

Juarez-Torres, Miriam; Puigvert, Jonathan

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Miriam Juárez-Torres

Banco de México

Jonathan Puigvert

Simon Fraser University

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# The effect of tropical cyclones on economic activities: micro level evidence from Mexico for secondary and tertiary activities\*

Miriam Juárez-Torres<sup>†</sup>  
Banco de México

Jonathan Puigvert<sup>‡</sup>  
Simon Fraser University

**Abstract:** This paper explores the effects of tropical cyclones on the economic activity of establishments in the manufacturing and service sectors in Mexico. The analysis relies on panel data that combines establishment-level economic activity with municipal-level exposure to tropical cyclones on a monthly basis to estimate an augmented distributed lag model. Results show that, after a tropical cyclone, the average manufacturing establishment experiences a short-term and small negative effect on production growth. For establishments in the service sector, the effect is small and negative on revenue growth, while positive, higher in magnitude, and more persistent on growth of operative expenditures. The disaggregated data allows for the analysis of the heterogeneity of the effects between manufacturing and services sectors.

**Keywords:** Tropical cyclones, Establishments, Economic impact, Maximum sustained wind exposure

**JEL Classification:** Q54, Q51, L60, O12, O14

**Resumen:** Este artículo explora los efectos de los ciclones tropicales en la actividad económica de los establecimientos de los sectores manufacturero y de servicios en México. El análisis se basa en datos panel que combinan la actividad económica a nivel de establecimiento con la exposición a ciclones tropicales a nivel municipal y periodicidad mensual para estimar un modelo de rezagos distribuidos. Los resultados muestran que, después de un ciclón tropical, el establecimiento de manufactura promedio experimenta un efecto de corto plazo negativo de magnitud pequeña sobre el crecimiento de la producción. Para los establecimientos del sector servicios, el efecto es pequeño y negativo sobre el crecimiento de los ingresos, mientras que positivo, de mayor magnitud y más persistente en el crecimiento de los gastos operativos. Los datos desagregados permiten analizar la heterogeneidad de los efectos entre los sectores de manufactura y servicios.

**Palabras Clave:** Ciclones tropicales, Establecimientos, Impacto económico, Exposición a vientos máximos sostenidos

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<sup>†</sup> Dirección General de Investigación Económica. Email: mjuarez@banxico.org.mx.

<sup>‡</sup> Simon Fraser University, Department of Economics. Email: jpuigver@sfu.ca.

## 1. Introduction

Tropical cyclones are atmospheric phenomena with an important function in the hydrological cycle of tropical and subtropical regions. These are rotating storm systems in which strong winds lead to lower pressure and are continuously fed by warm water condensation (Emanuel, 1987; Emanuel, 2003). Tropical cyclones have well-known formation patterns within seven basins around the world in the different seasons throughout the year. In the northern hemisphere, hurricanes originate from June through November with peak activity occurring in September in the North Atlantic, and in July and August in the Northeast Pacific.

These atmospheric events cause damage and economic losses due to a combination of intensity, size, wind speed, and rainfall across the area affected. Tropical cyclones are classified according to their maximum sustained winds (MSW), defined as the maximum speed averaged over 10 minutes of wind at an altitude of 10 m (for the United States, the scale is for 1 min average).<sup>1</sup> In this classification, tropical depressions and storms are the less severe type, while hurricanes are classified from 1 to 5 according to the Saffir-Simpson Hurricane Wind Scale, with category 3 and higher being considered as the most dangerous ones because of their potential to cause loss of life and damage.<sup>2</sup>

Since the 2005 tropical cyclone season that included three of the ten most intense North Atlantic hurricanes ever (Katrina, Wilma, and Rita), tropical cyclones have received augmented attention because of their increasing adverse effects on the economy. In particular, Katrina and Wilma, both category 5 hurricanes, were the second costliest and the most intense (by lowest barometric pressure) North Atlantic hurricanes on record. In

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<sup>1</sup> See Emanuel (2000) and Emanuel (2003).

<sup>2</sup> A tropical depression shows maximum sustained winds (MSW) of 38 mph or less (<61 km/h and <17 m/s) and a tropical storm from 39 to 73 mph (62-118 km/h and 18-32 m/s). A category 1 hurricane is characterized by MSW of 74-95 mph (119-153 km/h and 33-42 m/s) that usually produces some minor damage. Category 2 could produce some damage with MSW of 96-110 mph (154-177 km/h and 43-49 m/s). Category 3 is a major devastating damage event with MSW of 111-129 mph (178-208 km/h and 50-58 m/s). Category 4 refers to severe damage with MSW of 130-156 mph (209-251 km/h and 59-69 m/s). Category 5 indicates catastrophic damage with MSW of 157 mph and over (252 km/h or higher and more than 70 m/s).

See <https://www.nhc.noaa.gov/aboutsshws.php>

Mexico, hurricanes Wilma and Stan caused important economic losses in 2005, in particular Stan due the torrential rains across five states. Later, in 2010, the extreme rain associated with hurricanes Karl and Matthew flooded the Veracruz capital. Also in 2010, hurricane Alex caused major flooding in eight states, power outages, and damage in infrastructure, including the facilities of manufacturing establishments in two of the most industrialized states in Mexico, Tamaulipas and Nuevo León, interrupting their regular operations for several weeks.

The 2017 tropical cyclone season was catastrophic, featuring six major hurricanes. For the first time on record, three active hurricanes were simultaneously lined up in the same basin (Irma, Jose, and Katia), with two of them reaching maximum sustained winds of over 150 miles per hour. In Texas, hurricane Harvey devastated parts of the coastline and produced more rainfall than any hurricane on record, creating higher costs and fuel shortages, which eventually led to rising production costs in Mexico. Hurricane Irma had a record-breaking duration as a Category 5, while hurricane Maria was the tenth-most intense hurricane on record and the most intense tropical cyclone worldwide of 2017.

Interest in studying the consequences of tropical cyclones for economic activities has increased with global warming. Cyclone intensity depends on sea water temperature, as it requires the sea-surface temperature to be above 26°C. These rising temperatures are causing growing concern about the possibility of increased frequency and severity of tropical cyclones in the future, which can be confirmed by the 25–30% increase in the proportion of Category 4 to 5 hurricanes around the world since 1975 for every additional 1°C rise in the world's average temperature (Knutson *et al.*, 2010; Emanuel, 2011; Holland and Bruyère, 2014). In addition, weaker storms have scaled up into weather phenomena of higher intensity by extracting moisture from the area surrounding the core of the hurricane, which results in higher volumes of net rain mainly in the North Atlantic basin (Mendelsohn *et al.*, 2012). More frequent episodes of heavy rain associated with tropical cyclones increase disruptions of economic activities, especially in developing countries.

The study of the effects of tropical cyclones on economic activity started with the seminal paper by Nordhaus (2010), which examined the economic impacts of US hurricanes from

1900 to 2008. He estimated the economic damage of hurricanes as a function of maximum wind speed and found especially high vulnerabilities for hurricanes that originate in the Atlantic. In addition, the damage caused by hurricanes in the US could increase by 0.08% due to the intensification effect of CO<sub>2</sub>. Likewise, Hsiang (2010) examined the effects of windstorms, based on their trajectories, on the economic activities of 28 countries in the Caribbean basin. He shows that production losses due to tropical cyclones in nonagricultural industries exceed the losses in the agricultural sector. Also, he finds that average temperatures during September-November have an important effect on sectors such as retail, restaurants, hotels, transport, and communication. In contrast, the effects are negligible and statistically non-significant in manufacturing and construction.

Hsiang and Narita (2012) documented the adaptation process of countries to different weather conditions using data from 1950 to 2008. They find that the most exposed countries respond with heavy investments in infrastructure, which reduces the impact of hurricanes over time. Hsiang and Jina (2014) study the long-term effects of tropical cyclones on economic growth, and they find evidence that these natural phenomena have a negative effect on long-term income growth for both developed and developing countries. In particular, they find that a tropical cyclone may lower growth rates in the fifteen years following the disaster. More recent studies on countries in Central America and the Caribbean have used synthetic tracks based on satellite images to study the effects of hurricanes on economic activity and estimate the expected risks and losses of similar events (Bertinelli et al., 2016). Also, Krichene et al., (2012) documented long-run reductions in growth at the country level from severe exposure to tropical cyclones.

In the economic literature, the impact of tropical cyclones has been mainly studied at the country level (see Hsiang, 2010; Hsiang, 2012; Hsiang and Jina, 2014), and the findings suggest that the effects of tropical cyclones on economic activity may be highly heterogeneous across regions and economic sectors. Nonetheless, these studies focus on the effects of hurricanes on economic aggregates, while analysis at the establishment level is scarce. In this context, this paper provides empirical evidence about the effects of tropical cyclones on economic activity at the establishment level in Mexico. It focuses on the

manufacturing and service sectors that may experience interruptions in operations, blackouts, staff delays, and other perturbations due to the occurrence of tropical cyclones.

Our main contribution consists of estimating local effects of tropical cyclones' exposure on establishments' economic activity using a unique panel that combines monthly economic indicators at the establishment level (manufacturing for the period 1994–2017; services for the period 2008–2015) with climate and tropical cyclones data (i.e., maximum sustained winds, trajectory) at the municipality level for all these events recorded from 1994 to 2017 on the North Atlantic and Northeastern Pacific shores. Based on these data, we use an augmented distributed lag model to quantify the effect of tropical storms on establishments at the national and sector levels. In addition, we show estimations for two types of establishments according to their location: i) establishments located in municipalities frequently exposed to tropical cyclones, and ii) establishments located in municipalities rarely exposed to tropical cyclones.

Our results suggest a short-term negative effect of cyclones on establishments' economic activity. However, the impacts differ by sector and the level of exposure. In the case of manufacturing establishments, we find that tropical cyclones have a negative short-term impact on the growth of production index statistically significant although small in magnitude. For establishments of services, we find that the effect of tropical cyclone exposure on revenue index is slightly negative in the immediate months after the shock, which contrasts with the greater magnitude, lagged and more persistent impact on the growth of their operating expenditure. Although this pattern is observable across almost all sectors of services, the effects are higher and more persistent in establishments of sectors 71 (arts, entertainment, and recreation services), 51 (information services), and 72 (accommodation and food services). Regarding their level of exposure, establishments located in municipalities with low exposure tend to show higher impacts in magnitude and statistical significance, which may reflect a lower adaptation capacity in comparison with establishments located in municipalities with high exposure.

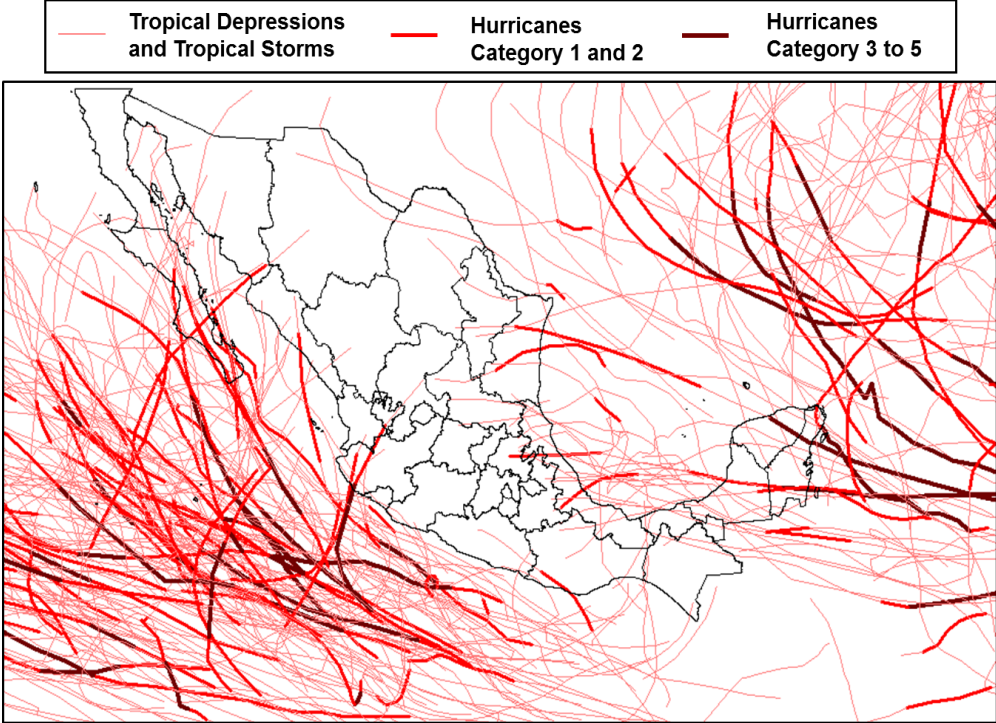
The rest of the paper is organized as follows. Section 2 presents some stylized facts about tropical cyclones in Mexico. Section 3 outlines the estimation strategy. Section 4 explains

data sources, and describes the main variables used in the analysis. Section 5 shows the results of the estimates for the national and for 2-digit NAICS levels in the manufacturing and service sectors, respectively. Section 6 presents some robustness of the estimations. Finally, section 7 concludes and proposes directions for future research.

**2. Stylized facts about tropical cyclones in Mexico**

Mexico’s littorals extend 9,330 km, bordering with the Pacific Ocean and the Gulf of California in the west and with the Gulf of Mexico and the Caribbean Sea in the east. Mexico has 17 coastal states (11 on the Pacific Ocean and 6 on the Gulf of Mexico, made up of 153 municipalities consisting of 35,626 towns and villages) that represent 56.3% of its mainland surface. Since Mexico is located at mid latitude and in the vicinity of the Tropic of Cancer, some of its coastal municipalities experience frequent and severe tropical cyclones on both of its coasts (the North Atlantic and Northeast Pacific). Hsiang and Jina (2014) ranked Mexico as ninth highest country on their list in terms of its average frequency and severity of tropical cyclones.

**Figure 1. The trajectories of the 793 tropical cyclones across Mexico, 1994 – 2017**

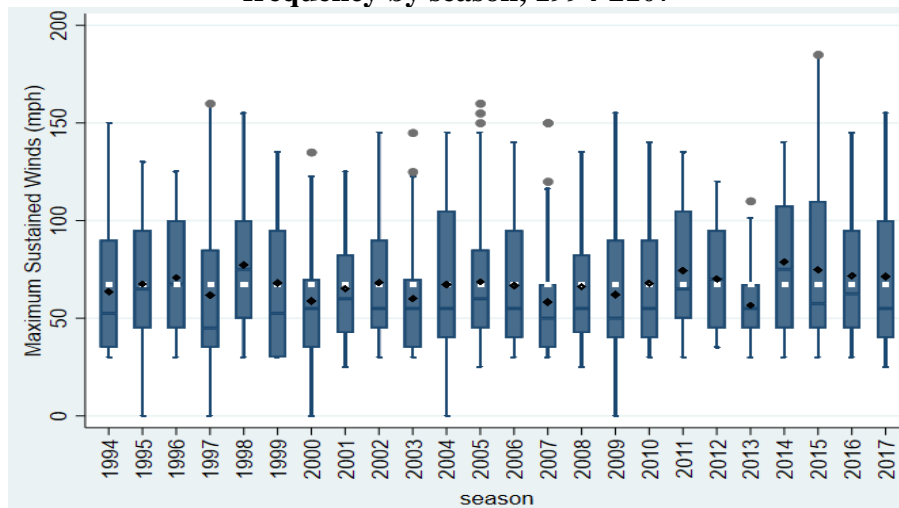


Source: Prepared by authors using the International Best Track Archive for Climate Stewardship (IBTrACS) from the U.S. National Oceanic and Atmospheric Administration (NOAA).



Figure 1 shows the trajectories of all tropical cyclones in the North Atlantic basin and the Northeast Pacific basin occurred between 1994 and 2017. The map reveals the trajectories of a total of 793 tropical cyclones that occurred from 1994 to 2017 in the two basins bordering Mexico.<sup>3</sup> At a first glance, we can observe that the Northeast Pacific basin has experienced the highest number of hurricanes, while the North Atlantic basin has recorded some of the most severe ones (UNIATMOS, 2018). Also, we can see that most hurricane landfalls have occurred in Baja California Sur, Sonora, Tamaulipas, Jalisco, Yucatán and Quintana Roo states. Given the trends in global warming, these phenomena could bring devastating consequences for the Mexican population, because economic activity often diminishes as a short-term effect of hurricanes winds and severe storms. Figure 2 shows the occurrence and frequency of tropical cyclones recorded on the Northeast Pacific and North Atlantic shores from 1994 through 2017, and differentiating hurricanes above category 3.

**Figure 2. Box-plot of tropical cyclones’ records of maximum sustained winds and frequency by season, 1994-2107**



Season	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Hurricanes 3 and higher	5	6	3	6	5	6	3	4	5	2	6	6	3	3	5	4	5	7	1	0	7	9	6	6
Tropical Cyclones	34	35	28	33	30	30	39	36	31	38	34	47	33	32	35	33	33	32	36	36	31	36	39	39

Source: Prepared by authors using the IBTrACS from NOAA.

Note: Years group maximum sustained winds for all the tropical cyclones during the period of analysis; boxes represent interquartile ranges; black diamonds represent the yearly mean per state; white squares stand for the historical mean of the whole period; rectangles denote the 25th percentile of distribution; and balls characterize municipality outliers for every state.

<sup>3</sup> According to records of the IBTrACs, from 1950 to 2017, the Northeastern Pacific basin recorded a total of 1,501 tropical storms and the North Atlantic basin 1,046. About 10% of these tropical cyclones reached category 3 and above on the Saffir-Simpson scale (IBTrACs database Project, Version 4 in Knapp, et al. (2018)).

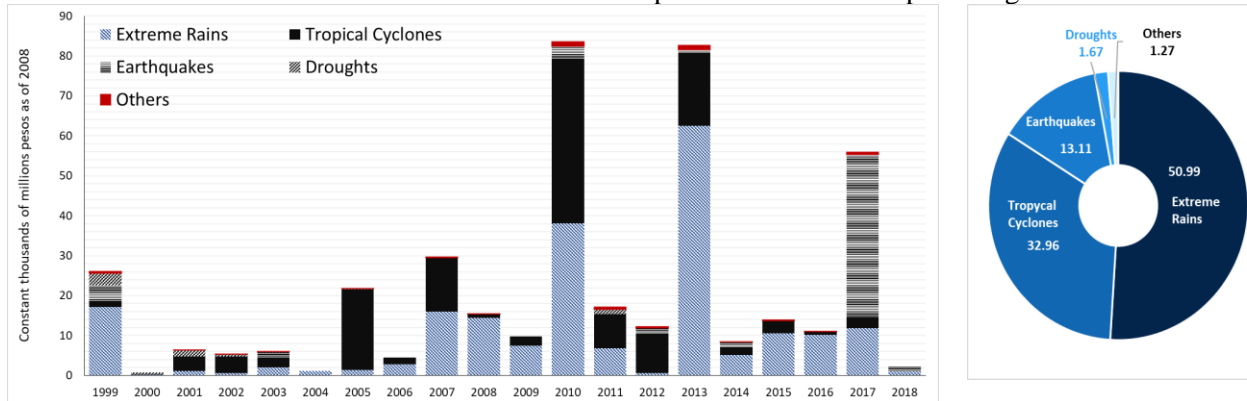
Also, the table at the bottom of Figure 2 shows a box plot of the maximum sustained winds of tropical cyclones per year. For most of the periods, the yearly means are below the mean of the whole period; however, from 2014 to 2017 yearly means were above the mean of the whole period, which can be explained by the notable increase of frequency in hurricanes of categories 3 to 5. Notably, the 2005 season recorded the highest number of tropical cyclones ever, and the 2016 and 2017 seasons are those with the highest number of hurricanes category 3 and higher. The highest outliers correspond to hurricane Patricia in 2015, and the hurricanes Katrina, Wilma, and Rita in 2005 as well.

To deal with the damage caused by natural disasters, the Mexican government established Mexico's Natural Disaster Fund (FONDEN, by its acronym in Spanish). The FONDEN was originally created as a budgetary tool in 1996, and eventually became operational in 1999, allocating resources from the Trust for the period 1999-2018, and was officially eliminated in July 2021. FONDEN allocated state resources and the federal expenditure budget for reconstruction of infrastructure and economic relief after the occurrence a natural disaster. Also, FONDEN used to provide entities with technical and/or financial support for the development of integrated risk management systems and efficiency, accuracy, and transparency of post-disaster damage assessments. Financial support from the FONDEN Trust was invested in highways and roads, recovery operations in natural protected areas, touristic areas, housing, sewage, fishing, health facilities, education facilities, indigenous population recovery, urban facilities, and agricultural and aquaculture activities in Mexico (World Bank, 2012).

During the operation of FONDEN, tropical cyclones were one of the most important categories of natural disasters causing major economic losses in infrastructure like highways, communications, and services like electricity, sewage, and utilities. Figure 3 in the left panel shows the dispersal of resources across years with 2005, 2007, 2010, and 2013 being the costliest. The right panel shows the share of FONDEN's resources allocated for reconstruction from 1999 to 2018 by disaster category. Between 2000 and 2018, about 15,420 municipalities received a declaration as a natural disaster area by FONDEN, of which nearly 33% were caused by tropical cyclones and 51% by extreme rain and flooding.

**Figure 3. FONDEN's resource allocation in Mexico 2000 – 2018  
by category of natural disaster**

Thousand million of constant Mexican pesos as of 2008 and percentages



Source: FONDEN Trust, state resources and federal expenditure budget, consulted in January 2021 at [http://www.gobernacion.gob.mx/es/SEGOB/Recursos\\_destinados\\_a\\_desastres\\_por\\_Estado](http://www.gobernacion.gob.mx/es/SEGOB/Recursos_destinados_a_desastres_por_Estado)

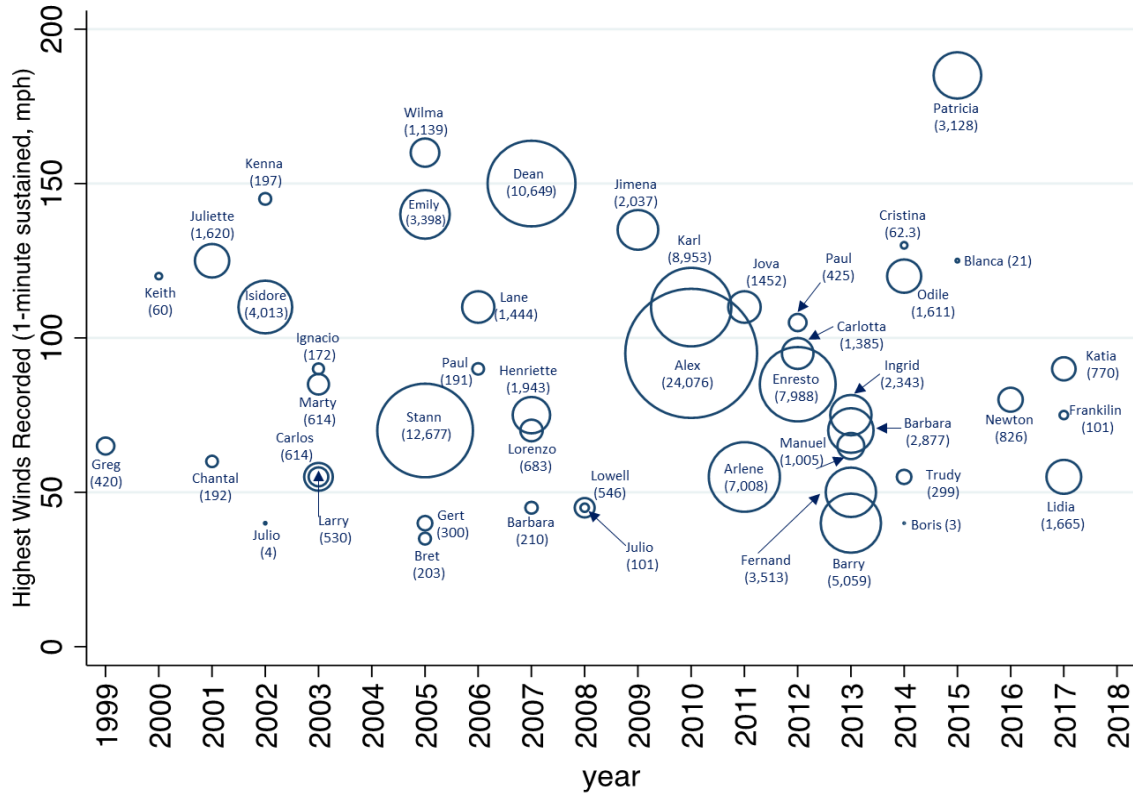
Note: The year of the allocation of the resources can be different from the year of occurrence of the natural disaster.

