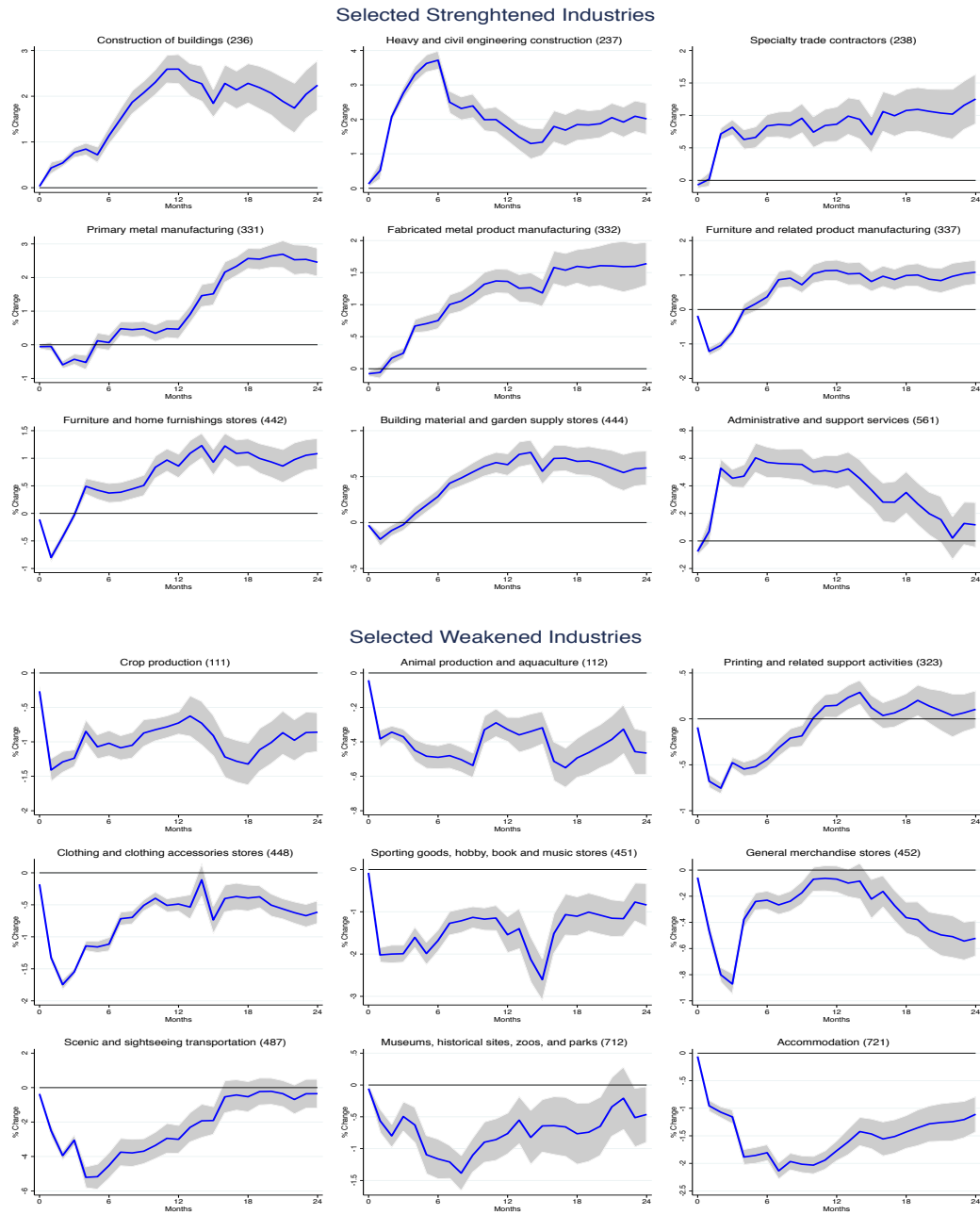


Figure E.2: **Employment Effects of Natural Disasters: Selected Industries**



F Robustness II: Depperman Formula

Figures F.1, F.2 report the equivalent of the analysis presented in the Figures 2 and 3 of the main text. Here we change the formula used to compute w_{ch} , the wind speed at each county c for each landmark h . We use here the classical Depperman formula instead of the HURRECON model. The Depperman formula describes sustained wind velocity at any point, in the specific case each population weighted centroid, in the following way:

$$w_{ch} = V_h \cdot \left(\frac{D_{ch}}{26.9978} \right) \text{ if } D_{ch} \leq 26.9978 \quad w_{ch} = V_h \cdot \left(\frac{26.9978}{D_{ch}} \right)^{0.5} \text{ if } D_{ch} > 26.9978.$$

D_{ch} is the radial distance of each county centroid from the landmark h and V_h the wind speed at the landmark h . The number 26.9978 (50km) corresponds to Simpson and Riehl radius of maximum wind speed. In general, the radius of maximum wind speed is computed using the gap between the barometric pressure between the center and the outskirts of the storm. Given the high number of missing measures of barometric pressure in the data, we follow [Simpson & Riehl \(1981\)](#) and [Hsu & Zhongde \(1998\)](#) and use the average radius of maximum windspeed (50 km) for all cyclones. The results are very similar to those reported in the main text.