In terms of the most destructive tropical cyclones for FONDEN, Figure 4 shows the hurricanes that caused the greatest damage and to which the highest amounts were allocated by this fund. In consistency with the previous graph, 2010 was the year with the highest amounts of allocation by FONDEN due to damage by hurricanes Karl, Matthew and Alex. Karl and Mathew flooded Veracruz, causing power outages and damage in infrastructure. In particular, Karl created severe flooding in Veracruz, displacing between 250,000 and 500,000 people. Also in 2010, hurricane Alex caused flooding and power outages, as well as damage in infrastructure across eight states affecting the regular operations of manufacturing firms in Tamaulipas and Nuevo León, as those were interrupted for several weeks. Widespread flooding affected 500,000 people throughout northeast Mexico, ruining over 200,000 hectares (500,000 acres) of crops in the region, which represented 11% of regional production. In 2005, hurricanes Stan, Wilma and Emily caused important losses in the service sector on the Yucatán Peninsula, affecting the tourism sector and services.

Moreover, there were numerous tropical storms and hurricanes in September 2013 that caused important losses in productive infrastructure. Tropical storm Barry caused major flooding in Veracruz, while Hurricane Manuel caused major flooding: 6 rivers overflowed their banks, and 20,000 persons were evacuated in Guerrero and over 100,000 people in

Sinaloa. In 2013 a total of 107 municipalities were declared natural disaster areas associated with tropical cyclones.

**Figure 4. Disaster relief resources from FONDEN by tropical cyclones (1999-2018)**  
 Amounts allocated in thousand millions of constant Mexican pesos as of 2008, by maximum sustained winds and year



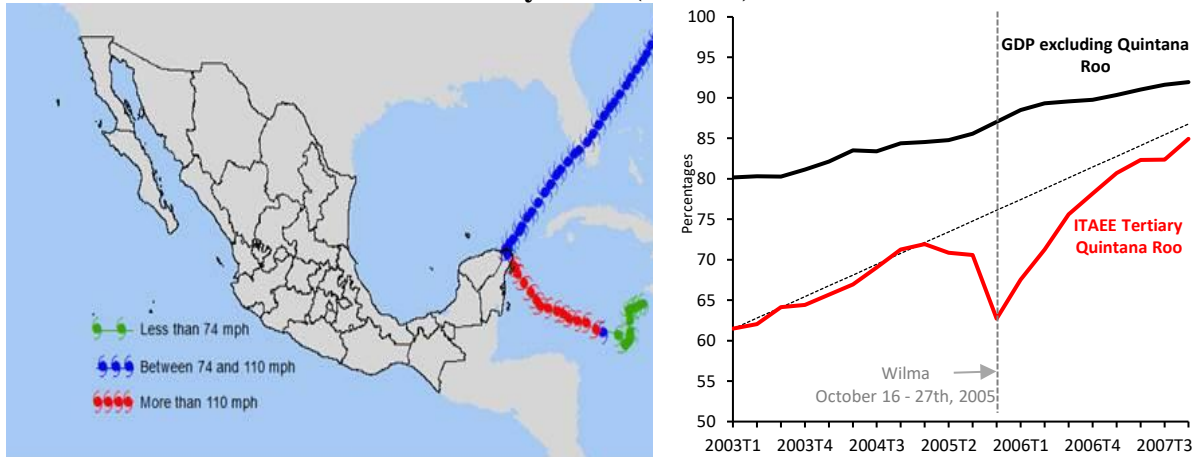
Source: Prepared by authors using data of the FONDEN Trust, state resources and the federal expenditure budget, consulted on January, 2021 at

[http://www.gobernacion.gob.mx/es/SEGOB/Recursos\\_destinados\\_a\\_desastres\\_por\\_Estado](http://www.gobernacion.gob.mx/es/SEGOB/Recursos_destinados_a_desastres_por_Estado)

Note: Bubbles' size indicates the amount of the resources allocated. This resource allocation differs from those of the Mexican insurance industry that ranks hurricane Wilma as the costliest natural disaster ever that hit Mexican coasts in October 2005, with private insurance compensations payments over 2.3 billion U.S. dollars. <https://www.statista.com/statistics/753668/most-expensive-natural-disasters-insurance-compensation/>

Next, we show the empirical evidence of how the impact of hurricane Wilma affected economic activity in the state of Quintana Roo in the southeast of the country. This tropical cyclone first made landfall on October 21<sup>st</sup>, 2005 on the island of Cozumel, Quintana Roo, with a maximum sustained wind up to 150 mph and a second landfall on the north coast of the Yucatán Peninsula. On its path, Wilma struck Cancún causing widespread damage in important tourist destinations.

**Figure 5. Trajectory and impact of hurricane Wilma on the quarterly state economic activity index (ITAEE)**



Source: Left: Prepared by authors using the IBTrACS from NOAA. Right: Seasonally adjusted series for the quarterly state economic activity index, published by the National Institute of Statistics and Geography (INEGI).

Figure 5 (left) displays the geographical trajectory of Hurricane Wilma. While passing through the Yucatán Peninsula, this hurricane reached its highest wind intensity. Numerous hotels, highways, and electricity infrastructure sustained severe damage for several weeks. Also, Figure 5 (right) shows a contraction of ten percentage points in the quarterly state Economic Activity Index (ITAEE 2013=100) that measures the economic activity in the tertiary sector of the state Quintana Roo in the contemporaneous shock quarter, when the hurricane Wilma made landfall on the Peninsula. Even if economic activity appeared to turn back to its original path, an incomplete recovery is observed after three quarters. In contrast, the rest of the states, excluding Quintana Roo, show an unaffected indicator of economic activity in the shock quarter and their performance remained on the same growth path.

### 3. Estimation method

One of the greatest advantages of estimating the effects of climate events relies on exploiting the exogeneity of these events with respect to the economic activity within a delimited spatial area (see Deschênes and Greenstone, 2007; Deschênes and Moretti, 2009; Dell et al., 2009; Dell et al., 2012; Deschênes and Greenstone, 2011; Jones and Olken,

2010). In this paper, we use the exogeneity in the path of tropical cyclones and the severity of their maximum sustained winds to identify their effects on economic activity.

We use an unbalanced panel that allows us to use different fixed effects to separate the short-term random variability of the winds from many other sources of possible omitted variable bias (Dell et al., 2014). In particular, we use time and geographical area fixed effects to control for unobservable from static spatial features and possible changes over time common to all establishments. Our identification strategy hinges on the assumption that the intensity and trajectory of the maximum sustained winds of tropical cyclones are exogenous and uncorrelated with other unobserved factors, which may influence the economic performance of the establishments (see Hsiang, 2016). In this framework of analysis, we exploit the exogeneity of variability of maximum sustained winds of tropical cyclones in intensity and trajectory across time, which means from month to month and within cross-section variability at the municipality level. This is because intensity is not spatially correlated with the dynamics of the economic activity, and it is unlikely that a correlation exists between the most frequently affected regions and the most economically active municipalities, especially in service sector.

In the estimation, we also control for temperature and precipitation, since some papers suggest that these variables are correlated with patterns of tropical cyclone exposure over time (see Hsiang, 2010). In Mexico, mainly in coastal areas, there is evidence of the role of tropical cyclones in replenishing water reserves. Breña-Naranjo et al. (2015) find that tropical cyclones have an important rainfall contribution for some arid and semiarid regions of Mexico and are also an active source of water recharge for aquifers, rivers, lakes and dams (Domínguez and Magaña, 2018). For instance, municipalities from the Baja California Peninsula in the Northwestern region receive between 55% and 60% of their total mean cumulative annual precipitation from tropical storms. Moreover, about 20% of the rain on the Central Northern Pacific coasts and the Yucatán Peninsula, is associated with the occurrence of tropical cyclones. For these reasons, we include controls for temperature and precipitation in the estimation to reduce or avoid omitted variable bias.

Our objective is to estimate the marginal effect of a temporary change in the maximum sustained winds occasioned by tropical cyclones on the establishments' economic performance. Although multiple approaches have been used in economic literature to study the impact of natural disasters on economic activity, we use the Augmented Distributed Lagged Model, because it allows modeling the cumulative incidence of the exposure of establishments to tropical cyclones' maximum sustained winds with a straightforward method. The specification uses the first difference of logs for dependent variables to make sure of modeling stationary series that should produce estimates free of spurious correlations, as in Hsiang (2012); Hsiang and Jina (2014); and Krichene *et al.*, (2021). We use the following specification of the Augmented Distributed Lagged Model fitted to panel data.

$$\begin{aligned} \Delta \ln Y_{i,j,t} = & \alpha_i + \sum_{l=0}^L \beta_l Wind_{j,t-l} + \sum_{l=0}^L \tau_l Temp_{j,t-l} + \sum_{l=0}^L \phi_l Rain_{j,t-l} + \rho_t \\ & + \mu_{statexyear} + \lambda_{sectorxyear} + \varepsilon_{i,j,t} \end{aligned} \quad (1)$$

With

$$\widehat{B} = \sum_{l=0}^L \widehat{\beta}_l \quad \widehat{T} = \sum_{l=0}^L \widehat{\tau}_l \quad \widehat{\Phi} = \sum_{l=0}^L \widehat{\phi}_l$$

where  $Y_{i,j,t}$  denotes the outcome of establishment  $i$  located in municipality  $j$  and time  $t$ ;  $Wind_{j,t}$  measures the exposure to maximum sustained winds of tropical cyclones at the 10-meter-altitude in every municipality  $j$  during period  $t$ ;  $Temp_{j,t}$  is the average temperature recorded in municipality  $j$  during time  $t$ ;  $Rain_{j,t}$  stands for the cumulative precipitation recorded in the municipality  $j$  during time  $t$ . The coefficients of interest  $\beta_l$ ,  $\tau_l$  and  $\phi_l$  provide the dynamic impact of one additional unit of maximum sustained winds (1 m/s), temperature (1°C), and cumulative precipitation (1 mm), respectively, on the growth rate of the establishments' output variable at the lag  $l$  after the shock. While  $\widehat{B}$ ,  $\widehat{T}$ ,  $\widehat{\Phi}$  measure long-run marginal cumulative impacts after  $L$  periods resulting from a one-unit climatic event 1 m/s for maximum sustained winds, 1°C for average monthly temperature and 1 mm for cumulative monthly precipitation, respectively, on the growth of the output variables of establishments. This estimate is the sum of month-to-month growth effects from month  $t$  to

$t+L$ . Also in this specification,  $\alpha_i$  captures fixed differences in the growth rate of the output variable for the establishment  $i$ ;  $\rho_t$  are month-year fixed effects that control for common seasonality patterns of the month and year affecting the growth of the output variables of the establishments. In particular, we considered  $\mu_{statexyyear}$  as state-year fixed-effects that capture common shocks for all establishments;  $\lambda_{sectorxyyear}$  controls for specific yearly dynamics common for all establishments. Finally,  $\varepsilon_{i,j,t}$  is the error term clustered by state to allow for arbitrary serial correlation across different establishments from the same state. We included as controls more aggregate levels of geographical fixed-effects by considering state-year fixed-effects that allow us to guarantee enough residual variation in exposure to tropical cyclones and weather variation to identify their effects on the economic performance of establishments.<sup>4</sup> Furthermore, it makes sense that differences at the state level such as legal and fiscal regulations, facility for starting business, infrastructure conditions and issues of public security could generate differentiated patterns on the economic performance of establishments, in comparison to a more local level such as municipality.

We perform linear regressions with multiple levels of fixed effects in Stata using the *reghdfe* package of Correia (2016), because of its computationally efficient procedures quite convenient for estimation with microdata. For companies in the manufacturing sector, we use the output variable volume production index, while in the service sector, we estimate the effects for the real revenues index and real operative expenditures.

In order to guarantee that the model represents a good description of the data, we determine the optimal number of lags to include in the model. When the model has a lower number of lags, it is possible that serial correlation is still present in the residuals and the least squares estimators are biased and inconsistent with misleading results and erroneous confidence intervals and hypothesis-testing (see Maddala and Lahiri, 2009). In contrast, when irrelevant variables are included in the model, least squares estimators are unbiased and

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<sup>4</sup> Instead, the incorporation of municipality-fixed effect may soak up most of the variation in weather and tropical cyclone exposure, resulting on insufficient residual variation in those to identify their effects on the economic performance of establishments (see Jessoe et al., 2018).



consistent, but they will have a bigger variance in comparison with the correct specification. Although there are many methodologies, we have decided to use the Bayesian (BIC) and Akaike information (AIC) criteria, as well as the Hannan and Quinn information criterion (HQ). We select the specification that results in the lowest BIC and AIC criteria and perform a robustness check with the extra criterion of the adjusted R-squared. Since we estimate linear models, if an additional lag does not add to the explanatory power of the model, we omit it (see Maddala and Lahiri, 2009). We show some results for the main estimations in Appendix B, most of all estimations show an optimal number close to 12 lags. All results are available from the authors upon request.

We perform an additional robustness analysis by estimating specifications that include lagged values of the dependent variable in the regressors to corroborate whether our main specification is robust to multicollinearity and to serial correlation in the residuals. We also perform estimations for subsamples according to their level of exposure to tropical cyclones, whose results are shown in the section on the robustness of the main results.

Finally, the structure of the data imposes some limitations in terms of the attrition of the sample, which is common in this kind of surveys. Even when fixed effects of size, economic activity and state might mitigate certain effects, we are aware that attrition might be a non-negligible problem and more tests are required in order to provide robust evidence about it.

## **4. Data**

### ***4.1 Tropical cyclone exposure data***

In the economic literature, wind speed has been broadly used as a proxy variable for exposure to tropical cyclones (Emanuel, 2005; Emanuel, 2011; Hsiang and Jina, 2014; Boose et al., 2004). For this paper, we have assembled a unique database containing information on municipality exposure to tropical cyclones from January 1994 to December 2017. The data set contains information for all the 2,456 municipalities of Mexico.

To build this database, we considered a total of 793 tropical cyclones that occurred on the North Atlantic and East Pacific shores between January 1994 and December 2017, and they

are recorded at the International Best Track Archive for Climate Stewardship (IBTrACS) database (Knapp et al., 2010 and Knapp et al., 2018), published by the National Hurricanes Center of the National Oceanic and Atmospheric Administration of the U.S. government. Using this data, we estimate observations of maximum sustained winds for the surface of the 2,456 municipalities across Mexico, using the Storm Wind Model package in R developed by Brook Anderson from Colorado State University based on Willoughby et al. (2006).<sup>5</sup> For every tropical cyclone, this program models and maps wind speeds across the storm's path based on estimations generated from the Willoughby wind speed model that employs parameters of forward speed, direction of forward motion of the storm, gradient-level wind speed, radius of maximum winds, and parameters for decay of winds away from the storm's center. Thus, for each municipality centroid, the model estimates the maximum sustained wind speed at the altitude of 10 meters by 1-minute as well as the wind gust speeds, which means how many minutes winds were above a speed limit. Finally, to obtain a single monthly measure for every municipality, we take the maximum value of the sustained winds recorded at the municipality-level during that particular month.

Figure 6 shows a box-plot of the municipality data about maximum sustained winds as an exposure measure to tropical cyclones estimated by the RwindStorm Model at the state level for the period 1994-2017. The distribution across states shows an important heterogeneity in their measures of exposure. States like Baja California Sur, Nayarit, Jalisco, Oaxaca, Quintana Roo, and Yucatán show the municipalities with the highest measures of exposure to tropical cyclones. States like Quintana Roo, Nayarit and Jalisco display the maximum values.

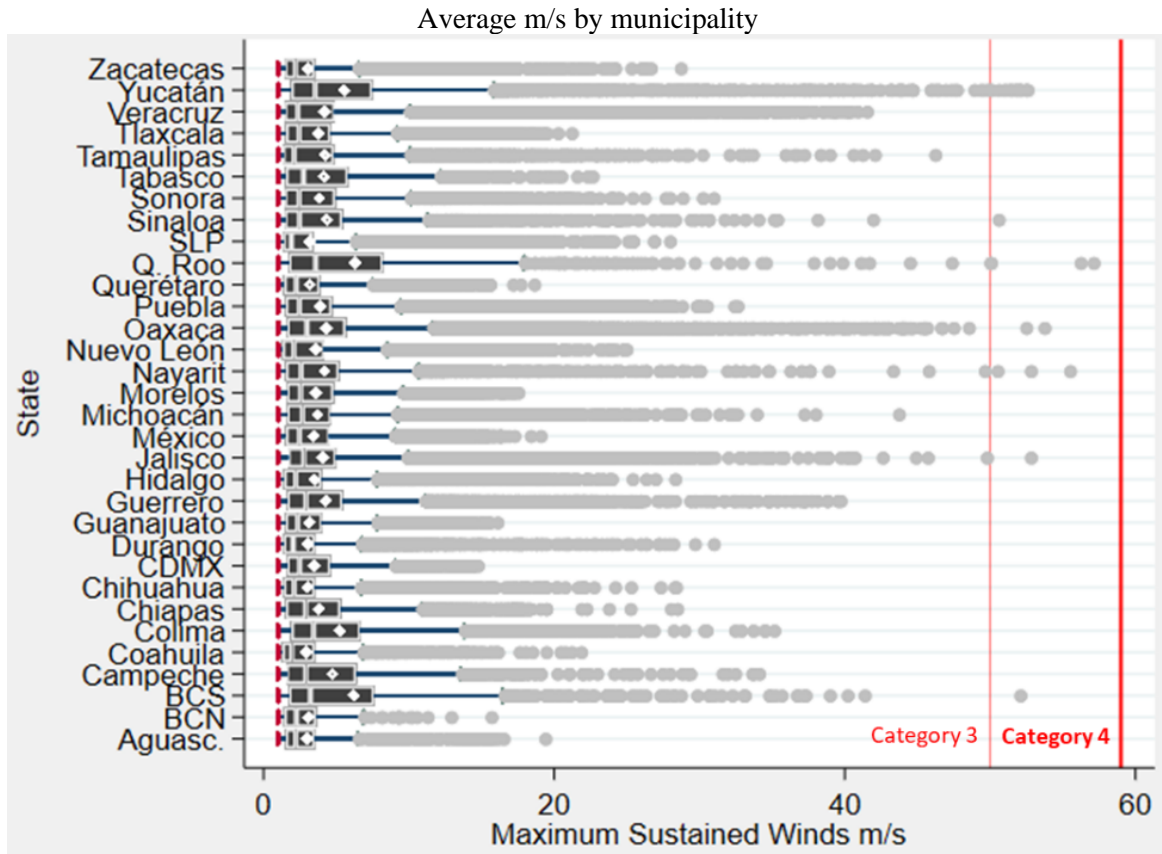
Table 1A, in Appendix A, shows descriptive statistics for the variables of exposure at the state level. We can observe an important heterogeneity of exposure across states, with Baja California Sur and Quintana Roo showing the highest standard deviations of the maximum sustained winds. However, the maximum measure of exposure recorded on land during the period of study was 57.13 m/s, corresponding to hurricane Isidore (category 4) in Quintana

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<sup>5</sup> Code available at <https://github.com/geanders/stormwindmodel>

Roo and to hurricane Odile (category 4) in Nayarit, the most intense landfall ever for Mexico.<sup>6</sup>

**Figure 6. Box-plot of within-state distribution of maximum sustained winds (m/s) in Mexico, 1994-2017**



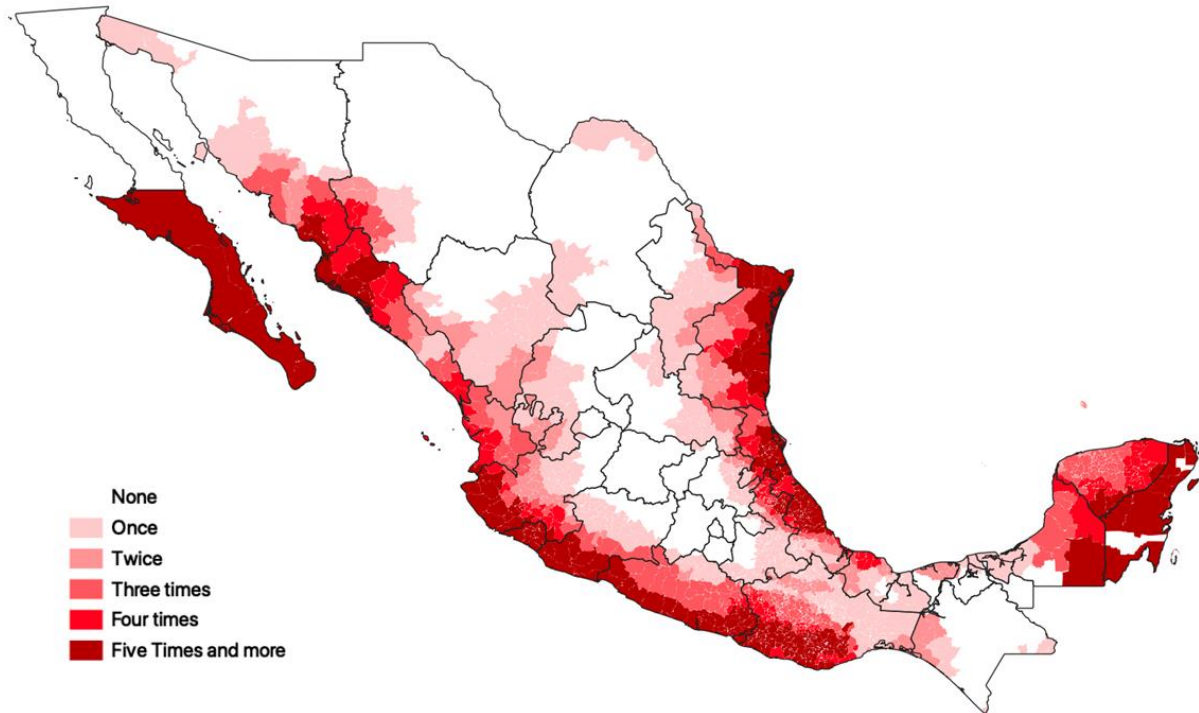
Source: Estimated by authors based on the RwindStorm Model.

Note: Boxes represent interquartile ranges; white lines represent the median for every state; white diamonds stand for the mean of every state for the whole period of study (1994-2017); grey points represent outliers.

Figure 7 shows a frequency map that details the recurrence of tropical storms and hurricanes at the municipality level for the period 1994-2017. This sort of risk map is calculated by counting the times a municipality had to deal with maximum sustained winds equivalent to at least a tropical storm category or higher ( $\geq 39$  mph, which is equivalent to  $\geq 18$  m/s). Using this threshold, we classify municipalities as low and high exposure to tropical cyclones municipalities.

<sup>6</sup> Patricia is the most intense tropical cyclone ever observed in the western hemisphere, as recorded in the IBTrACs, with maximum sustained winds of 185 miles per hour and minimum pressure of 872. Its maximum sustained winds recorded on land was a magnitude of 52.8 m/s at the municipality of Villa Purificación, Jalisco, in October 2015.

**Figure 7. Maps of frequency to tropical storms and hurricanes, 1994 – 2017**



Source: Prepared by authors using the IBTrACS from NOAA.

The map displays 865 high exposed municipalities in dark red that have experienced a tropical storm or hurricane with high frequency at least three times. More than 60% of those municipalities are on the Pacific coast in municipalities of the states of Baja California Sur, Jalisco, Colima, Michoacán, Guerrero and Oaxaca. While, on the Atlantic coast, the most frequently affected municipalities are concentrated in the states of Veracruz, Tamaulipas, Quintana Roo and Campeche. This map permits us to identify the two types of municipalities, those with low and high exposure to tropical cyclones, which allows splitting the sample in two and perform additional tests of robustness for the main results.

#### ***4.2 Weather database***

For the climate data, we assembled a monthly weather database at the municipality level using Daymet (Thornton et al., 2018). This database provides monthly gridded observations of the weather at a 1km-by-1km resolution for the period 1980–2019. Weather

variables include monthly averages of maximum and minimum temperature and monthly accumulated precipitation.

Using this information, we construct observations at the municipality level by averaging grid cells that fall within the boundaries of each municipality. In general, this algorithm estimates climate variables at each grid by combining interpolation and extrapolation of input data from multiple weather stations with weights that reflect the spatial and temporal relationships between a Daymet gridcell (measured from its center) and the nearby weather stations. Thus, we construct balanced panel data with monthly observations on cumulative precipitation and average maximum and minimum temperatures for the 2,546 municipalities across Mexico from January 1994 to December 2017.

### *4.3 Economic surveys*

This study estimates the impact of tropical cyclones on the manufacturing and service sectors, which jointly made up about 90% of GDP in 2018 (30% by the manufacturing sector and about 60% by the service sector). We carry out an independent analysis for each sector using surveys that capture the evolution of the economic performance of establishments in those sectors on a monthly basis.

#### *4.3.1 Manufacturing Sector*

To estimate the effects of tropical cyclones on manufacturing establishments, we use microdata from the Monthly Survey of Manufacturing Industry (EMIM, by its acronym in Spanish) published by the National Institute of Statistics and Geography (INEGI, by its acronym in Spanish) and consulted at the microdata laboratory of INEGI.<sup>7</sup> The EMIM records provide, on a monthly basis, information on short-term economic behavior of establishments in the manufacturing sector individually identified by their location at the

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<sup>7</sup> The Mexican establishment configuration is characterized by a high concentration of micro and small establishments. According to the 2014 Economic Census of a total of 4.23 million of establishments recorded, only 3.13% have more than 15 workers.

municipality level. In general, the sample is composed of manufacturing establishments with more than 15 workers.<sup>8</sup>

EMIM mainly entails a quota sampling design with the sample of establishments representing about 70-80% of the gross value added reported for between 205 and 240 industry class groups (6-digit North American Industrial Classification System, NAICS), according to the survey's wave. Sampling procedures in this survey include a multistage deterministic selection of establishments according to their economic importance based on annual reported revenues and employed personnel for all industry class groups. This survey has three waves, each of them updated with the Economic Censuses of 2004, 2008, and 2014, respectively. The first EMIM wave runs from 1994 through 2005 as the Monthly Industrial Survey (Encuesta Industrial Mensual, EIM, by its acronym in Spanish), which considers 205 class groups (NAICS 6-digit activities) with a 6,867-establishment sample. The second wave goes from 2005 to 2010 as the Expanded Monthly Industrial Survey (Encuesta Industrial Mensual Ampliada, EIMA, by its acronym in Spanish), which considers 230 class groups and a 7,238-establishment sample size. The third wave runs from 2007 through 2017 as the Monthly Survey of Manufacturing Industry (Encuesta Mensual Industrial Manufacturera, EMIM, by its acronym in Spanish), with a 11,406-establishment sample representing 240 class activities (NAICS 6-digit class groups), INEGI (2005) and INEGI, 2015).

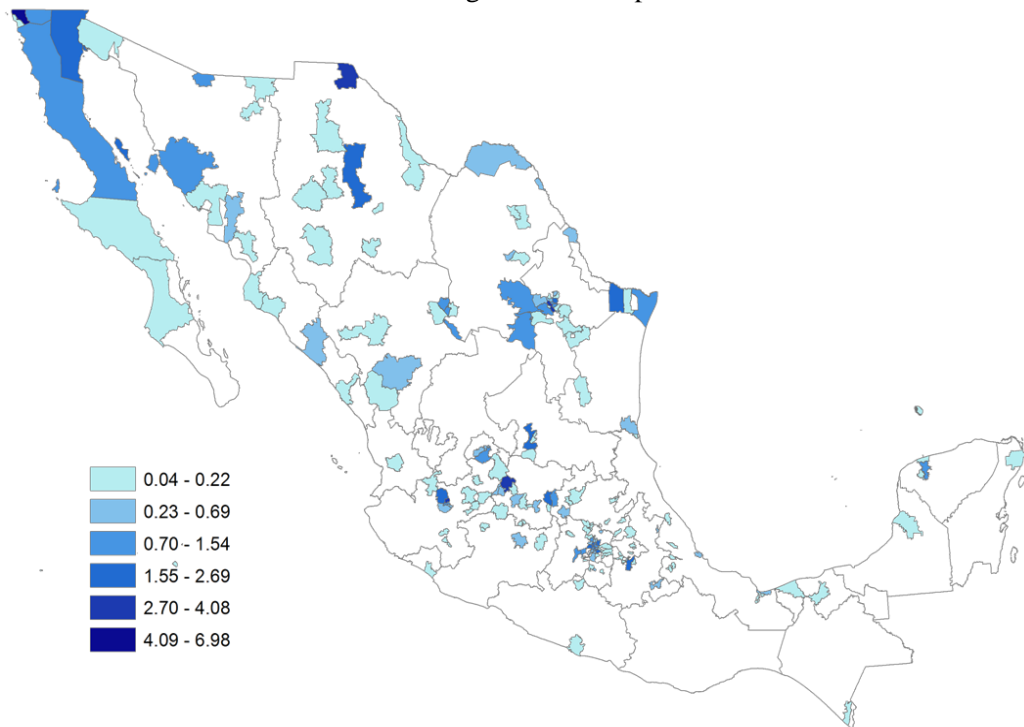
Since it is possible to follow the establishments across the three manufacturing surveys, the ideal panel would have monthly observations for every establishment from January 1994 to December 2017. However, due to attrition (a frequent problem in these surveys), the final sample employed for the analysis consists of an unbalanced panel with observations at the establishment level. Figure 8 shows the geographical distribution of our final sample composed of an unbalanced panel that contains information for 18,511 establishments that are geographically distributed over about 195 municipalities in all states.

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<sup>8</sup> Initially the survey excluded maquila activities. However, due to the increasing importance of this activity since 2005, the survey has incorporated manufacturing establishments with maquila and maquila export activities, and basic petrochemical and oil refining.

**Figure 8. Geographical distribution of establishments in monthly industrial manufacturing survey, EMIM, sample 1994-2017**

Percentages of the sample



Source: INEGI, Encuesta Industrial Mensual (EIM); Encuesta Industrial Mensual Ampliada (EIMA); Encuesta Mensual Industrial Manufacturera, EMIM.

Note: This map satisfies the confidentiality criteria of the microdata laboratory since we only show municipalities that have at least five establishments.

The map in Figure 8 shows the location at municipality level of the complete sample that includes 7,238 establishments, along the three waves, with a total of 2,542 of them with a complete set of 288 observations. We observe that 19 of the 32 states in the country show an important concentration of the manufacturing activities and are mainly located in the north, center and west parts of the country: Aguascalientes, Coahuila, Chihuahua, Mexico City, Guanajuato, Jalisco, Estado de México, Nuevo León, Puebla, Querétaro de Arteaga, San Luis Potosí, Sonora, Veracruz, Baja California, Durango, Morelos, Sinaloa, Tlaxcala and Yucatán. However, the states with the highest concentration of manufacturing establishments are located in the North, in border states, and at the Center of the country, surrounding Mexico City.

### 4.3.2 Service Sector

To estimate the effect of tropical cyclone exposure on the economic performance of establishments from service sector, we use microdata from the Monthly Services Survey (EMS, by its acronym in Spanish), that covers 105 6-digit NAICS code class groups representing about 85% of the revenue value reported at the Economic Census 2004. The EMS collects, on monthly basis, information on establishments' economic performance in the non-financial service subsectors, excluding services related to insurance services, corporate management, agricultural, forestry and mining activities, public sector activities and government, international and extraterritorial organizations, unions, and non-profit units (ENIGH, 2014).

Like the manufacturing survey, the sampling method of the EMS entails a non-probabilistic (deterministic) quota sampling design that selects the units under study according to their percentage contribution to the design variables (total revenue, production value, or employed personnel) to reach the coverage established for each domain of study. According to their economic importance, the sample represents above 80% of the revenue' values in the class group.<sup>9</sup>

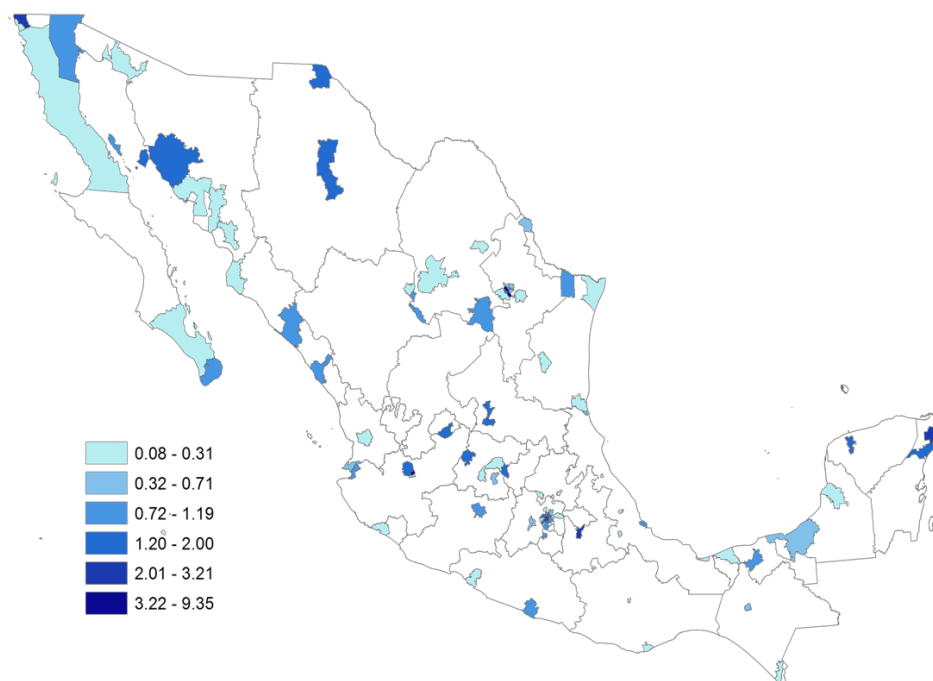
For the service sector, we only consider the available information microdata from one wave of the survey for the period 2008-2015 and a final sample of an unbalanced panel with 7,465 establishments, including a total of 4,921 establishments with the complete set of 95 observations. We rule out information regarding establishments with fewer than 12 observations, which do not exceed 3% of the sample. Figure 9 shows the geographical distribution of the sample.

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<sup>9</sup> The sampling design of the EMS is a quota-sampling (deterministic) consisting of three stages for selecting the units under study according to their percentage contribution to total income, production value, or employed personnel. At the first stage, the study includes 45 NAICS 6-digit level class groups in the high level of coverage; second, a medium level of representativeness for 45 classes by a quota sampling procedure that includes all establishments representing, by their level of revenue, above 80% of the value of revenues in the class; third, a medium level of representativeness for 12 classes by a random selection process for each class representing a range from 70% to 80% of the value of revenues (ENIGH, 2014).



**Figure 9. Geographical distribution of establishments in monthly services survey, EMS 2008-2015**  
Percentages of the sample



Source: INEGI, Encuesta Mensual de Servicios, EMS.

Note: This map satisfies the confidentiality criteria of the microdata laboratory since we only show municipalities that have at least five establishments.

The map in Figure 9 shows the 7,465 establishments geographically distributed across more than 101 municipalities in the 32 states of the country. States that concentrate an important share of the population also show a notable service profile, like Mexico City, Estado de México, Jalisco, Nuevo León, Baja California Norte and Yucatán.

#### ***4.4 Indicators of economic activity for establishments in manufacturing and service sectors***

In this paper, we focus on certain outcome variables in these surveys that describe the dynamics of economic activity of establishments that may be affected by the occurrence of tropical cyclones. For the manufacturing sector, we construct a Laspeyres volume index that use quantifiable volumes of production to assemble the production index per establishment, using 2008 as the baseline year to show variation across months and years (see INEGI, 2015).

For the service sector, we focus on two variables, i) the real revenue index using a composite index that assembles all revenue categories for the establishments weighted by their share in total revenue; and ii) the real operative expenditures that aggregate the amount of expenses for consumption of products and materials of any kind consumed by the establishment to provide their service activity in real values (see INEGI, 2014). For both variables, we use 2008 as the baseline year, because it is the year of the records of the Economic Census used as the population framework of the sampling design.

Since EMIM and EMS present a non-probabilistic (deterministic) design at the national level and the sector level, the analysis is performed with sampling data for these variables and no expansion factors are calculated or applied.<sup>10</sup> These results represent valid estimates of the behavior or evolution of the study domains. At the level of the national sample, EMIM has a coverage of 88.1% of total revenues, while, for 2-digit NAICS, the coverage is higher than 85% of the revenues of establishments (see INEGI, 2015). In the next section, we present estimations for the national level and for sector aggregations (2-digit NAICS code) of the manufacturing and service sectors.

However, to obtain further analysis on possible adaptation practices, we also present additional estimations by splitting the sample into low-exposure municipalities and high exposure ones, based on Figure 6. The set of establishments located in municipalities with high exposure to tropical cyclones approximately represents between 10% and 15% of the total sample. However, it's important to mention limitations of the estimation that may show some bias due to higher disaggregation levels of the surveys EMIM and EMS. In the non-probabilistic (deterministic) sample design, the use of an additional disaggregation, different from study domains, may result in biased estimates and being non-informative. In consequence, to prevent biased estimations we used sampling microdata, without weighting.

Tables 2A.1 and 2A.2, in Appendix A, present the descriptive statistics of the growth in percentage (first difference of the logarithm approximation) for establishment variables in

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<sup>10</sup> <http://en.www.inegi.org.mx/programas/emim/2007/#Microdata>

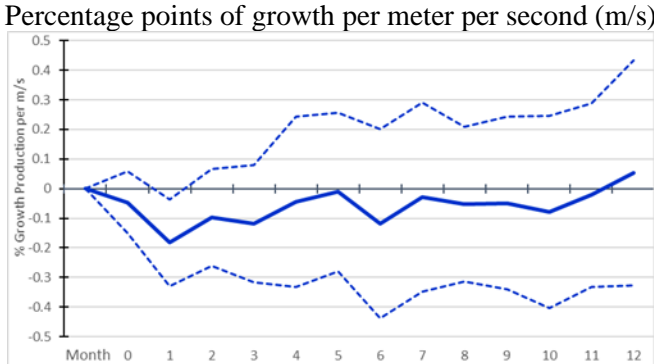
terms of their location in municipalities with high exposure and low exposure to tropical cyclones, for manufacturing establishments from EMIM and for the service establishments from EMS, respectively.

**5. Results**

**5.1. National-level results of tropical cyclone exposure effects on the manufacturing production index**

In general, results suggest a small temporary negative and statistically significant effect of tropical cyclone exposure on production at the national level one month after the shock. Figure 10 shows that a 1 m/s increase in the maximum sustained winds of tropical cyclones leads to a decrease of 0.18 percentage points (p.p.) in the growth of the volume production index one month after the shock. See Table 3A in Appendix A for precise estimates.

**Figure 10. National industry level of manufacturing: marginal cumulative effect of tropical cyclone exposure on the volume production index**



Source: Estimated by authors based on microdata for the period (1994-2017) from EIM, EIMA and EMIM from INEGI.

Note: Dotted lines indicate 95% confidence intervals. Standard errors clustered by state. Point estimates are in Table 3A in Appendix A.

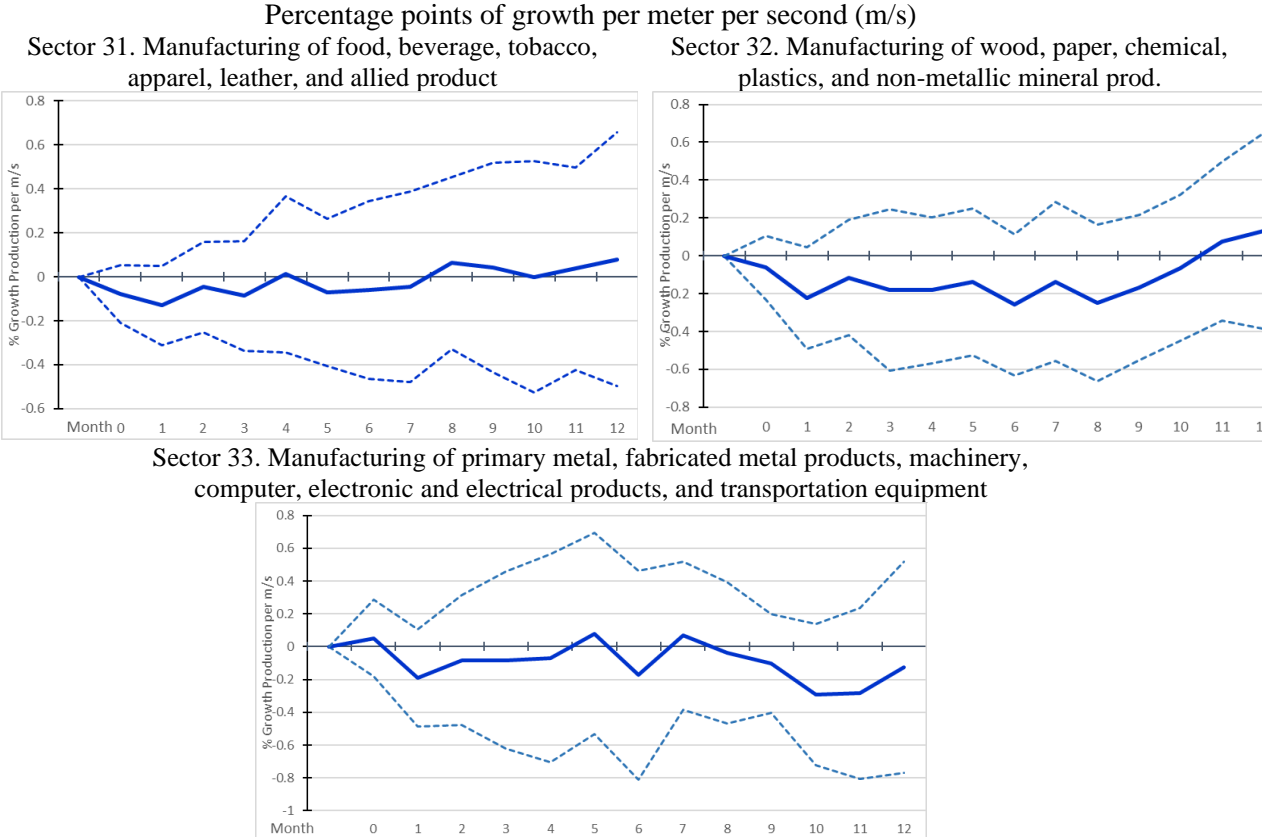
To put these findings in perspective, we use the parameter estimates shown in Figure 10 to evaluate the average effect that tropical cyclone exposure has on the establishments contained in the sample. A one standard deviation-increase in maximum sustained wind, equivalent to 3.12 m/s, would generate an average loss of 0.57 p.p. in the growth of the volume production index of manufacturing establishments one month after the shock. Note that the effect resulting from an extreme event like a hurricane, whose maximum sustained winds reach at least 33 m/s, is ten-fold higher. For instance, the sample shows that the top

three maximum sustained wind events recorded in municipalities with manufacturing activities were: Hurricane Kenna with up to 52.8 m/s in municipality Santiago Ixcuintla in state Nayarit in October 2002, Hurricane Isidore with 49.3 m/s in municipality Mérida in state Yucatán in September 2002, and Hurricane Wilma with 47.4 m/s in municipality of Benito Juárez in state Quintana Roo in September 2005.

5.1.1. Heterogeneous results within the manufacturing sector

In Figure 11, we can also observe the estimates of the cumulative effect of tropical cyclone wind exposure on the growth of the volume production index by sector of economic activity.

**Figure 11. Manufacturing sector: marginal cumulative effect of tropical cyclone exposure on the volume production index**



Source: Estimated by authors based on microdata for the period (1994-2017) from EIM, EIMA and EMIM from INEGI. Note: Dotted lines indicate 95% confidence intervals. Standard errors clustered by state. Point estimates are in Table 3A in Appendix A.

Consistent with national manufacturing estimates, establishments from manufacturing sectors 31 (manufacturing of food, beverage, tobacco, apparel, leather, and allied product), 32 (manufacturing of wood products, paper, chemical, plastics, and non-metallic mineral products), and 33 (manufacturing of primary metal, fabricated metal products, machinery, computer, electronic products, electrical, and transportation equipment) show a negative effect, but the estimates are not statistically significant (specific estimates are shown in Table 3A in Appendix A).

#### *5.1.2. Temperature and precipitation effects on the manufacturing sector*

Estimates show some short-term positive effects of temperature on the volume production index of manufacturing establishments at the national level. This effect is also present for manufacturing sectors 32 (manufacturing of wood products, paper, chemical, plastics, and non-metallic mineral products), and 33 (manufacturing of primary metal, fabricated metal products, machinery, computer, electronic products, electrical, and transportation equipment). However, manufacturing sector 31 (manufacturing of food, beverage, tobacco, apparel, leather, and allied product) shows a negative effect in the second month after the shock, which may be due to a reduced effectiveness of cold storage or other procedures on processed food and beverage manufacturing. For precipitation, estimates show marginal and delayed positive effects occurring some months after the shock at the national level and for the three manufacturing sectors (see Table 4A in Appendix A).

#### *5.2. National-level results of tropical cyclone exposure effects on the service sector*

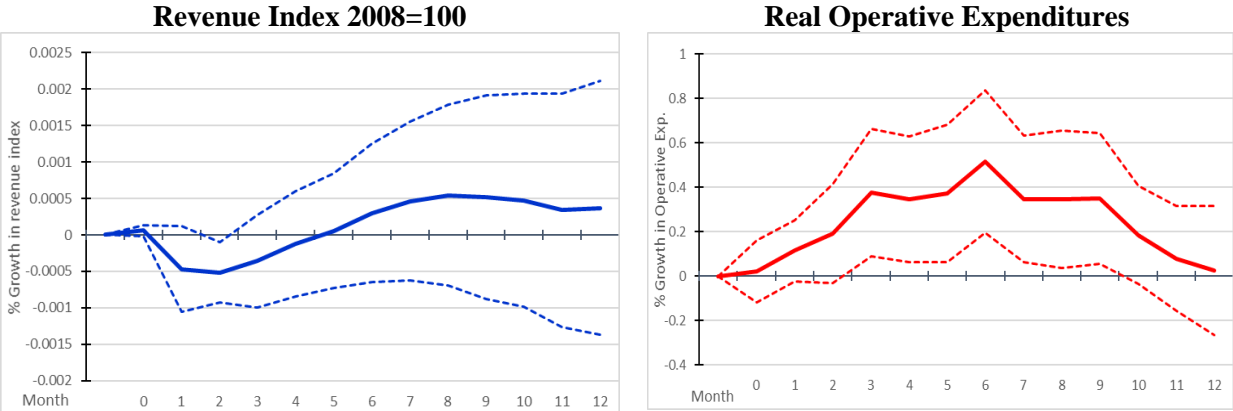
Figure 12 shows a small negative short-term effect of tropical cyclone exposure on the growth of the revenue index at the national level for the second month after the shock. However, we observe a persistent and significant impact on the real operative expenditures of the establishments that appears shortly after the shock (see detailed estimates in Tables 7A and 9A in Appendix A). For every additional 1 m/s increase in maximum sustained winds, the real operative expenditures of establishments increase from 0.19 p.p. in the second month up to 0.35 p.p. in the ninth month after the shock. This result suggests that establishments from the service sector experience a decrease in the growth of their net revenues, mainly because they have to struggle in order to keep operating, and this effect

may have a duration of up to eight months after the shock. These results are consistent with the estimations obtained for every service sector at 2-digit NAICS code (see Tables 7A and 9A in Appendix A) and for subsamples of municipalities with different levels of exposure (see Tables 11A and 13A in Appendix A).