Figure F.1: Employment Effects of Natural Disasters: Panel Results

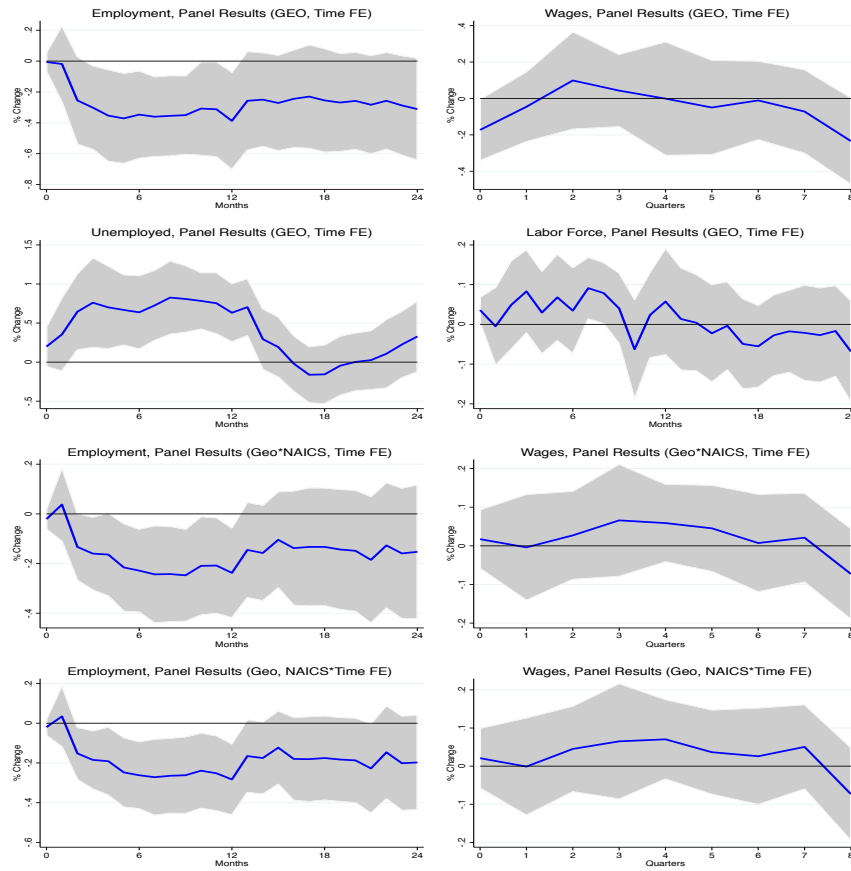
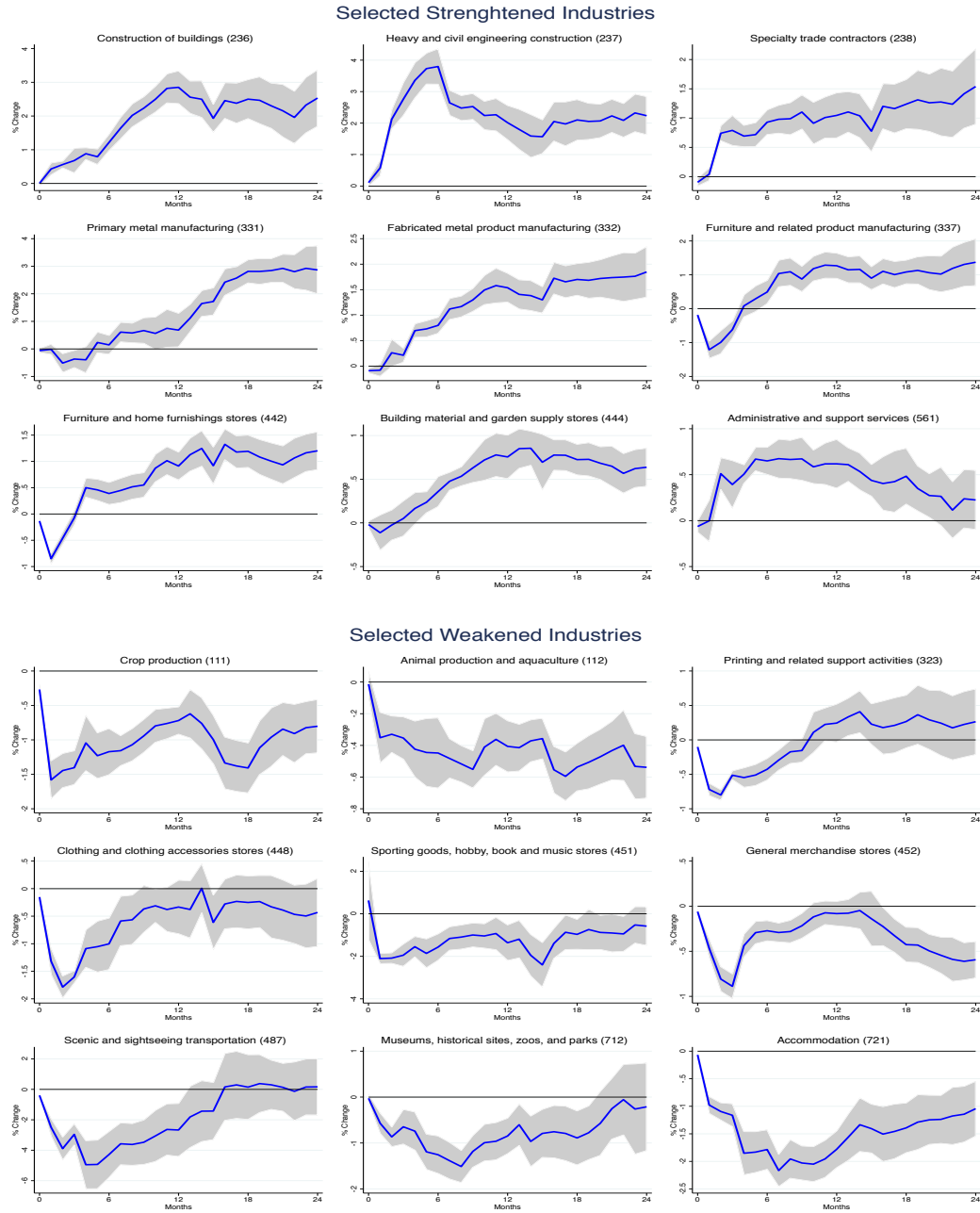