**Figure 12. Marginal cumulative effect of tropical cyclone exposure on revenue index growth and real operative expenditures of service establishments**

Percentage points of growth per meter per second (m/s)

Service Sector



Source: Estimated by authors based on microdata from EMS for the period (2008-2015) from INEGI.

Note: Dotted lines indicate 95% confidence intervals. Standard errors clustered by state. Point estimates are in Table 7A and 9A in Appendix A.

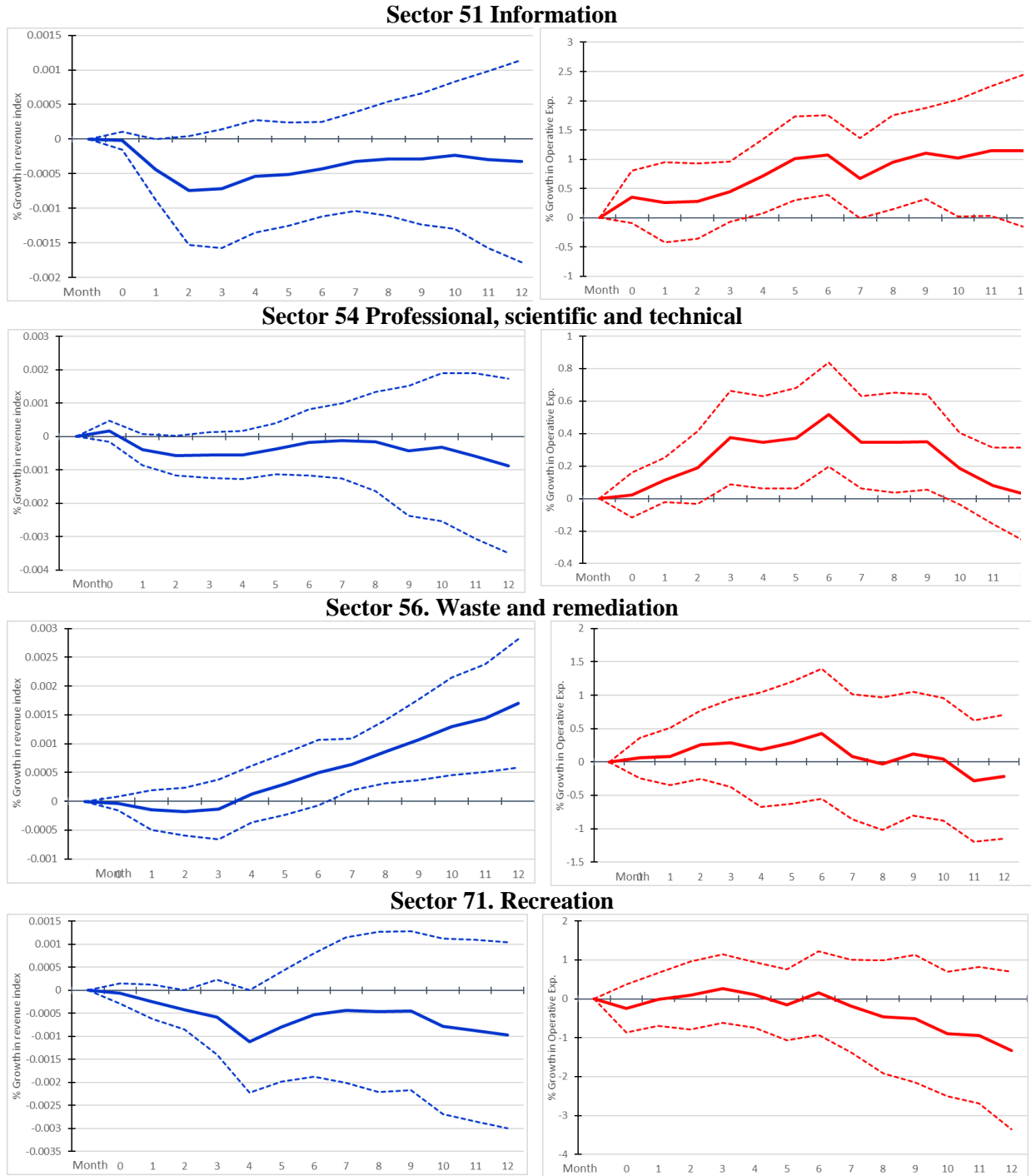
To have a better sense of the magnitude of the estimated impact, we calculate the effect of a one standard deviation increase in maximum sustained wind exposure on the growth of revenue index and operative expenditures. For the sample of municipalities included in the survey, a one standard deviation increase is equivalent to a 3.5 m/s maximum sustained wind exposure. Such an increase would generate a marginal cumulative loss of 0.002 p.p. in the growth of the revenue index the second month after the shock. Such an increase would also generate a 1.22 p.p. rise in the cumulative growth of the real operative expenditures of establishments in the ninth month after the shock. This effect might be at least 10 times higher during extreme events like hurricanes. The two highest maximum sustained winds recorded in the sample were hurricane Wilma with a magnitude of up to 57.1 m/s recorded in the municipality Quintana Roo in state Quintana Roo in October 2005, and hurricane Odile with a magnitude of 52.1 m/s in municipality Los Cabos in state Baja California Sur in September 2014.

**Figure 13. Marginal cumulative effect of tropical cyclone exposure on the growth of revenue index and real operative expenditures of service establishments by sector**

Percentage points of growth per meter per second (m/s)

Revenue Index 2008=100

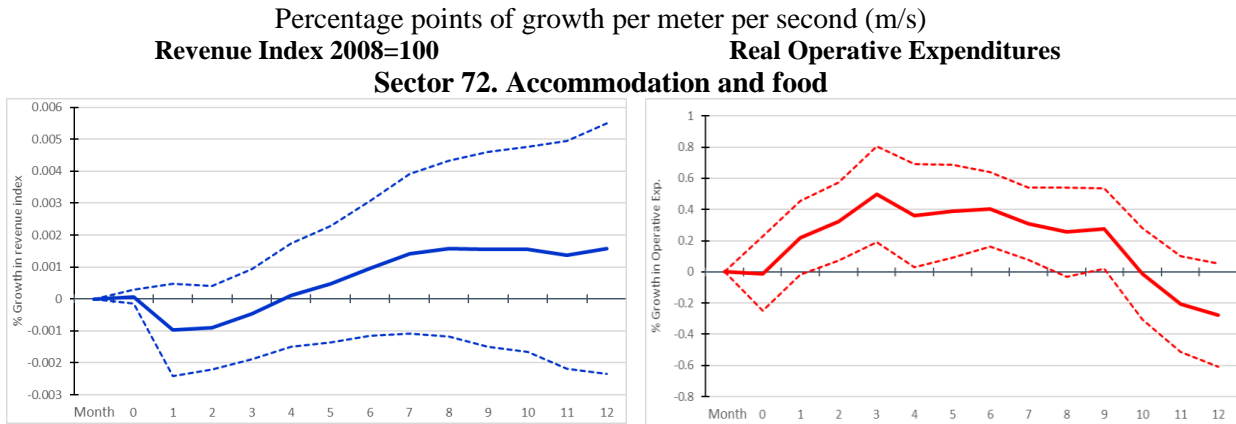
Real Operative Expenditures



Source: Estimated by authors based on microdata from EMS for the period (2008-2015) from INEGI.

Note: Dotted lines indicate 95% confidence intervals. Standard errors clustered by state. Point estimates are in Tables 7A and 9A in Appendix A.

**Figure 13 (cont.) Marginal cumulative effect of tropical cyclone exposure on the growth of revenue index and real operative expenditures of service establishments by sector**



Source: Estimated by authors based on microdata from EMS for the period (2008-2015) from INEGI.

Note: Dotted lines indicate 95% confidence intervals. Standard errors clustered by state. Point estimates are in Tables 7A and 9A in Appendix A.

### 5.2.1. *Heterogeneous results within the service sector*

We carry out the analysis for the ten sectors (2-digit NAICS sector code) included in the Monthly Services Survey and find heterogeneous responses in both the revenue index and the real operative expenditures. In general, most sectors show a short-term marginal negative and barely statistically significant effect in the revenue index and a persistent statistically significant positive effect on operative expenditures. Some particular findings stand out. For instance, the three most affected sectors in terms of the magnitude of the loss on revenue index are sectors 71 (arts, entertainment, and recreation services), 51 (information services), and 54 (professional, scientific, and technical services). On the other hand, the most affected sectors by magnitude of the increase of the operative expenditures are sectors 51 (information services), 54 (professional, scientific, and technical services), and 72 (accommodation and food services).

Some individual results by sector illustrate how tropical cyclone exposure impacts the economic activity of diverse economic units differently. Establishments from information services sector 51 and professional, scientific, and technical services sector 54 show a similar behavior pattern. Both show short-term marginal negative and barely statistically significant effects on the revenue index, while impacts on their real operative expenditures are positive and increasingly persistent from the third month and up to the twelfth month



after the shock. In the case of the sector 51, such an effect may be associated with damage in infrastructure making operation services potentially more difficult, while the case of sector 54 may be explained by the character, typically irrecoverable, of loss in the numbers of hours worked during these events.

Likely for sector 71 (arts, entertainment, and recreation services), results at the national level show that the highest impact on the revenue index is experienced during the second and the fourth month after the shock. In terms of real operative expenditures, findings are mixed but not statistically significant. For sector 72 (accommodation and food services), results show a non-statistically significant negative effect on the revenue index at the national level. However, the effect on the real operative expenditures at the national level is positive and increasing from the first and up the ninth month after the shock. These findings may suggest that while revenues are not affected, establishments such as hotels and restaurants deal with a 9-month increase in operative expenditures that shows its peak in the fifth month after the shock and completely disappears in the ninth month after the shock (see Figure 13).

In contrast, establishments from sector 48 (transportation) show a positive effect on the revenue index but no statistically significant effect on the operative expenditures. These findings suggest that establishments in this sector could see their revenues increase after a shock, possibly due to reconstruction activities and the need for transportation that such activities generate. In addition, for establishments sector 56 (administrative and support services, and waste management and remediation services), results show a positive and statistically significant effect on the revenue index starting in the sixth month after the shock, while the real operative expenditures do not show any impact at all. These findings, as expected, may suggest that, some months after catastrophic natural disasters, establishments in this sector benefit from increased revenues due to the reconstruction and remediation services associated with the damage caused by tropical cyclones.

For other sectors like the 61 (educational services) and 62 (health care and social assistance services), results show no conclusive or no statistically significant effects at the national level.

### *5.2.2 Temperature and precipitation effects on the service sector*

For the service sector, in general terms and at the national level, results for temperature and precipitation show positive marginal effects on the growth of the revenue index, although the estimated effects are barely statistically significant. Nevertheless, temperature estimations show short-term mixed effects, while precipitations show delayed but positive and persistent effects. Detailed results for temperature and precipitation are shown in Table 1A, Appendix A. Estimated effects are heterogeneous across sectors. For instance, a 1°C increase in temperature raises the growth of real operative expenditures in establishments of sectors 48 (transportation), 49 (warehousing), 51 (information services), 54 (professional and technical services), 61 (educational services), and 72 (accommodation and food services), see table 8A in Appendix A. Also, a 1°C additional increase in temperature boosts growth in the revenue index from establishments of sector 72 (accommodation and food services). In contrast, precipitation increases the real operative expenditures in establishments of sectors 49 (warehouses services), and 71 (arts, entertainment, and recreation services); while decreases real operative expenditures in sectors 53 (real state) and 61 (health services).

### *5.3. Differentiated results for low-exposure and high-exposure municipality samples*

Even when short-run variation in climate and tropical cyclones allows for an appropriate identification of their causal effect on economic activity, these estimates do not account for the adaptations that establishments, located in municipalities with a high frequency of extreme weather events, may have to carry out in the medium and long term. In contrast, establishments located in municipalities at low risk of occurrence might not adapt to a few short-run shocks.

Thus, in order to check if medium- to long-run adaptation might underestimate impacts, since regional differences in levels of adaptive capital possibly reflect differences in long-run climate adaptation, we perform separate estimations for establishments located in municipalities with high and low exposure to tropical cyclones. Although the main limitation of this set up relies on the possible bias of estimations since sample design does

not consider municipalities as dominions of study, these findings may provide some useful insights into how effects are temporally and spatially distributed.

In general, as expected, estimations show that establishments located at high-exposure municipalities exhibit mostly non-statistically significant effects or marginally significant effects at the national level and for most sectors. This evidence may suggest the existence of regional differences in the implementation of adaptive practices to decrease the impacts on the economic activities of the establishments. In contrast, establishments located in low-exposure municipalities reflect more persistent and more negative effects as a response to rare extreme weather events. For specific estimates, see Tables 11A to 14A in Appendix A.

## **6. Robustness of the results including lagged dependent variable controls**

To check the robustness of our analysis, we include autoregressive terms of the dependent variable in the model to obtain estimations robust to multicollinearity and to avoid serial correlation in the residuals, which is typical of models with lagged values. We estimate specifications with one and two lags of the dependent variable among the regressors. As expected, since we are using first-differenced data at the dependent variable, estimates in general terms remain close in magnitude to the main specification of the model. Consistently, we observe that estimates for the autoregressive terms are low, lower than 0.5, in both cases AR(1) and AR(2), suggesting that these variables have low persistence and that they do not change our main results.<sup>11</sup> In this case, the panel does not show the typical bias in fixed-effect dynamic panel estimation due to “small T, and large N” (few time periods and numerous establishments), which suggest the possibility of being correlated with past and possibly current realizations of the error.<sup>12</sup> In contrast, our sample has a large time periods and numerous establishments, which suggest that we do not have to correct for this issue because the dynamic panel bias becomes insignificant when we use a fixed-effects estimator.

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<sup>11</sup> Results are similar in magnitude and are available from the authors upon request.

<sup>12</sup> Econometric literature suggests dynamic panel estimators Arellano–Bond and Arellano–Bover/Blundell–Bond which assumes that first differences of instrument variables are uncorrelated with the fixed effects allowing to include more instruments in GMM system to improve efficiency. However, this method can generate invalid instruments in differences and system GMM tends to explode with T (see Roodman, 2009).

## 7. Conclusions

In Mexico, tropical cyclones are an important cause of economic losses and large-scale damage in infrastructure. In the economic literature, the study of the effects is mostly focused on country-level estimations, while the more disaggregated evidence about how economic units deal with tropical cyclone exposure is scarce.

In this paper, we estimate the impact of tropical cyclones on economic activity using monthly data at the establishment level. We combine this with data about 793 tropical cyclones that impacted Mexico between 1994 and 2017 to assemble a panel data set in order to estimate the impact of tropical cyclones on the economic performance of establishments in the manufacturing and service sectors.

Our findings are in line with the empirical evidence in the economic literature (Hsiang, 2010). At the national level, results indicate that, for establishments in the manufacturing sector, tropical cyclone exposure slightly decreases production briefly, after which the effect disappears. In contrast, in the service sector, we find a small negative short-term effect on revenue while operative expenditures show a delayed and persistent positive effect that may last up to seven months after the shock, depending on the sector. This discovery suggests that, when a tropical cyclone hits, not only are establishments' revenues affected, but that they also have to deal with increased operative expenses in the following months in order to keep operating and eventually recover from the shock. These results are heterogeneous across sectors, being more notorious in sectors like 51 (information services), 54 (professional, scientific, and technical services), and 72 (accommodation and food services). In contrast, sectors such as 48 (transportation) and 56 (administrative and support services, and waste management and remediation services) show positive delayed effects of tropical cyclones exposure, which is probably associated with the reconstruction activities that usually follow natural disasters.

Additional estimations may suggest that the differentiated effects of tropical cyclone exposure on establishments could be explained by the adoption of capital investments and practices. These may be more frequently adopted in highly exposed municipalities, which

could decrease impacts in the long run. As a result, investments to decrease damage may change how effects are temporally and spatially distributed.

An important contribution of this paper is based on the more disaggregated temporal and spatial character of its results, which allows identifying how heterogeneity plays a role in the magnitude of the impact, which is especially useful for policy design. Climate change is associated with increments in the probability of having higher frequency and severity of tropical cyclones, so policymaking requires supporting adaptation and economic resilience in the most vulnerable areas. Finally, as a future step in the research, it could be of interest to incorporate climate change scenarios into these estimations of impact to gauge possible future risks.

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## Appendix A

**Table 1A. Summary statistics for monthly tropical cyclone exposure at municipality level, aggregated by state, 1994-2017**  
Maximum sustained winds (MSW) in m/s

State	Mean	Stand. Dev.	Percent. 50	Percent. 75	Percent. 99	Maximum
Baja California Norte	1.01	1.77	0.39	4.80	9.30	15.69
Chihuahua	1.58	2.40	0.60	6.12	11.62	28.40
Coahuila	1.59	2.35	0.66	6.47	11.79	21.86
Sonora	1.78	3.05	0.52	8.27	14.52	30.99
Mexico City	2.08	3.16	1.94	10.19	13.96	14.76
Nuevo Leon	2.09	3.27	0.69	9.72	15.53	24.99
Durango	2.16	2.93	1.09	7.52	13.48	30.99
Aguascalientes	2.49	2.86	1.69	8.55	14.68	19.39
Zacatecas	2.51	3.06	1.50	8.58	14.71	28.73
San Luis Potosi	2.55	3.42	1.28	10.36	15.61	27.98
Tamaulipas	2.70	4.57	0.85	12.61	22.09	46.23
Guanajuato	2.73	2.74	1.86	8.43	12.26	16.10
Queretaro	2.73	3.02	1.59	9.48	13.44	18.64
Chiapas	2.79	3.19	1.29	9.07	13.71	28.48
Hidalgo	3.02	3.76	1.49	11.60	16.02	28.33
Tabasco	3.03	3.72	1.13	10.88	15.25	22.65
Estado de Mexico	3.10	3.17	2.03	9.52	14.30	19.07
Tlaxcala	3.26	3.81	1.69	11.68	15.95	21.21
Morelos	3.29	3.29	2.09	10.12	13.94	17.55
Campeche	3.34	4.85	1.21	13.35	22.40	34.11
Sinaloa	3.36	4.90	1.40	13.17	24.28	50.60
Puebla	3.40	4.14	1.67	12.60	18.35	32.63
Veracruz	3.51	4.91	1.37	14.24	21.90	41.53
Yucatan	3.56	5.53	1.07	14.05	25.43	52.59
Michoacan	3.62	3.78	2.60	11.15	16.98	43.73
Oaxaca	3.78	4.48	2.02	12.19	20.60	53.75
Jalisco	4.01	4.51	2.70	12.91	19.98	52.82
Nayarit	4.08	5.11	2.28	13.08	24.15	55.51
Quintana Roo	4.08	6.76	1.08	17.82	32.14	57.13
Guerrero	4.26	4.78	2.72	13.49	22.03	39.72
Baja California Sur	4.84	7.68	1.43	22.68	35.66	52.09
Colima	5.64	5.97	4.05	18.92	25.29	35.15

Source: Estimated by authors based on the RwindStorm Model and IBTrACS.

**Table 2A.1. Manufacturing establishments,  
descriptive statistics of the physical production Index 2008=100**

Percentages							
Sample	Observations	Mean	Stand. Dev.	Perc. 25	Perc. 50	Perc. 75	Perc. 95
<i>Index 2008=100</i>							
National Manufacturing	880,494	416.370	21,753	70.661	100.000	134.008	357.475
<i>Monthly Change in Percentage</i>							
National Manufacturing	777,587	0.018	67.296	-18.272	0.000	19.136	89.537
31. Manufacturing of food, beverage, tobacco, apparel, leather, and allied product	253,489	-0.015	66.664	-17.223	0.000	17.739	87.098
32. Manufacturing of wood products, paper, chemical, plastics, and non-metallic mineral	270,340	0.104	64.328	-17.713	0.000	18.460	82.900
33. Manufacturing of primary metal, fabricated metal, machinery, computer, electronic, and electrical products, and transportation equipment	190,588	0.050	71.233	-21.972	0.000	23.195	101.160

Source: Sample values from the Monthly Industrial Survey (1994-2005), the Extended Monthly Industrial Survey (2005-2006), and the Monthly Survey of Manufacturing Industry class (2007-2017).

**Table 2A.2. Service establishments, descriptive statistics of  
monthly growth for real revenue index and real operative expenditures**

Percentages							
Sample	Observations	Mean	Stand. Dev.	Perc. 25	Perc. 50	Perc. 75	Perc. 95
<i>Real Revenue Index, Monthly Change in Percentage</i>							
<b>National Service Sector</b>	<b>515,103</b>	<b>-0.328</b>	<b>0.373</b>	<b>-0.560</b>	<b>-0.374</b>	<b>-0.173</b>	<b>0.320</b>
49 Warehousing	7,107	0.132	35.944	-8.450	-0.098	8.882	44.511
51 Information	26,634	-0.011	75.701	-16.380	-0.174	16.956	100.682
53 Real State	24,960	-0.559	63.443	-14.297	-0.211	13.763	86.376
54 Professional	107,987	-0.136	75.946	-21.068	-0.221	22.682	108.578
56 Waste, Remediation	84,516	-0.224	51.782	-10.198	-0.190	10.763	64.008
61 Education	75,021	-0.350	58.346	-11.479	-0.315	10.901	71.536
62 Health	42,512	-0.231	48.044	-12.620	-0.275	13.033	69.123
71 Recreation	18,479	-0.504	76.963	-18.707	-0.374	17.508	111.117
72 Accommodation, Food	117,662	-0.185	33.950	-11.361	-0.239	11.537	48.488
<i>Real Operative Expenditures, Monthly Change in Percentage</i>							
<b>National Service Sector</b>	<b>566,453</b>	<b>-0.176</b>	<b>59.644</b>	<b>-13.858</b>	<b>-0.274</b>	<b>14.483</b>	<b>83.101</b>
49 Warehousing	7,101	0.321	42.720	-9.555	0.061	10.323	53.735
51 Information	27,192	-0.190	78.222	-17.726	-0.159	18.916	109.078
53 Real State	25,365	-0.274	67.746	-14.656	-0.344	14.578	97.557
54 Professional	109,263	-0.229	77.491	-21.826	-0.253	23.045	114.198
56 Waste, Remediation	82,419	-0.110	67.765	-15.725	-0.221	16.764	92.870
61 Education	75,161	-0.140	56.901	-15.599	-0.284	16.169	86.995
62 Health	42,346	-0.177	53.436	-12.339	-0.300	12.862	81.153
71 Recreation	18,982	-0.521	67.707	-16.441	-0.374	16.201	104.954
72 Accommodation, Food	117,673	-0.150	37.089	-11.225	-0.277	11.361	51.017

Source: sample values from the Monthly Services Survey (2008-2015).

**Table 3A. National and manufacturing sectors 31-33:  
marginal cumulative effects of MSW on production index 2008=100, 1994-2017**

Percentage points of growth per meter per second (m/s)

<b>Period</b>	<b>National</b>	<b>Sector 31</b>	<b>Sector 32</b>	<b>Sector 33</b>
Trop. Cyclones <sub>t</sub>	-0.0457 [0.0530]	-0.0783 [0.0667]	-0.0625 [0.0852]	0.0518 [0.1198]
Trop. Cyclones <sub>t-1</sub>	-0.1829 ** [0.0751]	-0.1305 [0.0919]	-0.2240 [0.1375]	-0.1897 [0.1507]
Trop. Cyclones <sub>t-2</sub>	-0.0971 [0.0839]	-0.0468 [0.1045]	-0.1149 [0.1555]	-0.0815 [0.2022]
Trop. Cyclones <sub>t-3</sub>	-0.1194 [0.1010]	-0.0869 [0.1270]	-0.1803 [0.2173]	-0.0822 [0.2747]
Trop. Cyclones <sub>t-4</sub>	-0.0443 [0.1471]	0.0123 [0.1815]	-0.1826 [0.1959]	-0.0697 [0.3238]
Trop. Cyclones <sub>t-5</sub>	-0.0110 [0.1369]	-0.0699 [0.1708]	-0.1381 [0.1988]	0.0806 [0.3138]
Trop. Cyclones <sub>t-6</sub>	-0.1191 [0.1629]	-0.0592 [0.2060]	-0.2589 [0.1900]	-0.1740 [0.3242]
Trop. Cyclones <sub>t-7</sub>	-0.0287 [0.1629]	-0.0458 [0.2217]	-0.1362 [0.2146]	0.0679 [0.2304]
Trop. Cyclones <sub>t-8</sub>	-0.0521 [0.1334]	0.0638 [0.1997]	-0.2490 [0.2117]	-0.0395 [0.2198]
Trop. Cyclones <sub>t-9</sub>	-0.0486 [0.1487]	0.0426 [0.2439]	-0.1674 [0.1968]	-0.1022 [0.1542]
Trop. Cyclones <sub>t-10</sub>	-0.0787 [0.1654]	0.0001 [0.2688]	-0.0639 [0.1976]	-0.2938 [0.2198]
Trop. Cyclones <sub>t-11</sub>	-0.0215 [0.1580]	0.0373 [0.2352]	0.0760 [0.2143]	-0.2847 [0.2649]
Trop. Cyclones <sub>t-12</sub>	0.0536 [0.1942]	0.0799 [0.2939]	0.1299 [0.2628]	-0.1252 [0.3286]
Within R <sup>2</sup>	0.000	0.000	0.000	0.000
R <sup>2</sup>	0.020	0.021	0.020	0.029
Observations	735,706	266,636	282,668	186,388

Source: Estimated by authors based on the Monthly Industrial Survey (1994-2005), the Extended Monthly Industrial Survey (2005-2006), and the Monthly Survey of Manufacturing Industry class (2007-2017).

All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality and also: i) month-year fixed effects (FE); ii) establishment size FE; iii) 2 or 3-digit NAICS for national and sector specifications, respectively, FE; iv) state FE, v) low-exposed municipalities FE; vi) sector (2-digit NAICS) x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

**Table 4A. National and manufacturing sectors 31-33: marginal cumulative effects of temperature and precipitation on production index, 1994-2017**

Percentage points of growth per 1°C and 1 mm, respectively				
Period	National	Sector 31	Sector 32	Sector 33
<i>Average Temperature °C</i>				
Temperature <sub>t</sub>	0.2588 ** [0.0984]	0.3344 * [0.1657]	0.1833 [0.1330]	0.1859 [0.1685]
Temperature <sub>t-1</sub>	0.1964 [0.1554]	-0.1404 [0.1817]	0.2954 [0.2397]	0.3094 [0.3266]
Temperature <sub>t-2</sub>	0.0094 [0.0882]	-0.2727 * [0.1497]	-0.0773 [0.1091]	0.4290 [0.2277]
Temperature <sub>t-3</sub>	0.2581 ** [0.1051]	0.2635 [0.1801]	0.1589 [0.1171]	0.2311 [0.2290]
Temperature <sub>t-4</sub>	-0.0198 [0.1001]	0.0602 [0.1596]	-0.1064 [0.1927]	-0.2247 [0.1561]
Temperature <sub>t-5</sub>	0.1572 [0.1039]	0.0136 [0.1628]	0.2467 * [0.1445]	0.1249 [0.2867]
Temperature <sub>t-6</sub>	0.1201 [0.1374]	-0.0196 [0.2087]	0.0343 [0.1723]	0.3277 [0.3100]
Temperature <sub>t-7</sub>	0.1713 [0.1417]	0.5771 ** [0.2326]	-0.1816 [0.1954]	0.1102 [0.3188]
Temperature <sub>t-8</sub>	0.0644 [0.1767]	0.3073 [0.2258]	-0.2105 [0.2816]	-0.0434 [0.2349]
Temperature <sub>t-9</sub>	0.2044 [0.1445]	-0.0174 [0.1304]	0.3833 * [0.2137]	0.0511 [0.3416]
Temperature <sub>t-10</sub>	0.2834 ** [0.1214]	0.2169 [0.1785]	0.3624 * [0.2021]	0.2597 [0.2347]
Temperature <sub>t-11</sub>	-0.0795 [0.1246]	0.0340 [0.1859]	-0.1006 [0.1279]	-0.2136 [0.2265]
Temperature <sub>t-12</sub>	0.1964 ** [0.0877]	0.0183 [0.1435]	0.4022 *** [0.1171]	-0.0298 [0.1655]
<i>Cumulative Precipitation mm.</i>				
Precipitation <sub>t</sub>	0.0010 [0.0022]	0.0000 [0.0038]	0.0012 [0.0030]	0.0008 [0.0034]
Precipitation <sub>t-1</sub>	0.0051 ** [0.0020]	0.0079 ** [0.0033]	0.0042 [0.0034]	0.0021 [0.0066]
Precipitation <sub>t-2</sub>	0.0003 [0.0025]	-0.0030 [0.0047]	0.0002 [0.0033]	0.0053 [0.0074]
Precipitation <sub>t-3</sub>	0.0018 [0.0032]	0.0042 [0.0052]	-0.0029 [0.0042]	0.0074 [0.0086]
Precipitation <sub>t-4</sub>	0.0030 [0.0028]	0.0062 [0.0049]	-0.0002 [0.0044]	0.0020 [0.0110]
Precipitation <sub>t-5</sub>	0.0033 [0.0026]	0.0017 [0.0045]	0.0007 [0.0058]	0.0091 [0.0091]
Precipitation <sub>t-6</sub>	0.0051 [0.0033]	0.0015 [0.0059]	0.0005 [0.0050]	0.0180 * [0.0092]
Precipitation <sub>t-7</sub>	0.0120 [0.0037]	0.0118 * [0.0065]	0.0066 [0.0056]	0.0177 * [0.0086]
Precipitation <sub>t-8</sub>	0.0094 [0.0034]	0.0056 [0.0069]	0.0072 [0.0051]	0.0149 [0.0105]
Precipitation <sub>t-9</sub>	0.0073 ** [0.0037]	0.0013 [0.0078]	0.0081 [0.0055]	0.0154 [0.0111]
Precipitation <sub>t-10</sub>	0.0103 ** [0.0046]	0.0012 [0.0077]	0.0094 [0.0068]	0.0270 * [0.0143]
Precipitation <sub>t-11</sub>	0.0059 [0.0038]	-0.0029 [0.0072]	0.0049 [0.0065]	0.0220 * [0.0117]
Precipitation <sub>t-12</sub>	0.0097 * [0.0052]	-0.0083 [0.0085]	0.0151 * [0.0086]	0.0264 ** [0.0121]
Within R <sup>2</sup>	0.000	0.000	0.000	0.000
R <sup>2</sup>	0.020	0.021	0.020	0.029
Observations	735,706	266,636	282,668	186,388

Source: Estimated by authors based on the Monthly Industrial Survey (1994-2005), the Extended Monthly Industrial Survey (2005-2006), and the Monthly Survey of Manufacturing Industry class (2007-2017). All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) sector (2-digit NAICS) FE; iv) state FE; v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\*Significant at the 1 percent level. \*\*Significant at the 5 percent level. \*Significant at the 10 percent level.

**Table 5A. National and manufacturing sectors 31-33: marginal cumulative effects of MSW on production index for highly and low exposed municipalities, 1994-2017**

Percentage points of growth per meter per second (m/s)

Period	Total Manufacturing Sector		Sector 31 manufacturing		Sector 32 manufacturing		Subsector 33 manufacturing	
	Low Exposure	High Exposure	Low Exposure	High Exposure	Low Exposure	High Exposure	Low Exposure	High Exposure
	<i>Maximum Sustained Winds (m/s)</i>							
Trop. Cyclones <sub>t</sub>	-0.0840 [0.0649]	0.1048 [0.1127]	-0.0756 [0.0880]	0.0658 [0.1697]	-0.0820 [0.1091]	-0.0499 [0.1352]	-0.1035 [0.1101]	0.9336 [0.6432]
Trop. Cyclones <sub>t-1</sub>	-0.2622 ** [0.0975]	0.0169 [0.1607]	-0.1784 [0.1286]	-0.0157 [0.2196]	-0.3117 * [0.1664]	-0.1321 [0.1847]	-0.3339 ** [0.1434]	0.7580 [0.8388]
Trop. Cyclones <sub>t-2</sub>	-0.1482 [0.1040]	0.1328 [0.1495]	-0.1331 [0.1489]	0.2612 [0.1787]	-0.1804 [0.1961]	-0.1051 [0.2160]	-0.1307 [0.2135]	0.4107 [0.7166]
Trop. Cyclones <sub>t-3</sub>	-0.2339 * [0.1224]	0.1167 [0.1721]	-0.1519 [0.1796]	0.0475 [0.2351]	-0.2987 [0.3030]	-0.1749 [0.2871]	-0.3360 [0.2413]	1.6004 [1.1130]
Trop. Cyclones <sub>t-4</sub>	-0.2050 [0.1444]	0.2414 [0.2138]	-0.1557 [0.2018]	0.2215 [0.3288]	-0.2372 [0.2274]	-0.1788 [0.2050]	-0.3793 [0.2491]	1.5997 [1.0864]
Trop. Cyclones <sub>t-5</sub>	-0.1425 [0.1536]	0.3221 [0.2452]	-0.2196 [0.1787]	0.1000 [0.3621]	-0.2153 [0.2487]	0.1054 [0.2228]	-0.1319 [0.2811]	1.3643 [1.2986]
Trop. Cyclones <sub>t-6</sub>	-0.3227 * [0.1644]	0.3165 [0.2995]	-0.1834 [0.2062]	0.0989 [0.4153]	-0.4051 * [0.2139]	0.1078 [0.2754]	-0.5098 * [0.2759]	1.4174 [1.2796]
Trop. Cyclones <sub>t-7</sub>	-0.1949 [0.1757]	0.2837 [0.2898]	-0.2904 [0.1934]	0.3098 [0.4496]	-0.1762 [0.2834]	0.0448 [0.3091]	-0.1074 [0.1778]	0.5508 [1.1292]
Trop. Cyclones <sub>t-8</sub>	-0.1605 [0.1515]	0.3059 [0.2782]	-0.0561 [0.2143]	0.4015 [0.4181]	-0.2847 [0.2790]	0.1102 [0.3677]	-0.1673 [0.1888]	0.2887 [1.0637]
Trop. Cyclones <sub>t-9</sub>	-0.1496 [0.1562]	0.1422 [0.3354]	-0.1340 [0.2814]	0.3930 [0.4720]	-0.1902 [0.2274]	-0.0055 [0.3918]	-0.1030 [0.1357]	-0.5598 [0.8529]
Trop. Cyclones <sub>t-10</sub>	-0.2481 [0.1727]	0.2613 [0.3525]	-0.2817 [0.3071]	0.6525 [0.4616]	-0.1709 [0.2269]	0.1804 [0.3766]	-0.2732 [0.1785]	-1.1925 [1.1903]
Trop. Cyclones <sub>t-11</sub>	-0.1438 [0.1600]	0.2406 [0.3770]	-0.1431 [0.2422]	0.5970 [0.5102]	-0.0273 [0.2463]	0.2691 [0.4431]	-0.2346 [0.2029]	-1.3701 [1.2390]
Trop. Cyclones <sub>t-12</sub>	-0.0801 [0.1931]	0.3189 [0.4441]	-0.1294 [0.3217]	0.7897 [0.6029]	0.0101 [0.2912]	0.2750 [0.4889]	-0.0479 [0.2627]	-1.6089 [1.3405]
Within R <sup>2</sup>	0.000	0.001	0.000	0.003	0.0004	0.0018	0.0004	0.009
R <sup>2</sup>	0.021	0.020	0.022	0.036	0.0210	0.0326	0.0302	0.104
Observations	676,072	59,633	239,539	27,096	256,485	26,183	180,036	6,340

Source: Estimated by authors based on the Monthly Industrial Survey (1994-2005), the Extended Monthly Industrial Survey (2005-2006), and the Monthly Survey of Manufacturing Industry class (2007-2017).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality, and also: i) month-year fixed effects (FE); ii) establishment size FE; iii) 2 and 3-digit NAICS for national and sector specifications, respectively, FE; iv) state FE, v) low-exposed municipalities FE; vi) sector (2-digit NAICS) x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level.

\* Significant at the 10 percent level.

**Table 6A. National and manufacturing sectors 31-33: marginal cumulative effects of temperature and precipitation on production index for highly and low exposed municipalities, 1994-2017**

Percentage points of growth per 1°C and 1 mm, respectively

Period	Total Manufacturing Sector		Sector 31 manufacturing		Sector 32 manufacturing		Subsector 33 manufacturing	
	Low Exposure	High Exposure	Low Exposure	High Exposure	Low Exposure	High Exposure	Low Exposure	High Exposure
<i>Average Temperature °C</i>								
Temperature <sub>t</sub>	0.2095 **	0.2532	0.2624	0.5806	0.1187	0.2462	0.1786	-1.5433
	[0.0978]	[0.4178]	[0.1810]	[0.6249]	[0.1433]	[0.4965]	[0.1774]	[1.7990]
Temperature <sub>t-1</sub>	0.2636	-0.2425	-0.0976	-0.4429	0.4019	-0.1646	0.2909	-2.1059
	[0.1886]	[0.4642]	[0.1782]	[0.6038]	[0.2990]	[0.8555]	[0.3470]	[2.1064]
Temperature <sub>t-2</sub>	0.0707	-0.1908	-0.2183	-0.1124	-0.0347	-0.4880	0.4369 **	-4.2216 *
	[0.0835]	[0.3499]	[0.1519]	[0.5941]	[0.1239]	[0.4980]	[0.2077]	[2.0293]
Temperature <sub>t-3</sub>	0.2657 **	-0.2405	0.1380	0.7895 *	0.3353 ***	-1.4075 **	0.1395	-2.8113 **
	[0.1094]	[0.3364]	[0.1897]	[0.4238]	[0.1050]	[0.5352]	[0.2426]	[1.1450]
Temperature <sub>t-4</sub>	-0.0471	0.0805	-0.0655	0.6912	-0.0814	-0.2894	-0.2058	-5.4320 ***
	[0.1087]	[0.3909]	[0.1636]	[0.5805]	[0.1990]	[0.4355]	[0.1702]	[1.4799]
Temperature <sub>t-5</sub>	0.1743	0.6751	-0.1617	1.3257	0.3965 **	0.0382	0.1296	-4.6157
	[0.1137]	[0.5709]	[0.1292]	[0.8345]	[0.1455]	[0.6109]	[0.2873]	[2.5994]
Temperature <sub>t-6</sub>	0.2037	-0.9285	-0.0187	-0.1057	0.1749	-1.4400 *	0.3794	-7.9247 **
	[0.1502]	[0.5925]	[0.2301]	[0.9410]	[0.1989]	[0.6867]	[0.3084]	[3.5065]
Temperature <sub>t-7</sub>	0.1601	-0.0132	0.5006 *	0.3164	-0.1162	-0.3597	0.1116	-8.2739 *
	[0.1542]	[0.5388]	[0.2731]	[0.9931]	[0.1799]	[0.7083]	[0.3405]	[4.1276]
Temperature <sub>t-8</sub>	0.0855	0.1368	0.2437	0.9042	-0.1206	-0.2991	-0.0049	-9.9178 ***
	[0.1864]	[0.5543]	[0.2658]	[0.6349]	[0.2859]	[0.8424]	[0.2266]	[2.6768]
Temperature <sub>t-9</sub>	0.2399	-0.1666	-0.0715	0.3883	0.5211 **	-0.5967	0.0415	-9.4253 **
	[0.1648]	[0.6008]	[0.1001]	[1.0955]	[0.2454]	[0.7287]	[0.3876]	[4.0780]
Temperature <sub>t-10</sub>	0.4078 ***	-0.1810	0.1725	0.8711	0.6698 ***	-1.1544	0.3016	-10.0240 **
	[0.1214]	[0.8213]	[0.2148]	[0.9259]	[0.1812]	[0.9373]	[0.2494]	[4.3121]
Temperature <sub>t-11</sub>	-0.0427	0.2108	0.0449	0.7087	-0.1060	0.2343	-0.0690	-12.8107 ***
	[0.1285]	[0.7192]	[0.2294]	[0.9538]	[0.1216]	[0.8699]	[0.2026]	[4.0133]
Temperature <sub>t-12</sub>	0.2102 **	0.2941	0.0392	0.2826	0.3673 ***	0.6577	0.0993	-11.7169 **
	[0.0951]	[0.7691]	[0.1406]	[1.2307]	[0.0963]	[0.8952]	[0.1730]	[5.2360]
<i>Cumulative Precipitation mm.</i>								
Precipitation <sub>t</sub>	0.0040 **	-0.0155 **	0.0058 *	-0.0223 **	0.0036	-0.0101 *	0.0014	-0.0236 **
	[0.0019]	[0.0066]	[0.0028]	[0.0092]	[0.0034]	[0.0055]	[0.0042]	[0.0080]
Precipitation <sub>t-1</sub>	0.0069 ***	0.0008	0.0122 ***	-0.0031	0.0043	0.0069	0.0042	-0.0099
	[0.0018]	[0.0081]	[0.0034]	[0.0068]	[0.0034]	[0.0145]	[0.0069]	[0.0116]
Precipitation <sub>t-2</sub>	0.0030	-0.0054	0.0022	-0.0219 **	0.0022	-0.0007	0.0065	0.0160
	[0.0031]	[0.0080]	[0.0054]	[0.0099]	[0.0045]	[0.0083]	[0.0084]	[0.0130]
Precipitation <sub>t-3</sub>	0.0033	-0.0054	0.0075	-0.0110	-0.0018	-0.0116	0.0091	0.0285
	[0.0036]	[0.0107]	[0.0049]	[0.0130]	[0.0058]	[0.0108]	[0.0101]	[0.0306]
Precipitation <sub>t-4</sub>	0.0025	-0.0037	0.0060	-0.0086	0.0007	-0.0125	0.0025	0.0264
	[0.0037]	[0.0092]	[0.0062]	[0.0114]	[0.0055]	[0.0086]	[0.0125]	[0.0355]
Precipitation <sub>t-5</sub>	0.0068 **	-0.0104	0.0035	-0.0164	0.0063	-0.0124	0.0144	-0.0258
	[0.0030]	[0.0086]	[0.0050]	[0.0098]	[0.0061]	[0.0192]	[0.0098]	[0.0349]
Precipitation <sub>t-6</sub>	0.0086 **	-0.0075	0.0031	-0.0116	0.0059	-0.0125	0.0226 **	-0.0179
	[0.0035]	[0.0104]	[0.0077]	[0.0109]	[0.0050]	[0.0217]	[0.0098]	[0.0362]
Precipitation <sub>t-7</sub>	0.0159 ***	-0.0122	0.0175 ***	-0.0232 **	0.0106 *	-0.0103	0.0205 **	-0.0260
	[0.0037]	[0.0077]	[0.0058]	[0.0106]	[0.0059]	[0.0161]	[0.0095]	[0.0401]
Precipitation <sub>t-8</sub>	0.0140 ***	-0.0131	0.0118 *	-0.0285	0.0114 **	-0.0084	0.0189 *	-0.0205
	[0.0036]	[0.0077]	[0.0063]	[0.0178]	[0.0053]	[0.0165]	[0.0108]	[0.0385]
Precipitation <sub>t-9</sub>	0.0137 ***	-0.0193 *	0.0105	-0.0374 **	0.0151 **	-0.0177	0.0178	-0.0019
	[0.0039]	[0.0099]	[0.0084]	[0.0157]	[0.0065]	[0.0159]	[0.0127]	[0.0345]
Precipitation <sub>t-10</sub>	0.0147 ***	-0.0163 *	0.0082	-0.0368 *	0.0139 *	-0.0162	0.0284 *	0.0135
	[0.0051]	[0.0093]	[0.0080]	[0.0180]	[0.0078]	[0.0162]	[0.0163]	[0.0439]
Precipitation <sub>t-11</sub>	0.0091 **	-0.0136	0.0023	-0.0319	0.0072	-0.0128	0.0234	-0.0121
	[0.0040]	[0.0096]	[0.0082]	[0.0186]	[0.0065]	[0.0192]	[0.0139]	[0.0379]
Precipitation <sub>t-12</sub>	0.0135 **	-0.0085	-0.0010	-0.0404 *	0.0168 *	0.0040	0.0284 *	-0.0078
	[0.0057]	[0.0098]	[0.0090]	[0.0196]	[0.0095]	[0.0219]	[0.0149]	[0.0470]
Within R <sup>2</sup>	0.000	0.001	0.000	0.003	0.0004	0.0018	0.0004	0.009
R <sup>2</sup>	0.021	0.020	0.022	0.036	0.0210	0.0326	0.0302	0.104
Observations	676,072	59,633	239,539	27,096	256,485	26,183	180,036	6,340

Source: Estimated by authors based on the Monthly Industrial Survey (1994-2005), the Extended Monthly Industrial Survey (2005-2006), and the Monthly Survey of Manufacturing Industry class (2007-2017).