Figure F.2: **Employment Effects of Natural Disasters: Selected Industries**



G Robustness III: Geographical Centroids

Figures G.1, G.2, report the equivalent of the analysis presented in the Figures 2 and 3 of the main text. Here we change the definition of the centroid of a county. Instead of using population weighted centroids, we use simply geographical centroids. The results are very similar to those reported in the main text.

Figure G.1: **Employment Effects of Natural Disasters: Panel Results**

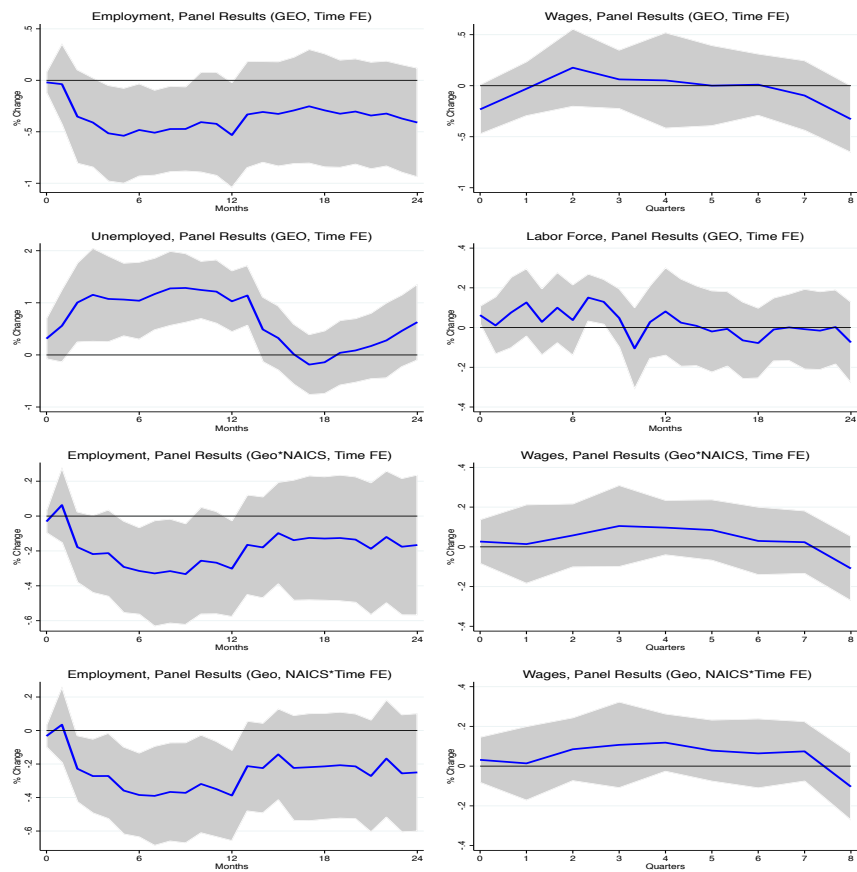
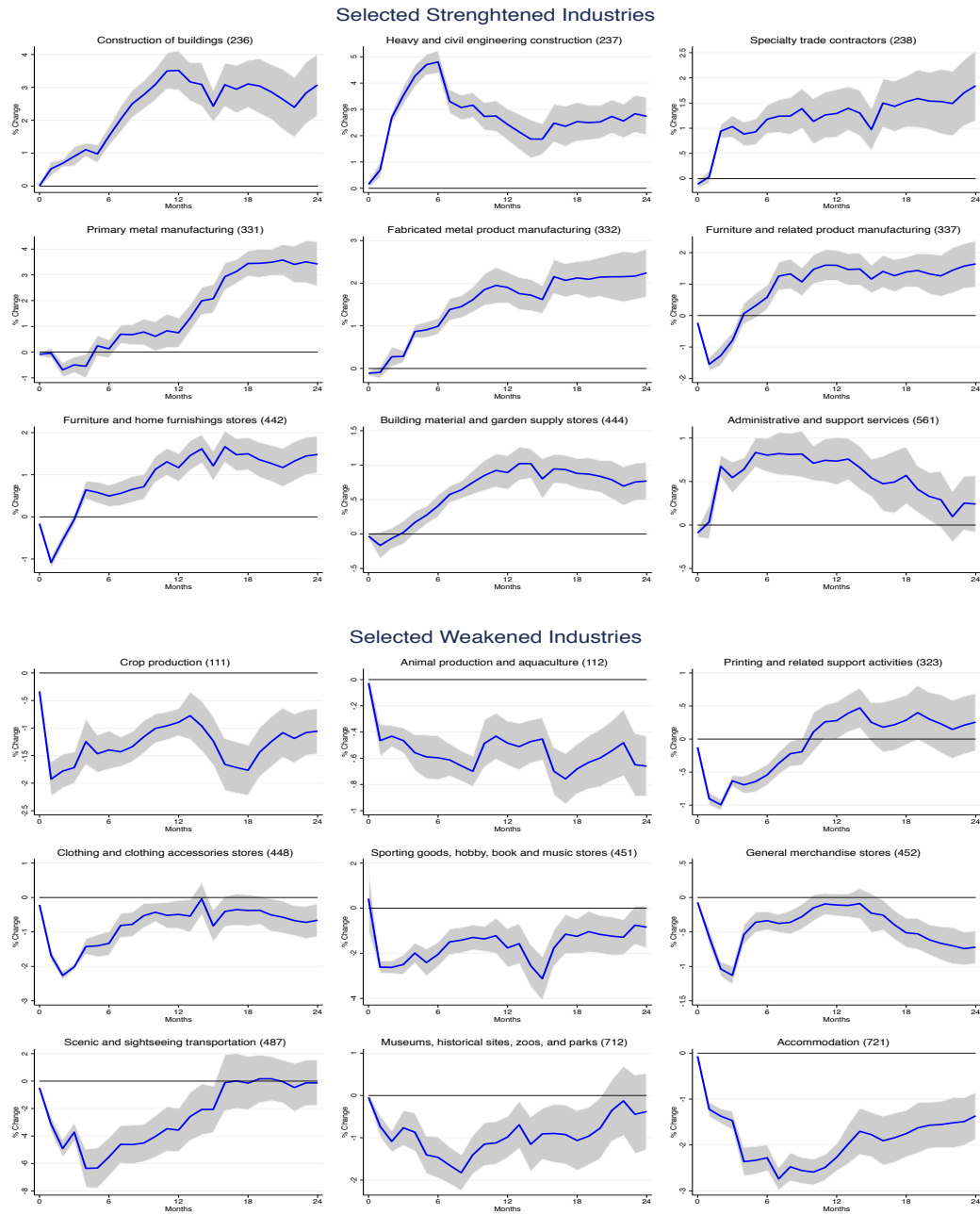


Figure G.2: **Employment Effects of Natural Disasters: Selected Industries**



References

- Hsu, S. & Zhongde, Y. (1998). A Note on the Radius of Maximum Wind for Hurricanes. *Journal of Coastal Research*, 14(2), 667–668.
- Simpson, R. & Riehl, H. (1981). *The Hurricane and Its Impact*. Louisiana State University Press.