The highly exposed municipalities are in the states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán. All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality, results also includes: i) month-year fixed effects (FE); ii) establishment size FE; iii) sector (2-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 7A. National and service sectors 48-72:  
marginal cumulative effects of MSW on real revenue index 2008=100, 2008-2015**  
Percentage points of growth per 1°C and 1 mm, respectively

Period	National	48 Transport.	49 Warehousing	51 Information	53 Real State	54 Professional Scientific	56 Waste, Remediation	61 Education	62 Health	71 Recreation	72 Accommodation, Food
<i>Maximum Sustained Winds m/s</i>											
Trop. Cyclones <sub>t</sub>	0.0001 [0.0000]	0.0003 [0.0003]	0.0000 [0.0000]	0.0000 [0.0001]	0.0000 [0.0000]	0.0002 [0.0002]	0.0000 [0.0001]	0.0000 [0.0000]	0.0000 [0.0000]	-0.0001 [0.0001]	0.0001 [0.0001]
Trop. Cyclones <sub>t-1</sub>	-0.0005 [0.0003]	0.0005 [0.0004]	0.0000 [0.0000]	-0.0004 * [0.0002]	0.0000 [0.0000]	-0.0004 [0.0002]	-0.0002 [0.0002]	-0.0001 * [0.0001]	0.0001 [0.0001]	-0.0002 [0.0002]	-0.0010 [0.0007]
Trop. Cyclones <sub>t-2</sub>	-0.0005 * [0.0003]	0.0006 [0.0004]	0.0000 [0.0000]	-0.0007 * [0.0004]	0.0000 [0.0000]	-0.0006 * [0.0003]	-0.0002 [0.0002]	-0.0001 [0.0001]	0.0001 [0.0001]	-0.0004 * [0.0002]	-0.0009 [0.0007]
Trop. Cyclones <sub>t-3</sub>	-0.0004 [0.0003]	0.0008 * [0.0005]	0.0000 [0.0000]	-0.0007 [0.0004]	0.0000 [0.0000]	-0.0006 [0.0003]	-0.0001 [0.0003]	-0.0001 [0.0001]	0.0001 [0.0001]	-0.0006 [0.0004]	-0.0005 [0.0007]
Trop. Cyclones <sub>t-4</sub>	-0.0001 [0.0004]	0.0009 [0.0005]	0.0000 [0.0000]	-0.0005 [0.0004]	0.0000 [0.0000]	-0.0006 [0.0004]	0.0001 [0.0003]	0.0000 [0.0001]	0.0001 [0.0001]	-0.0011 * [0.0006]	0.0001 [0.0008]
Trop. Cyclones <sub>t-5</sub>	0.0001 [0.0004]	0.0010 * [0.0006]	0.0000 [0.0000]	-0.0005 [0.0004]	0.0000 [0.0000]	-0.0004 [0.0004]	0.0003 [0.0003]	0.0000 [0.0001]	0.0001 [0.0001]	-0.0008 [0.0006]	0.0005 [0.0009]
Trop. Cyclones <sub>t-6</sub>	0.0003 [0.0005]	0.0014 * [0.0008]	0.0000 [0.0000]	-0.0004 [0.0003]	0.0000 [0.0000]	-0.0002 [0.0005]	0.0005 * [0.0003]	0.0001 [0.0001]	0.0001 [0.0001]	-0.0005 [0.0007]	0.0010 [0.0011]
Trop. Cyclones <sub>t-7</sub>	0.0005 [0.0006]	0.0012 [0.0009]	0.0000 [0.0000]	-0.0003 [0.0004]	0.0000 [0.0000]	-0.0001 [0.0006]	0.0005 ** [0.0002]	0.0001 [0.0001]	0.0001 [0.0001]	-0.0004 [0.0008]	0.0014 [0.0013]
Trop. Cyclones <sub>t-8</sub>	0.0005 [0.0006]	0.0013 [0.0008]	0.0000 [0.0000]	-0.0003 [0.0004]	0.0000 [0.0000]	-0.0002 [0.0008]	0.0009 ** [0.0003]	0.0001 * [0.0001]	0.0001 [0.0001]	-0.0005 [0.0009]	0.0016 [0.0014]
Trop. Cyclones <sub>t-9</sub>	0.0005 [0.0007]	0.0012 [0.0009]	0.0000 [0.0000]	-0.0003 [0.0005]	0.0000 [0.0000]	-0.0004 [0.0010]	0.0011 ** [0.0004]	0.0002 ** [0.0001]	0.0001 [0.0001]	-0.0004 [0.0009]	0.0016 [0.0016]
Trop. Cyclones <sub>t-10</sub>	0.0005 [0.0007]	0.0005 [0.0008]	0.0000 [0.0000]	-0.0002 [0.0005]	0.0000 [0.0000]	-0.0003 [0.0011]	0.0013 ** [0.0004]	0.0001 * [0.0001]	0.0001 [0.0001]	-0.0008 [0.0010]	0.0016 [0.0016]
Trop. Cyclones <sub>t-11</sub>	0.0003 [0.0008]	0.0006 [0.0008]	0.0000 [0.0000]	-0.0003 [0.0007]	0.0000 [0.0000]	-0.0006 [0.0013]	0.0014 ** [0.0005]	0.0001 [0.0001]	0.0001 [0.0001]	-0.0009 [0.0010]	0.0014 [0.0018]
Trop. Cyclones <sub>t-12</sub>	0.0004 [0.0009]	0.0006 [0.0010]	0.0000 [0.0000]	-0.0003 [0.0007]	0.0000 [0.0000]	-0.0009 [0.0013]	0.0017 ** [0.0006]	0.0001 [0.0001]	0.0002 [0.0001]	-0.0010 [0.0010]	0.0016 [0.0020]
Within R <sup>2</sup>	0.002	0.002	0.004	0.005	0.002	0.003	0.002	0.002	0.001	0.011	0.009
R <sup>2</sup>	0.975	0.955	0.990	0.995	0.955	0.979	0.990	0.998	0.999	0.984	0.956
Observations	452,231	48,583	5,606	22,814	19,739	84,698	68,383	58,754	33,377	14,217	96,060

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality, results also includes: i) month-year fixed effects (FE); ii) establishment size FE; iii) sector (2-digit NAICS) FE; iv) state FE; v) low-exposed municipalities FE; vi) 2 and 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\*Significant at the 5 percent level. \*Significant at the 10 percent level.



**Table 8A. National and service sectors 48-72: marginal cumulative effects of temperature and precipitation on real revenue index 2008=100, 2008-2015**

Percentage points of growth per 1°C and 100 mm, respectively

Period	National	48 Transport.	49 Warehousing	51 Information	53 Real State	54 Professional Scientific	56 Waste, Remediation	61 Education	62 Health	71 Recreation	72 Accommodation, Food
<i>Temperature °C</i>											
Temperature <sub>t</sub>	0.0017 ** [0.0008]	-0.0029 [0.0032]	0.0000 [0.0000]	0.0012 * [0.0007]	0.0000 [0.0000]	0.0019 [0.0014]	0.0008 [0.0013]	0.0004 [0.0005]	-0.0002 [0.0002]	0.0015 [0.0014]	0.0049 ** [0.0015]
Temperature <sub>t-1</sub>	0.0002 [0.0005]	-0.0015 [0.0010]	0.0000 [0.0000]	-0.0003 [0.0002]	0.0000 [0.0000]	0.0011 [0.0012]	-0.0002 [0.0003]	0.0001 [0.0002]	0.0002 [0.0001]	0.0016 [0.0015]	0.0000 [0.0008]
Temperature <sub>t-2</sub>	-0.0001 [0.0005]	-0.0023 [0.0014]	0.0000 [0.0000]	-0.0005 [0.0003]	0.0000 [0.0000]	0.0007 [0.0014]	-0.0010 * [0.0005]	0.0001 [0.0002]	0.0002 [0.0002]	0.0018 [0.0017]	0.0000 [0.0009]
Temperature <sub>t-3</sub>	-0.0001 [0.0006]	-0.0019 [0.0014]	0.0000 [0.0000]	-0.0001 [0.0002]	0.0000 [0.0000]	0.0002 [0.0012]	-0.0009 [0.0006]	0.0001 [0.0002]	0.0000 [0.0002]	0.0001 [0.0010]	0.0004 [0.0013]
Temperature <sub>t-4</sub>	-0.0001 [0.0006]	-0.0011 [0.0014]	0.0000 [0.0000]	-0.0002 [0.0003]	0.0000 [0.0000]	0.0001 [0.0012]	-0.0007 [0.0005]	0.0003 [0.0003]	0.0000 [0.0002]	0.0007 [0.0012]	-0.0005 [0.0011]
Temperature <sub>t-5</sub>	0.0005 [0.0007]	-0.0019 [0.0021]	0.0000 * [0.0000]	0.0000 [0.0004]	0.0000 [0.0000]	0.0005 [0.0018]	-0.0007 [0.0005]	0.0004 [0.0004]	0.0001 [0.0002]	0.0010 [0.0013]	0.0013 [0.0013]
Temperature <sub>t-6</sub>	0.0007 [0.0007]	-0.0002 [0.0017]	0.0000 [0.0000]	-0.0002 [0.0005]	0.0000 ** [0.0000]	0.0010 [0.0021]	-0.0004 [0.0004]	0.0005 [0.0004]	0.0003 [0.0002]	0.0025 [0.0019]	0.0012 [0.0015]
Temperature <sub>t-7</sub>	0.0006 [0.0008]	-0.0025 [0.0022]	0.0000 ** [0.0000]	-0.0004 [0.0004]	0.0000 [0.0000]	0.0020 [0.0022]	-0.0005 [0.0004]	0.0006 [0.0006]	0.0002 [0.0002]	0.0022 [0.0023]	0.0013 [0.0016]
Temperature <sub>t-8</sub>	0.0006 [0.0009]	-0.0022 [0.0021]	0.0000 * [0.0000]	0.0000 [0.0004]	0.0000 [0.0000]	0.0016 [0.0023]	-0.0004 [0.0006]	0.0003 [0.0005]	0.0002 [0.0003]	0.0019 [0.0020]	0.0014 [0.0020]
Temperature <sub>t-9</sub>	0.0008 [0.0010]	-0.0016 [0.0024]	0.0000 [0.0000]	0.0003 [0.0006]	0.0000 [0.0000]	0.0009 [0.0026]	-0.0008 [0.0006]	0.0008 [0.0006]	0.0001 [0.0004]	0.0029 [0.0024]	0.0016 [0.0023]
Temperature <sub>t-10</sub>	0.0004 [0.0009]	-0.0016 [0.0023]	0.0000 [0.0000]	-0.0005 [0.0006]	0.0000 [0.0000]	0.0013 [0.0026]	-0.0013 [0.0009]	0.0007 [0.0005]	0.0003 [0.0003]	0.0040 [0.0028]	0.0005 [0.0025]
Temperature <sub>t-11</sub>	0.0000 [0.0008]	-0.0013 [0.0019]	0.0000 ** [0.0000]	-0.0006 [0.0004]	0.0000 [0.0000]	0.0008 [0.0024]	-0.0011 [0.0009]	0.0007 [0.0006]	0.0003 [0.0003]	0.0024 [0.0026]	-0.0007 [0.0025]
Temperature <sub>t-12</sub>	0.0002 [0.0007]	0.0001 [0.0020]	0.0000 ** [0.0000]	-0.0004 [0.0005]	0.0000 ** [0.0000]	0.0004 [0.0021]	-0.0005 [0.0005]	0.0007 [0.0006]	0.0004 [0.0003]	0.0032 [0.0026]	-0.0004 [0.0025]
<i>Cumulative Precipitation (mm)</i>											
Precipitation <sub>t</sub>	0.0000 *** [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 * [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 ** [0.0000]
Precipitation <sub>t-1</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-2</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 * [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-3</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-4</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-5</sub>	0.0000 [0.0000]	0.0001 * [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-6</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-7</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]
Precipitation <sub>t-8</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0001 [0.0001]	0.0000 [0.0000]
Precipitation <sub>t-9</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0001 [0.0001]	0.0000 [0.0000]
Precipitation <sub>t-10</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0001 [0.0001]	0.0000 [0.0000]
Precipitation <sub>t-11</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0001 [0.0001]	0.0000 [0.0001]
Precipitation <sub>t-12</sub>	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 ** [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0000 [0.0000]	0.0001 [0.0001]	0.0000 [0.0000]
Within R <sup>2</sup>	0.002	0.002	0.004	0.005	0.002	0.003	0.002	0.002	0.001	0.011	0.009
R <sup>2</sup>	0.975	0.955	1.000	0.995	0.955	0.979	0.990	0.998	0.999	0.984	0.956
Observations	452,231	48,583	5,606	22,814	19,739	84,698	68,383	58,754	33,377	14,217	96,060

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) sector (2-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 and 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, standard errors are robust to spatial correlation by state. \*\*\* Sign. at the 1 percent level. \*\* Sign. at the 5 percent level. \*Sign. at the 10 perc. level.

**Table 9A. National and service sectors 48-72: marginal cumulative effects of MSW on real operative expenditures, 2008-2015**

Percentage points of growth per meter per second (m/s)

Period	National	48 Transport.	49 Warehousing	51 Information	53 Real State	54 Professional	56 Waste, Remediation	61 Education	62 Health	71 Recreation	72 Accommod, Food
<i>Maximum Sustained Winds (m/s)</i>											
Trop. Cyclones <sub>t</sub>	0.0210 [0.0709]	-0.0018 [0.0786]	0.0658 [0.1552]	0.3556 [0.2297]	-0.0188 [0.1706]	0.1340 [0.0970]	0.0608 [0.1542]	-0.0878 [0.1392]	0.0839 [0.1545]	-0.2472 [0.3184]	-0.0120 [0.1215]
Trop. Cyclones <sub>t-1</sub>	0.1141 [0.0697]	0.0336 [0.1235]	0.1134 [0.1960]	0.2622 [0.3492]	0.1183 [0.2038]	0.1176 [0.1735]	0.0783 [0.2191]	-0.0642 [0.1411]	0.0707 [0.1545]	-0.0193 [0.3489]	0.2193 * [0.1212]
Trop. Cyclones <sub>t-2</sub>	0.1904 * [0.1141]	0.1379 [0.1652]	0.0189 [0.2922]	0.2822 [0.3288]	0.0246 [0.2141]	0.1865 [0.2181]	0.2604 [0.2626]	-0.1266 [0.1355]	0.0285 [0.1747]	0.0867 [0.4442]	0.3244 ** [0.1282]
Trop. Cyclones <sub>t-3</sub>	0.3755 ** [0.1465]	0.0390 [0.2256]	0.0579 [0.4009]	0.4440 * [0.2645]	-0.0722 [0.2488]	0.6819 ** [0.2179]	0.2835 [0.3367]	-0.0160 [0.2286]	0.2558 [0.1916]	0.2660 [0.4504]	0.5000 ** [0.1570]
Trop. Cyclones <sub>t-4</sub>	0.3455 ** [0.1451]	0.2085 [0.2226]	-0.0992 [0.3335]	0.7107 ** [0.3223]	0.2433 [0.2871]	0.4727 * [0.2539]	0.1837 [0.4380]	0.1512 [0.2305]	0.1060 [0.1813]	0.1017 [0.4273]	0.3601 ** [0.1694]
Trop. Cyclones <sub>t-5</sub>	0.3717 ** [0.1580]	0.0716 [0.2006]	-0.4519 [0.4193]	1.0117 ** [0.3652]	0.1642 [0.3112]	0.3975 [0.2466]	0.2850 [0.4653]	0.2918 [0.3082]	0.0768 [0.2271]	-0.1549 [0.4681]	0.3881 ** [0.1520]
Trop. Cyclones <sub>t-6</sub>	0.5165 ** [0.1636]	0.1534 [0.2059]	-0.5166 [0.3708]	1.0737 ** [0.3482]	0.6459 ** [0.2865]	0.7178 ** [0.3279]	0.4233 [0.4958]	0.3181 [0.3661]	0.0877 [0.3415]	0.1499 [0.5476]	0.4010 ** [0.1228]
Trop. Cyclones <sub>t-7</sub>	0.3464 ** [0.1449]	0.1809 [0.1958]	-0.2201 [0.3889]	0.6735 * [0.3486]	0.2511 [0.2761]	0.7582 ** [0.3420]	0.0801 [0.4788]	0.1190 [0.3935]	0.3539 [0.3960]	-0.1845 [0.6042]	0.3099 ** [0.1180]
Trop. Cyclones <sub>t-8</sub>	0.3446 ** [0.1575]	0.0250 [0.1844]	-0.6594 [0.4732]	0.9516 ** [0.4086]	0.2403 [0.3299]	1.0673 ** [0.3012]	-0.0274 [0.5056]	0.1314 [0.3864]	0.3485 [0.3726]	-0.4594 [0.7409]	0.2546 * [0.1466]
Trop. Cyclones <sub>t-9</sub>	0.3495 ** [0.1495]	0.0081 [0.1712]	-0.5840 [0.4397]	1.0998 ** [0.3948]	0.2347 [0.3394]	0.7924 ** [0.3455]	0.1216 [0.4738]	-0.0268 [0.4456]	0.4785 [0.4088]	-0.5048 [0.8369]	0.2767 ** [0.1310]
Trop. Cyclones <sub>t-10</sub>	0.1844 [0.1123]	0.1043 [0.2286]	-0.9177 [0.5456]	1.0175 * [0.5097]	0.2546 [0.3369]	0.7152 ** [0.3010]	0.0427 [0.4683]	0.0285 [0.4774]	0.4485 [0.4055]	-0.8973 [0.8161]	-0.0126 [0.1488]
Trop. Cyclones <sub>t-11</sub>	0.0786 [0.1201]	0.0666 [0.2357]	-1.3072 ** [0.6015]	1.1424 * [0.5644]	0.4610 [0.4024]	0.5233 * [0.2903]	-0.2832 [0.4634]	0.1918 [0.5323]	0.5626 [0.4524]	-0.9358 [0.8939]	-0.2066 [0.1568]
Trop. Cyclones <sub>t-12</sub>	0.0248 [0.1478]	0.2645 [0.3090]	-1.4641 ** [0.5823]	1.1455 * [0.6608]	0.2291 [0.4521]	0.5384 * [0.3023]	-0.2208 [0.4737]	-0.1128 [0.5282]	0.6060 [0.5566]	-1.3262 [1.0322]	-0.2773 [0.1687]
Within R <sup>2</sup>	0.000	0.002	0.006	0.001	0.002	0.001	0.001	0.001	0.001	0.004	0.003
R <sup>2</sup>	0.024	0.034	0.118	0.049	0.031	0.045	0.035	0.022	0.018	0.043	0.045
Observations	491,213	52,955	6,157	23,810	21,926	94,233	71,512	65,233	36,575	16,276	102,536

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality, and also includes: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low exposed municipalities FE; vi) 2 and 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \*Significant at the 10 percent level.

**Table 10A. National and service sectors 48-72: marginal cumulative effects of temperature and precipitation on real operative expenditures, 2008-2015**

Percentage points of growth per 1°C and 1 mm, respectively

Period	National	48 Transport.	49 Warehousing	51 Information	53 Real State	54 Professional	56 Waste, Remediation	61 Education	62 Health	71 Recreation	72 Accommod. Food
<i>Temperature °C</i>											
Temperature <sub>t</sub>	0.3527 ** [0.1433]	-0.0007 [0.2635]	-0.8690 [0.6448]	0.6528 [0.5659]	0.2643 [0.3576]	0.7820 ** [0.2386]	0.1106 [0.2287]	0.2783 [0.3698]	0.3216 [0.3292]	0.2218 [0.5869]	0.3131 [0.1935]
Temperature <sub>t-1</sub>	-0.0186 [0.1213]	-0.1890 [0.1863]	-0.2803 [0.6359]	0.5134 [0.5569]	0.0771 [0.8106]	-0.0374 [0.3120]	-0.2822 [0.3060]	-0.2862 [0.2837]	-0.4560 [0.3235]	0.0733 [0.8716]	0.3456 ** [0.1289]
Temperature <sub>t-2</sub>	0.1539 [0.1532]	-0.0108 [0.1513]	0.1755 [0.5047]	0.3961 [0.6851]	-0.6374 [0.7565]	0.0451 [0.2366]	0.0703 [0.3138]	1.1212 *** [0.2222]	0.1491 [0.3391]	0.2211 [0.8182]	0.2605 [0.2205]
Temperature <sub>t-3</sub>	-0.0636 [0.0804]	0.1387 [0.1748]	-0.8379 [0.9008]	0.2268 [0.4837]	-0.2621 [0.6255]	0.2974 [0.3192]	-0.2217 [0.2288]	0.0573 [0.3558]	0.4283 [0.3299]	-1.5880 [1.0820]	-0.0211 [0.2101]
Temperature <sub>t-4</sub>	-0.0055 [0.1519]	0.3240 [0.2253]	1.2856 * [0.6914]	-0.2823 [0.3712]	0.1904 [0.5807]	-0.0229 [0.3295]	-0.2181 [0.3850]	0.5235 [0.3130]	-0.2357 [0.3924]	-0.7232 [0.7404]	-0.1025 [0.1409]
Temperature <sub>t-5</sub>	-0.0418 [0.2372]	0.3527 [0.2243]	-1.0957 [0.9337]	0.2516 [0.5137]	-0.3168 [0.5297]	0.2633 [0.4695]	-0.3168 [0.4522]	0.1631 [0.3171]	0.2432 [0.3006]	-0.1593 [0.8939]	-0.0272 [0.2549]
Temperature <sub>t-6</sub>	0.1960 [0.1521]	0.0768 [0.2203]	-0.0376 [1.0006]	0.8602 [0.6223]	-0.3615 [1.0902]	0.4849 [0.3579]	0.1904 [0.3442]	-0.3179 [0.3437]	-0.3681 [0.4065]	-0.4532 [0.9896]	0.4792 ** [0.2012]
Temperature <sub>t-7</sub>	0.2626 [0.1778]	-0.1015 [0.1716]	-0.0718 [1.0396]	1.6235 ** [0.7746]	-0.9574 ** [0.4097]	0.7968 ** [0.3545]	-0.1219 [0.3369]	0.6752 ** [0.3252]	-0.0494 [0.4616]	-1.1154 [1.1837]	0.3090 [0.2533]
Temperature <sub>t-8</sub>	0.1727 [0.1574]	0.4401 * [0.2346]	-0.0526 [1.1757]	1.0917 ** [0.5289]	-0.5240 [0.5304]	1.0628 ** [0.3349]	-0.2647 [0.4833]	-0.1688 [0.2958]	0.1741 [0.4240]	-0.7401 [1.0815]	0.0715 [0.1775]
Temperature <sub>t-9</sub>	0.1090 [0.2173]	0.5684 ** [0.2166]	0.2191 [0.9835]	0.1588 [0.6763]	-0.7852 [0.8447]	0.2443 [0.3973]	-0.3639 [0.6364]	0.0721 [0.3887]	0.2557 [0.4024]	0.2432 [1.3644]	0.1980 [0.2514]
Temperature <sub>t-10</sub>	-0.3606 [0.2220]	0.2393 [0.1677]	1.0588 [1.4186]	1.1806 * [0.6806]	-0.6111 [0.8097]	-0.4240 [0.6227]	-0.7275 [0.5736]	0.0533 [0.4188]	-0.0346 [0.3765]	-0.7048 [0.9462]	-0.2293 [0.3109]
Temperature <sub>t-11</sub>	-0.0090 [0.1864]	0.3081 [0.2212]	0.9037 [1.4660]	0.3011 [0.5859]	-0.8988 [0.6583]	0.9859 ** [0.4348]	-0.0789 [0.4629]	0.0104 [0.3551]	-0.0588 [0.3918]	-0.7785 [0.9614]	-0.1143 [0.2766]
Temperature <sub>t-12</sub>	0.1107 [0.1045]	0.5948 ** [0.2021]	0.7131 [1.2756]	1.2391 ** [0.5676]	-0.7297 [0.4361]	0.4141 [0.3190]	-0.2784 [0.4799]	-0.3097 [0.2929]	0.0600 [0.2872]	0.2966 [0.8843]	0.2170 * [0.1204]
<i>Cumulative Precipitation (mm)</i>											
Precipitation <sub>t</sub>	-0.0022 [0.0025]	-0.0003 [0.0039]	0.0003 [0.0114]	-0.0015 [0.0089]	-0.0131 [0.0103]	-0.0036 [0.0052]	-0.0017 [0.0022]	0.0002 [0.0097]	0.0065 [0.0050]	-0.0115 [0.0136]	-0.0030 [0.0032]
Precipitation <sub>t-1</sub>	-0.0024 [0.0032]	-0.0043 [0.0033]	0.0051 [0.0104]	0.0006 [0.0085]	-0.0135 [0.0085]	0.0023 [0.0081]	-0.0025 [0.0053]	-0.0032 [0.0068]	-0.0134 ** [0.0062]	-0.0102 [0.0144]	0.0008 [0.0055]
Precipitation <sub>t-2</sub>	0.0052 [0.0038]	0.0044 [0.0037]	0.0036 [0.0119]	0.0139 [0.0106]	-0.0126 [0.0087]	0.0167 [0.0113]	0.0082 [0.0062]	-0.0008 [0.0082]	-0.0025 [0.0088]	-0.0154 [0.0171]	0.0003 [0.0080]
Precipitation <sub>t-3</sub>	0.0004 [0.0056]	0.0053 [0.0041]	0.0099 [0.0155]	0.0056 [0.0136]	-0.0045 [0.0099]	0.0013 [0.0079]	-0.0043 [0.0090]	-0.0132 [0.0087]	-0.0040 [0.0058]	-0.0088 [0.0182]	0.0060 [0.0077]
Precipitation <sub>t-4</sub>	0.0037 [0.0048]	-0.0001 [0.0031]	0.0300 * [0.0158]	0.0120 [0.0103]	-0.0252 ** [0.0088]	0.0114 [0.0157]	0.0052 [0.0055]	-0.0044 [0.0061]	-0.0088 [0.0088]	0.0087 [0.0175]	0.0006 [0.0042]
Precipitation <sub>t-5</sub>	0.0019 [0.0027]	0.0052 [0.0046]	0.0230 [0.0170]	0.0150 [0.0122]	-0.0242 ** [0.0104]	0.0127 [0.0137]	-0.0031 [0.0063]	-0.0145 [0.0119]	-0.0144 * [0.0074]	-0.0015 [0.0152]	0.0048 [0.0043]
Precipitation <sub>t-6</sub>	-0.0016 [0.0029]	-0.0009 [0.0050]	0.0441 [0.0313]	0.0011 [0.0147]	-0.0351 ** [0.0107]	0.0064 [0.0112]	-0.0064 [0.0081]	-0.0170 [0.0130]	-0.0056 [0.0076]	-0.0009 [0.0215]	0.0025 [0.0047]
Precipitation <sub>t-7</sub>	-0.0046 [0.0035]	-0.0029 [0.0056]	0.0404 [0.0287]	0.0022 [0.0120]	-0.0413 ** [0.0129]	0.0053 [0.0130]	-0.0079 [0.0087]	-0.0171 [0.0127]	-0.0236 ** [0.0088]	0.0064 [0.0207]	-0.0032 [0.0043]
Precipitation <sub>t-8</sub>	-0.0009 [0.0034]	0.0027 [0.0045]	0.0499 * [0.0267]	0.0100 [0.0140]	-0.0366 ** [0.0137]	0.0075 [0.0153]	-0.0022 [0.0085]	-0.0178 [0.0149]	-0.0153 [0.0093]	0.0169 [0.0211]	-0.0007 [0.0050]
Precipitation <sub>t-9</sub>	-0.0014 [0.0035]	0.0006 [0.0039]	0.0415 [0.0298]	0.0126 [0.0161]	-0.0278 [0.0170]	0.0083 [0.0164]	-0.0089 [0.0080]	-0.0174 [0.0156]	-0.0221 ** [0.0091]	0.0197 [0.0194]	0.0013 [0.0066]
Precipitation <sub>t-10</sub>	-0.0018 [0.0034]	0.0114 ** [0.0050]	0.0562 * [0.0285]	0.0135 [0.0175]	-0.0450 ** [0.0159]	0.0073 [0.0144]	-0.0124 [0.0086]	-0.0240 [0.0150]	-0.0215 ** [0.0097]	0.0393 ** [0.0182]	0.0011 [0.0068]
Precipitation <sub>t-11</sub>	-0.0039 [0.0032]	-0.0004 [0.0047]	0.0566 * [0.0326]	0.0138 [0.0193]	-0.0456 ** [0.0156]	0.0155 [0.0161]	-0.0117 [0.0094]	-0.0235 * [0.0136]	-0.0238 ** [0.0100]	0.0168 [0.0213]	-0.0037 [0.0052]
Precipitation <sub>t-12</sub>	-0.0031 [0.0047]	0.0042 [0.0044]	0.0627 * [0.0329]	0.0177 [0.0203]	-0.0393 * [0.0208]	0.0135 [0.0176]	-0.0155 [0.0091]	-0.0237 [0.0158]	-0.0212 * [0.0107]	0.0291 [0.0230]	-0.0040 [0.0072]
Within R <sup>2</sup>	0.000	0.002	0.006	0.001	0.002	0.001	0.001	0.001	0.001	0.004	0.003
R <sup>2</sup>	0.024	0.034	0.118	0.049	0.031	0.045	0.035	0.022	0.018	0.043	0.045
Observations	491,213	52,955	6,157	23,810	21,926	94,233	71,512	65,233	36,575	16,276	102,536

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 and 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 11A. National and service sectors 48-72: marginal cumulative effects of MSW on real revenue index for highly and low exposed municipalities, 2008-2015**

Percentage points of growth per meter per second (m/s)

Period	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High	Low Expos.	High Expos.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Expos. Municip.	Municip.	Municip.
	National		48 Transportation		49 Warehousing		51 Information		53 Real State	
<i>Maximum Sustained Winds m/s</i>										
Trop. Cyclones <sub>t</sub>	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000 ***
	[0.0001]	[0.0001]	[0.0001]	[0.0001]	[0.0000]	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-1</sub>	-0.0004 **	-0.0006	0.0002	0.0001	0.0000	0.0000	-0.0004	0.0000	0.0000	0.0000 ***
	[0.0001]	[0.0005]	[0.0001]	[0.0001]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-2</sub>	-0.0007 **	-0.0005	0.0003	0.0001	0.0000 *	0.0000 ***	-0.0010	0.0000	0.0000	0.0000 ***
	[0.0002]	[0.0005]	[0.0002]	[0.0000]	[0.0000]	[0.0000]	[0.0007]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-3</sub>	-0.0006 **	-0.0002	0.0009 *	0.0001	0.0000 *	0.0000	-0.0012	0.0000	0.0000 *	0.0000 ***
	[0.0002]	[0.0005]	[0.0006]	[0.0000]	[0.0000]	[0.0000]	[0.0008]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-4</sub>	-0.0004	0.0001	0.0010 *	0.0000	0.0000	0.0000	-0.0009	0.0000	0.0000	0.0000
	[0.0003]	[0.0005]	[0.0006]	[0.0001]	[0.0000]	[0.0000]	[0.0008]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-5</sub>	-0.0001	0.0004	0.0014	0.0000	0.0000	0.0000	-0.0006	0.0000 *	0.0000	0.0000
	[0.0003]	[0.0005]	[0.0010]	[0.0001]	[0.0000]	[0.0000]	[0.0006]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-6</sub>	0.0003	0.0007	0.0019	-0.0001	0.0000	0.0000	-0.0003	0.0000	0.0000	0.0000
	[0.0005]	[0.0005]	[0.0013]	[0.0001]	[0.0000]	[0.0000]	[0.0004]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-7</sub>	0.0006	0.0008	0.0017	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	[0.0006]	[0.0006]	[0.0014]	[0.0002]	[0.0000]	[0.0000]	[0.0004]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-8</sub>	0.0008	0.0008	0.0019	-0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	[0.0007]	[0.0007]	[0.0013]	[0.0002]	[0.0000]	[0.0000]	[0.0006]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-9</sub>	0.0009	0.0007	0.0017	-0.0003	0.0000	0.0000 *	0.0001	0.0000	0.0000	0.0000
	[0.0009]	[0.0008]	[0.0012]	[0.0003]	[0.0000]	[0.0000]	[0.0008]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-10</sub>	0.0009	0.0006	0.0008	-0.0005	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
	[0.0009]	[0.0008]	[0.0007]	[0.0004]	[0.0000]	[0.0000]	[0.0010]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-11</sub>	0.0008	0.0004	0.0009	-0.0007	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
	[0.0010]	[0.0009]	[0.0007]	[0.0005]	[0.0000]	[0.0000]	[0.0012]	[0.0000]	[0.0000]	[0.0000]
Trop. Cyclones <sub>t-12</sub>	0.0008	0.0004	0.0010	-0.0012	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
	[0.0012]	[0.0010]	[0.0008]	[0.0007]	[0.0000]	[0.0000]	[0.0014]	[0.0000]	[0.0000]	[0.0000]
Within R <sup>2</sup>	0.002	0.004	0.002	0.021	0.007	0.035	0.006	0.014	0.004	0.015
R <sup>2</sup>	0.982	0.954	0.970	0.997	0.990	0.990	0.996	1.000	0.980	0.980
Observations	364,913	87,318	42,425	6,158	4,458	1,148	19,782	3,032	14,422	5,317

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 11A (cont.) National and service sectors 48-72: marginal cumulative effects of MSW on real revenue index for highly and low exposed municipalities, 2008-2015**

Percentage points of growth per meter per second (m/s)

Period	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	54 Professional and		56 Waste and Remediation		61 Education		62 Health		71 Arts, Entertainment		72 Accommodation and	
	<i>Maximum Sustained Winds m/s</i>											
Trop. Cyclones <sub>t</sub>	0.002	-0.001	-0.002	0.001	0.000	0.000 ***	0.000	0.000 ***	-0.001	-0.003	0.001	0.001
	[0.003]	[0.000]	[0.001]	[0.001]	[0.000]	[0.000]	[0.001]	[0.000]	[0.001]	[0.002]	[0.002]	[0.002]
Trop. Cyclones <sub>t-1</sub>	-0.010 **	0.000	-0.006 **	0.002 **	-0.002 *	0.000 ***	0.001	0.000 ***	-0.002	-0.008	-0.008	-0.012 *
	[0.004]	[0.000]	[0.003]	[0.001]	[0.001]	[0.000]	[0.001]	[0.000]	[0.001]	[0.005]	[0.005]	[0.008]
Trop. Cyclones <sub>t-2</sub>	-0.014 **	0.000	-0.009 **	0.003 *	-0.003 *	0.000 ***	0.001	0.000	-0.004	-0.011	-0.014 *	-0.009
	[0.006]	[0.001]	[0.004]	[0.002]	[0.001]	[0.000]	[0.002]	[0.000]	[0.003]	[0.008]	[0.007]	[0.008]
Trop. Cyclones <sub>t-3</sub>	-0.015 **	0.001	-0.010 **	0.004 *	-0.002	0.000 ***	0.002	0.000 ***	-0.007	-0.013	-0.013	-0.003
	[0.006]	[0.002]	[0.005]	[0.002]	[0.001]	[0.000]	[0.001]	[0.000]	[0.005]	[0.008]	[0.008]	[0.009]
Trop. Cyclones <sub>t-4</sub>	-0.015 **	0.002	-0.007 *	0.005	0.000	0.000 ***	0.002	0.000 ***	-0.018 *	-0.013	-0.010	0.003
	[0.006]	[0.002]	[0.004]	[0.003]	[0.002]	[0.000]	[0.001]	[0.000]	[0.010]	[0.009]	[0.010]	[0.010]
Trop. Cyclones <sub>t-5</sub>	-0.011 *	0.003	-0.004	0.004	0.000	0.000 ***	0.002	0.000 ***	-0.018 *	-0.006	-0.003	0.007
	[0.006]	[0.003]	[0.004]	[0.003]	[0.001]	[0.000]	[0.002]	[0.000]	[0.010]	[0.006]	[0.009]	[0.010]
Trop. Cyclones <sub>t-6</sub>	-0.008	0.004	0.000	0.005	0.001	0.000 ***	0.002	0.000 ***	-0.016	0.000	0.005	0.012
	[0.008]	[0.004]	[0.005]	[0.004]	[0.001]	[0.000]	[0.002]	[0.000]	[0.010]	[0.006]	[0.012]	[0.011]
Trop. Cyclones <sub>t-7</sub>	-0.005	0.003	0.003	0.006	0.002	0.000	0.001	0.000 ***	-0.015	0.008	0.011	0.018
	[0.010]	[0.004]	[0.003]	[0.004]	[0.002]	[0.000]	[0.003]	[0.000]	[0.009]	[0.011]	[0.015]	[0.013]
Trop. Cyclones <sub>t-8</sub>	-0.006	0.005	0.010 **	0.006	0.002	0.000	0.002	0.000	-0.015	0.012	0.018	0.019
	[0.013]	[0.005]	[0.005]	[0.005]	[0.001]	[0.000]	[0.003]	[0.000]	[0.009]	[0.015]	[0.016]	[0.015]
Trop. Cyclones <sub>t-9</sub>	-0.012	0.006	0.016 **	0.007	0.003 *	0.000	0.003	0.000 ***	-0.012	0.013	0.023	0.015
	[0.018]	[0.006]	[0.007]	[0.005]	[0.002]	[0.000]	[0.002]	[0.000]	[0.009]	[0.016]	[0.019]	[0.016]
Trop. Cyclones <sub>t-10</sub>	-0.011	0.006	0.021 **	0.006	0.003	0.000	0.003	0.000 ***	-0.011	0.012	0.020	0.014
	[0.021]	[0.007]	[0.008]	[0.005]	[0.002]	[0.000]	[0.002]	[0.000]	[0.010]	[0.019]	[0.019]	[0.018]
Trop. Cyclones <sub>t-11</sub>	-0.018	0.008	0.024 **	0.007	0.001	0.000	0.004 *	0.000	-0.010	0.015	0.023	0.011
	[0.023]	[0.008]	[0.010]	[0.005]	[0.002]	[0.000]	[0.002]	[0.000]	[0.010]	[0.023]	[0.019]	[0.020]
Trop. Cyclones <sub>t-12</sub>	-0.023	0.008	0.028 **	0.008	0.002	0.000	0.004	0.000	-0.009	0.017	0.023	0.012
	[0.025]	[0.009]	[0.012]	[0.006]	[0.003]	[0.000]	[0.002]	[0.000]	[0.010]	[0.026]	[0.021]	[0.022]
Within R <sup>2</sup>	0.004	0.002	0.003	0.032	0.003	0.003	0.002	0.005	0.009	0.073	0.010	0.016
R <sup>2</sup>	0.978	0.992	0.991	0.995	0.998	0.980	0.999	0.990	0.989	0.976	0.973	0.935
Observations	76,539	8,159	58,563	9,820	51,122	7,632	25,931	7,446	11,108	3,109	60,563	35,497

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 12A. Service sectors 48-72: marginal cumulative effects of temperature and precipitation on real revenue index for highly and low exposed municipalities, 2008-15**

Percentage points of growth per 1°C and 100 mm, respectively

Period	Low Expos.	High Expos.	Low Expos.	High Expo.	Low Expos.	High Expo.	Low Expos.	High Expo.	Low Expos.	High Expo.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	National		48 Transportation		49 Warehousing		51 Information		53 Real State	
	Temperature 1°C									
Temperature <sub>t</sub>	0.0018 **	0.0015	0.0010	0.0019	0.0000	0.0000 **	0.0013	0.0000	0.0000 **	0.0000 **
	[0.0007]	[0.0037]	[0.0011]	[0.0013]	[0.0000]	[0.0000]	[0.0008]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-1</sub>	0.0006	-0.0020	-0.0005	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	[0.0004]	[0.0013]	[0.0005]	[0.0007]	[0.0000]	[0.0000]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-2</sub>	0.0002	-0.0023	-0.0011	-0.0007	0.0000	0.0000 *	-0.0001	0.0000	0.0000	0.0000
	[0.0006]	[0.0017]	[0.0009]	[0.0006]	[0.0000]	[0.0000]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-3</sub>	0.0002	-0.0022	-0.0001	-0.0010	0.0000	0.0000 *	0.0001	0.0000	0.0000 **	0.0000
	[0.0006]	[0.0027]	[0.0004]	[0.0007]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-4</sub>	0.0002	-0.0021	0.0005	0.0006	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000
	[0.0006]	[0.0023]	[0.0009]	[0.0007]	[0.0000]	[0.0000]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-5</sub>	0.0008	-0.0017	0.0006	0.0003	0.0000 **	0.0000 *	0.0002	0.0000	0.0000	0.0000
	[0.0007]	[0.0031]	[0.0009]	[0.0009]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-6</sub>	0.0008	-0.0007	0.0010	0.0002	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000 **
	[0.0008]	[0.0030]	[0.0013]	[0.0009]	[0.0000]	[0.0000]	[0.0004]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-7</sub>	0.0010	-0.0013	-0.0002	-0.0003	0.0000 *	0.0000 **	0.0002	0.0000	0.0000	0.0000
	[0.0009]	[0.0032]	[0.0014]	[0.0009]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-8</sub>	0.0010	-0.0017	-0.0001	0.0002	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000
	[0.0009]	[0.0039]	[0.0010]	[0.0011]	[0.0000]	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-9</sub>	0.0010	-0.0012	0.0005	0.0002	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000
	[0.0010]	[0.0040]	[0.0018]	[0.0012]	[0.0000]	[0.0000]	[0.0004]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-10</sub>	0.0007	-0.0021	-0.0003	-0.0003	0.0000	0.0000 **	0.0001	0.0000	0.0000	0.0000
	[0.0010]	[0.0039]	[0.0019]	[0.0012]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-11</sub>	0.0004	-0.0026	-0.0003	-0.0008	0.0000 *	0.0000	0.0001	0.0000	0.0000	0.0000
	[0.0009]	[0.0036]	[0.0017]	[0.0011]	[0.0000]	[0.0000]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
Temperature <sub>t-12</sub>	0.0002	-0.0007	0.0000	-0.0006	0.0000 **	0.0000	-0.0004	0.0000	0.0000 ***	0.0000
	[0.0008]	[0.0032]	[0.0020]	[0.0011]	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
	Cumulative Precipitation (100 mm)									
Precipitation <sub>t</sub>	0.0017 ***	0.0012	0.0006	0.0006	0.0000 ***	0.0000 ***	0.0013 *	0.0000 ***	0.0000	0.0000 ***
	[0.0004]	[0.0008]	[0.0014]	[0.0004]	[0.0000]	[0.0000]	[0.0007]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-1</sub>	0.0004	0.0012	0.0004	-0.0007	0.0000 ***	0.0000 ***	0.0005 *	0.0000 ***	0.0000	0.0000 ***
	[0.0004]	[0.0010]	[0.0011]	[0.0005]	[0.0000]	[0.0000]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-2</sub>	-0.0001	0.0018	0.0013	-0.0007	0.0000 ***	0.0000 ***	-0.0006	0.0000 ***	0.0000	0.0000 ***
	[0.0004]	[0.0017]	[0.0010]	[0.0005]	[0.0000]	[0.0000]	[0.0005]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-3</sub>	-0.0009	0.0016	0.0011	-0.0015	0.0000 ***	0.0000 ***	-0.0009	0.0000 ***	0.0000	0.0000 ***
	[0.0008]	[0.0021]	[0.0009]	[0.0009]	[0.0000]	[0.0000]	[0.0006]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-4</sub>	-0.0007	0.0017	0.0023	-0.0003	0.0000 ***	0.0000 ***	-0.0009	0.0000 ***	0.0000	0.0000 ***
	[0.0007]	[0.0026]	[0.0016]	[0.0006]	[0.0000]	[0.0000]	[0.0010]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-5</sub>	-0.0006	0.0031	0.0039 *	0.0001	0.0000 ***	0.0000 ***	-0.0012	0.0000 ***	0.0000	0.0000 ***
	[0.0008]	[0.0033]	[0.0022]	[0.0005]	[0.0000]	[0.0000]	[0.0010]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-6</sub>	-0.0004	0.0039	0.0031	-0.0001	0.0000 ***	0.0000 ***	-0.0007	0.0000 ***	0.0000	0.0000 ***
	[0.0009]	[0.0032]	[0.0022]	[0.0005]	[0.0000]	[0.0000]	[0.0007]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-7</sub>	-0.0001	0.0052	0.0035 *	-0.0008	0.0000 ***	0.0000 ***	-0.0001	0.0000 ***	0.0000	0.0000 ***
	[0.0008]	[0.0036]	[0.0020]	[0.0005]	[0.0000]	[0.0000]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-8</sub>	0.0002	0.0057	0.0030	-0.0002	0.0000 ***	0.0000 ***	-0.0003	0.0000 ***	0.0000	0.0000 ***
	[0.0009]	[0.0037]	[0.0022]	[0.0004]	[0.0000]	[0.0000]	[0.0005]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-9</sub>	0.0000	0.0054	0.0018	-0.0006	0.0000 ***	0.0000 ***	-0.0003	0.0000 ***	0.0000	0.0000 ***
	[0.0011]	[0.0037]	[0.0018]	[0.0005]	[0.0000]	[0.0000]	[0.0005]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-10</sub>	-0.0004	0.0056	0.0030	-0.0014	0.0000 ***	0.0000 ***	-0.0004	0.0000 ***	0.0000	0.0000 ***
	[0.0011]	[0.0041]	[0.0018]	[0.0009]	[0.0000]	[0.0000]	[0.0006]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-11</sub>	-0.0010	0.0038	0.0026 *	-0.0018 *	0.0000 ***	0.0000 ***	-0.0006	0.0000 ***	0.0000	0.0000 ***
	[0.0011]	[0.0040]	[0.0015]	[0.0010]	[0.0000]	[0.0000]	[0.0010]	[0.0000]	[0.0000]	[0.0000]
Precipitation <sub>t-12</sub>	-0.0013	0.0041	0.0028	-0.0020	0.0000 ***	0.0000 ***	-0.0009	0.0000 ***	0.0000	0.0000 ***
	[0.0012]	[0.0041]	[0.0019]	[0.0011]	[0.0000]	[0.0000]	[0.0010]	[0.0000]	[0.0000]	[0.0000]
Within R <sup>2</sup>	0.002	0.004	0.002	0.021	0.007	0.035	0.006	0.014	0.004	0.015
R <sup>2</sup>	0.982	0.954	0.970	0.997	1.000	1.000	0.996	1.000	0.980	0.980
Observations	364,913	87,318	42,425	6,158	4,458	1,148	19,782	3,032	14,422	5,317

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are in the states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán. All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality, results are in Annex A; also includes: i) month-year fixed effects (FE); ii) establishment size FE; iii) 2 or 3-digit NAICS for national and sector specifications, respectively, FE; iv) state FE, v) low-exposed municipalities FE; vi) subsector (3-digit NAICS) x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 12A (cont.) Service sectors 48-72: marginal cumulative effects of temperature and precipitation on real revenue index for highly and low exposed municipalities**

Percentage points of growth per 1°C and 100 mm, respectively

Period	Low Expos.	High Expo.	Low Expos.	High Expo.	Low Expos.	High Expo.	Low Expos.	High Expo.	Low Expos.	High Expo.	Low Expos.	High Expo.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	54 Professional Scientific		56 Waste and Remediation		61 Education		62 Health		71 Arts, Entertainment and		72 Accommodation and	
Temperature 1°C												
Temperature <sub>1</sub>	0.0020	0.0000	-0.0007	0.0050	0.0005	0.0000	-0.0002	0.0000 **	-0.0013	0.0117 *	0.0042 **	0.0086 **
	[0.0016]	[0.0003]	[0.0004]	[0.0030]	[0.0006]	[0.0000]	[0.0003]	[0.0000]	[0.0009]	[0.0057]	[0.0018]	[0.0031]
Temperature <sub>1,1</sub>	0.0008	-0.0001	-0.0004	0.0034	0.0001	0.0000	0.0001	0.0000	0.0003	0.0054 *	0.0011 **	-0.0027
	[0.0013]	[0.0003]	[0.0004]	[0.0022]	[0.0003]	[0.0000]	[0.0001]	[0.0000]	[0.0018]	[0.0029]	[0.0005]	[0.0023]
Temperature <sub>1,2</sub>	0.0002	0.0005	-0.0010 *	0.0023	0.0000	0.0000 **	0.0002	0.0000	0.0006	0.0053 *	0.0006	-0.0028
	[0.0017]	[0.0006]	[0.0005]	[0.0015]	[0.0002]	[0.0000]	[0.0003]	[0.0000]	[0.0018]	[0.0025]	[0.0006]	[0.0031]
Temperature <sub>1,3</sub>	0.0000	-0.0004	-0.0011	0.0027	0.0000	0.0000	0.0000	0.0000 **	-0.0014 **	0.0045 *	0.0007	-0.0011
	[0.0015]	[0.0004]	[0.0008]	[0.0016]	[0.0003]	[0.0000]	[0.0002]	[0.0000]	[0.0006]	[0.0025]	[0.0011]	[0.0043]
Temperature <sub>1,4</sub>	-0.0004	0.0003	-0.0013 **	0.0025	0.0003	0.0000	-0.0001	0.0000 **	-0.0010	0.0086 *	0.0003	-0.0023
	[0.0016]	[0.0007]	[0.0006]	[0.0017]	[0.0003]	[0.0000]	[0.0007]	[0.0000]	[0.0010]	[0.0044]	[0.0008]	[0.0036]
Temperature <sub>1,5</sub>	0.0002	0.0002	-0.0014 **	0.0032	0.0004	0.0000	0.0000	0.0000	-0.0015 *	0.0116 *	0.0015	0.0009
	[0.0023]	[0.0004]	[0.0006]	[0.0023]	[0.0005]	[0.0000]	[0.0003]	[0.0000]	[0.0008]	[0.0061]	[0.0011]	[0.0043]
Temperature <sub>1,6</sub>	0.0009	0.0002	-0.0010 *	0.0048	0.0006	0.0000 *	0.0003	0.0000 *	-0.0011	0.0143 **	0.0010	0.0021
	[0.0027]	[0.0006]	[0.0005]	[0.0031]	[0.0005]	[0.0000]	[0.0003]	[0.0000]	[0.0013]	[0.0058]	[0.0012]	[0.0048]
Temperature <sub>1,7</sub>	0.0019	0.0003	-0.0012 **	0.0053	0.0007	0.0000	0.0003	0.0000	-0.0016	0.0162 **	0.0020	-0.0001
	[0.0028]	[0.0009]	[0.0004]	[0.0035]	[0.0007]	[0.0000]	[0.0003]	[0.0000]	[0.0016]	[0.0073]	[0.0012]	[0.0058]
Temperature <sub>1,8</sub>	0.0015	0.0004	-0.0010	0.0051	0.0004	0.0000 **	0.0002	0.0000	-0.0018	0.0158 **	0.0028 *	-0.0018
	[0.0030]	[0.0006]	[0.0007]	[0.0033]	[0.0006]	[0.0000]	[0.0004]	[0.0000]	[0.0013]	[0.0068]	[0.0015]	[0.0073]
Temperature <sub>1,9</sub>	0.0006	0.0004	-0.0013 *	0.0053	0.0009	0.0000	0.0000	0.0000 **	-0.0009	0.0179 **	0.0024	-0.0010
	[0.0034]	[0.0007]	[0.0007]	[0.0033]	[0.0007]	[0.0000]	[0.0005]	[0.0000]	[0.0015]	[0.0076]	[0.0018]	[0.0078]
Temperature <sub>1,10</sub>	0.0012	0.0001	-0.0008	0.0030	0.0008	0.0000 *	0.0002	0.0000	-0.0008	0.0246 *	0.0011	-0.0020
	[0.0033]	[0.0009]	[0.0007]	[0.0023]	[0.0006]	[0.0000]	[0.0003]	[0.0000]	[0.0014]	[0.0114]	[0.0019]	[0.0079]
Temperature <sub>1,11</sub>	0.0006	0.0007	-0.0008	0.0028	0.0008	0.0000 **	0.0003	0.0000 **	-0.0014	0.0168 **	0.0005	-0.0035
	[0.0032]	[0.0010]	[0.0007]	[0.0027]	[0.0007]	[0.0000]	[0.0003]	[0.0000]	[0.0009]	[0.0078]	[0.0016]	[0.0080]
Temperature <sub>1,12</sub>	0.0004	0.0003	-0.0004	0.0021	0.0008	0.0000	0.0003	0.0000 ***	-0.0005	0.0168 **	0.0001	-0.0028
	[0.0031]	[0.0006]	[0.0003]	[0.0021]	[0.0007]	[0.0000]	[0.0003]	[0.0000]	[0.0009]	[0.0076]	[0.0015]	[0.0080]
Cumulative Precipitation (100 mm)												
Precipitation <sub>1</sub>	0.0025 **	0.0002	0.0005	0.0009 *	0.0003	0.0000 ***	-0.0001	0.0000 ***	-0.0003	0.0030 **	0.0052 **	0.0018
	[0.0008]	[0.0002]	[0.0005]	[0.0004]	[0.0003]	[0.0000]	[0.0000]	[0.0003]	[0.0005]	[0.0012]	[0.0024]	[0.0017]
Precipitation <sub>1,1</sub>	-0.0001	-0.0002	0.0002	0.0000	-0.0002	0.0000 ***	0.0000	0.0000 ***	0.0010	0.0007	0.0031 *	0.0014
	[0.0011]	[0.0001]	[0.0004]	[0.0004]	[0.0004]	[0.0000]	[0.0003]	[0.0000]	[0.0009]	[0.0016]	[0.0018]	[0.0021]
Precipitation <sub>1,2</sub>	-0.0003	0.0000	0.0001	0.0002	-0.0001	0.0000 ***	0.0005 *	0.0000 ***	0.0014	-0.0052	0.0012	0.0013
	[0.0016]	[0.0004]	[0.0005]	[0.0008]	[0.0004]	[0.0000]	[0.0003]	[0.0000]	[0.0012]	[0.0033]	[0.0017]	[0.0032]
Precipitation <sub>1,3</sub>	-0.0018	-0.0003	-0.0004	0.0016	0.0000	0.0000 ***	0.0005	0.0000 ***	0.0024	-0.0070	0.0002	0.0023
	[0.0021]	[0.0003]	[0.0009]	[0.0013]	[0.0006]	[0.0000]	[0.0003]	[0.0000]	[0.0017]	[0.0049]	[0.0024]	[0.0049]
Precipitation <sub>1,4</sub>	-0.0009	0.0001	-0.0008	0.0018	0.0002	0.0000 ***	0.0001	0.0000 ***	-0.0003	-0.0124 *	-0.0003	0.0022
	[0.0025]	[0.0003]	[0.0010]	[0.0017]	[0.0006]	[0.0000]	[0.0003]	[0.0000]	[0.0010]	[0.0060]	[0.0030]	[0.0056]
Precipitation <sub>1,5</sub>	-0.0009	0.0001	-0.0014	0.0029	0.0003	0.0000 ***	0.0004	0.0000 ***	-0.0005	-0.0100	0.0004	0.0049
	[0.0031]	[0.0006]	[0.0012]	[0.0018]	[0.0008]	[0.0000]	[0.0005]	[0.0000]	[0.0016]	[0.0069]	[0.0032]	[0.0069]
Precipitation <sub>1,6</sub>	-0.0006	0.0000	-0.0010	0.0030	0.0003	0.0000 ***	0.0005	0.0000 ***	0.0011	-0.0037	0.0013	0.0055
	[0.0034]	[0.0005]	[0.0015]	[0.0022]	[0.0009]	[0.0000]	[0.0005]	[0.0000]	[0.0022]	[0.0051]	[0.0039]	[0.0066]
Precipitation <sub>1,7</sub>	0.0010	0.0011	-0.0007	0.0027	0.0004	0.0000 ***	0.0005	0.0000 ***	0.0014	-0.0031	0.0017	0.0080
	[0.0040]	[0.0010]	[0.0014]	[0.0026]	[0.0011]	[0.0000]	[0.0006]	[0.0000]	[0.0024]	[0.0068]	[0.0038]	[0.0069]
Precipitation <sub>1,8</sub>	0.0014	0.0007	0.0001	0.0028	0.0010	0.0000 ***	0.0003	0.0000 ***	0.0016	-0.0027	0.0036	0.0074
	[0.0050]	[0.0008]	[0.0015]	[0.0030]	[0.0012]	[0.0000]	[0.0006]	[0.0000]	[0.0025]	[0.0073]	[0.0039]	[0.0069]
Precipitation <sub>1,9</sub>	0.0020	0.0006	0.0006	0.0029	0.0013	0.0000 ***	0.0005	0.0000 ***	0.0023	-0.0028	0.0028	0.0064
	[0.0052]	[0.0009]	[0.0016]	[0.0033]	[0.0015]	[0.0000]	[0.0006]	[0.0000]	[0.0030]	[0.0089]	[0.0044]	[0.0070]
Precipitation <sub>1,10</sub>	0.0017	0.0008	0.0008	0.0017	0.0012	0.0000 ***	0.0006	0.0000 ***	0.0030	-0.0026	0.0021	0.0059
	[0.0049]	[0.0010]	[0.0017]	[0.0035]	[0.0014]	[0.0000]	[0.0006]	[0.0000]	[0.0032]	[0.0098]	[0.0048]	[0.0076]
Precipitation <sub>1,11</sub>	0.0013	0.0005	0.0008	0.0006	0.0014	0.0000 ***	0.0006	0.0000 ***	0.0032	-0.0043	-0.0008	0.0020
	[0.0050]	[0.0011]	[0.0018]	[0.0037]	[0.0015]	[0.0000]	[0.0007]	[0.0000]	[0.0031]	[0.0097]	[0.0040]	[0.0068]
Precipitation <sub>1,12</sub>	0.0012	0.0003	0.0012	0.0000	0.0016	0.0000 ***	0.0006	0.0000 ***	0.0037	-0.0051	-0.0028	0.0021
	[0.0046]	[0.0011]	[0.0022]	[0.0039]	[0.0015]	[0.0000]	[0.0009]	[0.0000]	[0.0031]	[0.0096]	[0.0040]	[0.0068]
Within R <sup>2</sup>	0.004	0.002	0.003	0.032	0.003	0.003	0.002	0.005	0.009	0.073	0.010	0.016
R <sup>2</sup>	0.978	0.992	0.991	0.995	0.998	0.980	0.999	0.980	0.989	0.976	0.973	0.935
Observations	76,539	8,159	58,563	9,820	51,122	7,632	25,931	7,446	11,108	3,109	60,563	35,497

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 13A. Service sectors 48-72: marginal cumulative effects of MSW on real operative expenditures for highly and low exposed municipalities, 2008-2015**

Percentage points of growth per meter per second (m/s)

Period	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	National		48 Transportation		49 Warehousing		51 Information		53 Real State	
<i>Maximum Sustained Winds m/s</i>										
Trop. Cyclones <sub>t</sub>	0.0449 [0.0630]	-0.0050 [0.0828]	-0.1508 * [0.0861]	0.2062 [0.2016]	-0.2311 [0.2884]	0.4240 [0.4971]	0.8668 ** [0.3388]	-0.1805 [0.3639]	0.0009 [0.3562]	-0.1485 [0.1943]
Trop. Cyclones <sub>t-1</sub>	0.1376 * [0.0781]	0.0739 [0.0696]	-0.1249 [0.0969]	0.2065 [0.2514]	0.2246 [0.2964]	0.1815 [0.5843]	1.1515 ** [0.3078]	-0.3715 [0.3675]	0.1368 [0.3401]	0.0167 [0.2549]
Trop. Cyclones <sub>t-2</sub>	0.0691 [0.1205]	0.1401 ** [0.0556]	-0.0950 [0.1171]	0.4012 [0.3538]	-0.2905 [0.4270]	0.5189 [0.7795]	1.0612 ** [0.3466]	-0.0167 [0.5584]	-0.5161 [0.5180]	0.1164 [0.2997]
Trop. Cyclones <sub>t-3</sub>	0.1416 [0.1089]	0.2711 *** [0.0664]	-0.2855 * [0.1711]	0.4438 [0.4428]	-0.1751 [0.4189]	0.8958 [1.0966]	1.4035 ** [0.5716]	-0.3120 [0.3702]	-0.5145 [0.3903]	0.0410 [0.3343]
Trop. Cyclones <sub>t-4</sub>	0.1223 [0.0863]	0.1965 ** [0.0656]	-0.0974 [0.1513]	0.5842 [0.4403]	-0.5586 ** [0.2536]	0.7904 [0.9869]	1.5985 ** [0.4641]	-0.3422 [0.5678]	0.2935 [0.5132]	0.0872 [0.3357]
Trop. Cyclones <sub>t-5</sub>	0.0560 [0.1251]	0.2185 ** [0.0841]	-0.2621 [0.1776]	0.5453 [0.4261]	-0.8357 ** [0.3833]	0.4559 [1.1444]	2.0612 ** [0.6847]	-0.3050 [0.6168]	-0.3882 [0.5998]	0.3029 [0.4218]
Trop. Cyclones <sub>t-6</sub>	0.1749 [0.1381]	0.3116 ** [0.1074]	-0.1071 [0.2213]	0.5175 [0.4077]	-0.8972 ** [0.3406]	0.5425 [1.0467]	1.8453 ** [0.7769]	-0.4020 [0.6523]	0.4013 [0.5851]	0.6767 * [0.3663]
Trop. Cyclones <sub>t-7</sub>	0.1130 [0.1494]	0.1790 [0.1047]	-0.0896 [0.1957]	0.4649 [0.4100]	-1.1195 ** [0.4272]	1.2662 [0.9251]	1.4655 * [0.7938]	-0.7465 [0.6777]	0.5217 [0.5326]	0.0818 [0.3727]
Trop. Cyclones <sub>t-8</sub>	0.1919 [0.1293]	0.1439 [0.1158]	-0.2090 [0.2284]	0.3001 [0.4294]	-1.4283 ** [0.5245]	0.8760 [1.0932]	1.7670 [1.0529]	-0.6423 [0.6654]	0.6628 [0.7252]	0.0176 [0.4561]
Trop. Cyclones <sub>t-9</sub>	0.2473 * [0.1321]	0.1128 [0.1102]	-0.1968 [0.2282]	0.2479 [0.4289]	-1.3200 * [0.6917]	0.9785 [1.0651]	1.6643 [0.9899]	-0.2128 [0.6644]	1.0114 [0.6493]	-0.2569 [0.4789]
Trop. Cyclones <sub>t-10</sub>	0.2413 [0.1527]	-0.1010 [0.1368]	-0.0928 [0.2355]	0.2987 [0.5969]	-2.2393 *** [0.4822]	0.9842 [1.1095]	2.3668 * [1.3128]	-0.8972 [0.7407]	1.0004 [0.7653]	-0.0417 [0.5060]
Trop. Cyclones <sub>t-11</sub>	0.1667 [0.1614]	-0.1160 [0.1177]	-0.1709 [0.3109]	0.3776 [0.5183]	-2.5270 *** [0.6026]	0.8985 [1.2984]	2.4127 [1.4282]	-0.8660 [0.5930]	1.5070 * [0.8581]	0.0010 [0.5640]
Trop. Cyclones <sub>t-12</sub>	0.1635 [0.2058]	-0.1426 [0.1618]	-0.0940 [0.4107]	0.7688 [0.6545]	-2.3419 ** [0.7908]	0.7857 [1.4855]	2.2817 [1.6654]	-0.9859 [0.7375]	1.4027 [1.0145]	-0.2743 [0.6135]
Within R <sup>2</sup>	0.000	0.002	0.001	0.009	0.010	0.021	0.001	0.013	0.002	0.009
R <sup>2</sup>	0.025	0.032	0.035	0.067	0.135	0.148	0.053	0.074	0.034	0.057
Observations	396,242	94,971	46,113	6,842	4,926	1,231	20,678	3,132	16,098	5,828

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.



**Table 13A (cont.) Service sectors 48-72: marginal cumulative effects of MSW on real operative expenditures for highly and low exposed municipalities, 2008-2015**

Percentage points of growth per meter per second (m/s)

Period	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	54 Professional and		56 Waste and Remediation		61 Education		62 Health		71 Arts, Entertainment		72 Accommodation, Food	
	<i>Maximum Sustained Winds m/s</i>											
Trop. Cyclones <sub>t</sub>	0.1201 [0.1587]	-0.0347 [0.1596]	-0.0573 [0.1947]	0.2713 [0.2799]	-0.0573 [0.1947]	-0.0837 [0.1933]	0.2045 [0.2656]	-0.0764 [0.2340]	0.3859 [0.3585]	-0.5739 [0.4030]	0.1083 * [0.0573]	-0.0762 [0.0983]
Trop. Cyclones <sub>t-1</sub>	0.2561 [0.2252]	-0.4091 [0.2763]	0.0581 [0.1578]	0.2371 [0.2766]	0.0581 [0.1578]	-0.1157 [0.1988]	0.3761 [0.3207]	-0.2605 [0.2355]	0.2565 [0.5315]	-0.3211 [0.5094]	0.2387 ** [0.1112]	0.0856 [0.0771]
Trop. Cyclones <sub>t-2</sub>	0.4976 * [0.2736]	-0.4380 * [0.2205]	-0.1859 [0.1566]	0.2822 [0.3755]	-0.1859 [0.1566]	0.0028 [0.2511]	0.3058 [0.2672]	-0.3048 [0.2135]	0.4063 [0.7116]	-0.4452 [0.7219]	-0.0147 [0.1130]	0.1213 * [0.0682]
Trop. Cyclones <sub>t-3</sub>	0.7463 *** [0.1962]	0.1991 [0.2894]	-0.1412 [0.2924]	0.4039 [0.3716]	-0.1412 [0.2924]	0.1899 [0.1946]	0.6217 [0.4153]	-0.0377 [0.2237]	0.4603 [0.6893]	-0.2783 [0.7562]	0.1761 [0.1345]	0.2187 ** [0.0643]
Trop. Cyclones <sub>t-4</sub>	0.5563 * [0.2693]	-0.0521 [0.3645]	-0.0906 [0.3198]	0.1482 [0.4698]	-0.0906 [0.3198]	0.3934 * [0.2067]	0.7219 * [0.4028]	-0.2064 [0.2672]	-0.2031 [0.7093]	0.0212 [0.7460]	0.0552 [0.1932]	0.0795 [0.0937]
Trop. Cyclones <sub>t-5</sub>	0.1633 [0.3254]	-0.1082 [0.4094]	0.1152 [0.4238]	0.1911 [0.4745]	0.1152 [0.4238]	0.2865 [0.3146]	0.6271 [0.4058]	-0.1302 [0.3815]	-0.0516 [0.8194]	-0.4692 [0.6722]	-0.1222 [0.1485]	0.1093 [0.1036]
Trop. Cyclones <sub>t-6</sub>	0.4504 [0.4411]	0.2189 [0.3681]	0.1863 [0.4887]	0.2977 [0.4551]	0.1863 [0.4887]	0.1905 [0.3173]	0.6650 [0.4281]	0.0345 [0.5380]	-0.3388 [1.0873]	0.3380 [0.6397]	-0.1378 [0.1756]	0.0747 [0.1769]
Trop. Cyclones <sub>t-7</sub>	0.6063 [0.4650]	0.1354 [0.3740]	-0.1468 [0.5841]	-0.0967 [0.5421]	-0.1468 [0.5841]	0.1020 [0.3961]	1.0353 ** [0.4532]	0.2166 [0.5594]	-0.5483 [0.9783]	-0.1317 [0.5604]	-0.0206 [0.2361]	0.0797 [0.1475]
Trop. Cyclones <sub>t-8</sub>	0.9304 * [0.4525]	0.3985 [0.4560]	-0.0345 [0.5537]	-0.1700 [0.5410]	-0.0345 [0.5537]	-0.0173 [0.4020]	1.1687 ** [0.4723]	0.0856 [0.5203]	-1.0359 [1.1959]	-0.3348 [0.6278]	-0.0474 [0.1879]	0.0486 [0.1834]
Trop. Cyclones <sub>t-9</sub>	0.7842 * [0.4197]	-0.0014 [0.4953]	-0.1574 [0.6697]	-0.1692 [0.5827]	-0.1574 [0.6697]	-0.0948 [0.4326]	1.1597 ** [0.5583]	0.3121 [0.5437]	-1.0595 [1.2583]	-0.2405 [0.6672]	0.1118 [0.2333]	0.0006 [0.1904]
Trop. Cyclones <sub>t-10</sub>	0.7191 * [0.3789]	-0.0208 [0.4945]	-0.0608 [0.7345]	-0.4692 [0.5767]	-0.0608 [0.7345]	-0.1782 [0.4660]	1.0753 * [0.5741]	0.2794 [0.5269]	-1.7290 [1.3768]	-0.3475 [0.5967]	-0.0028 [0.2486]	-0.2024 [0.1775]
Trop. Cyclones <sub>t-11</sub>	0.4525 [0.3969]	-0.2814 [0.4128]	0.0498 [0.8490]	-0.6045 [0.5084]	0.0498 [0.8490]	0.0255 [0.4941]	1.1759 ** [0.5334]	0.4630 [0.6041]	-1.6606 [1.5526]	-0.1965 [0.6845]	-0.1260 [0.2487]	-0.2311 [0.1913]
Trop. Cyclones <sub>t-12</sub>	0.5693 [0.4110]	-0.2688 [0.5355]	-0.3293 [0.8294]	-0.5534 [0.5710]	-0.3293 [0.8294]	-0.3192 [0.5055]	1.2992 ** [0.6127]	0.4408 [0.7915]	-1.9171 [1.7584]	-0.3902 [0.6855]	-0.1196 [0.3064]	-0.2783 [0.2220]
Within R <sup>2</sup>	0.001	0.007	0.001	0.004	0.001	0.004	0.001	0.005	0.004	0.019	0.001	0.003
R <sup>2</sup>	0.044	0.074	0.024	0.050	0.024	0.033	0.017	0.043	0.042	0.128	0.035	0.090
Observations	85,227	9,006	56,540	10,794	56,540	8,693	28,578	7,997	12,728	3,548	64,636	37,900

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include control for monthly mean temperature and monthly cumulative precipitation by municipality, and also: i) month-year fixed effects (FE); ii) establishment size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 or 3-digit NAICS for national and sector specifications, respectively x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 14A. Service subsectors 48-72: marginal cumulative effects of temperature and precipitation on real operative for highly and low exposed municipalities, 2008-2015**

Percentage points of growth per 1°C and 1 mm, respectively

Period	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	National		48 Transportation		49 Warehousing		51 Information		53 Real State	
<i>Temperature 1°C</i>										
Temperature <sub>t</sub>	0.4541 **	0.3012	0.0195	-0.5308	-1.0676	-0.4091	1.1960 *	-1.5979	-0.0068	1.4914 **
	[0.1483]	[0.2417]	[0.2609]	[1.2685]	[0.7869]	[2.0099]	[0.5767]	[1.0354]	[0.5044]	[0.6951]
Temperature <sub>t-1</sub>	-0.1454	0.3662	-0.1584	0.2093	-0.4990	-0.9951	0.6682	0.3337	0.5201	-1.7198 **
	[0.1267]	[0.3265]	[0.1662]	[0.4084]	[0.6524]	[2.0335]	[0.6635]	[0.8020]	[0.9022]	[0.5090]
Temperature <sub>t-2</sub>	0.2747 **	-0.2940	0.0098	0.1338	0.5623	-1.4243	0.9125	-1.6843	-0.5096	-2.2011 **
	[0.1137]	[0.2621]	[0.1517]	[0.4179]	[0.5938]	[2.9313]	[0.8176]	[1.2589]	[0.9218]	[0.6933]
Temperature <sub>t-3</sub>	-0.0615	-0.4328 *	0.1366	-0.4136	-0.8163	-2.3313	0.4062	0.1222	-0.5061	-0.3339
	[0.0734]	[0.2285]	[0.2078]	[0.7027]	[1.0968]	[3.3757]	[0.4993]	[1.0139]	[0.7679]	[1.0311]
Temperature <sub>t-4</sub>	0.0931	-0.2814	0.0754	2.3024 *	2.0556 **	-1.7232	-0.2079	-1.2804	0.3310	-0.7704
	[0.1959]	[0.1968]	[0.2045]	[1.2048]	[0.8514]	[4.0055]	[0.5051]	[1.0177]	[0.6487]	[0.6378]
Temperature <sub>t-5</sub>	0.0062	-0.2948	0.2968	0.9311 *	-1.3138	-2.6963	0.8312	-0.8807	-0.5188	-0.2849
	[0.2337]	[0.3969]	[0.2266]	[0.4321]	[0.9810]	[4.5341]	[0.5331]	[1.0352]	[0.6892]	[0.7209]
Temperature <sub>t-6</sub>	0.0172	-0.1570	0.0572	0.2889	0.2920	-2.8922	1.0213	-0.1370	-0.1988	-1.4437
	[0.1951]	[0.3446]	[0.1750]	[0.7773]	[1.2898]	[4.4125]	[0.6417]	[0.8552]	[1.4394]	[1.1011]
Temperature <sub>t-7</sub>	0.2878 **	-0.2451	-0.2507	1.5931 *	-0.2110	-2.4500	2.3879 ***	-2.2143	-1.1109 **	-1.3696
	[0.1314]	[0.3257]	[0.1657]	[0.8428]	[1.4066]	[5.2002]	[0.4423]	[1.4799]	[0.4743]	[1.2295]
Temperature <sub>t-8</sub>	0.2037	-0.3867	0.3314	1.3262	0.4806	-3.4145	0.9771 *	-0.0217	-0.7093	-0.4197
	[0.1785]	[0.3282]	[0.2669]	[0.9387]	[1.3764]	[6.6163]	[0.5120]	[1.3010]	[0.6941]	[1.0670]
Temperature <sub>t-9</sub>	-0.1343	-0.5600	0.4450 **	1.9973 **	0.2375	-3.3862	0.3395	-2.8273	-0.9518	-1.5171
	[0.2465]	[0.3276]	[0.2142]	[0.8023]	[1.3562]	[7.4578]	[0.8060]	[1.5976]	[0.9897]	[0.9047]
Temperature <sub>t-10</sub>	-0.2018	-0.9790 **	0.0948	1.8856	0.8055	-1.5552	1.8600 **	-0.5677	-0.4242	-1.0981
	[0.2238]	[0.2983]	[0.1563]	[1.0592]	[1.5109]	[7.6434]	[0.5802]	[0.9597]	[1.0523]	[1.2048]
Temperature <sub>t-11</sub>	0.1264	-0.4204	0.1678	2.0581	1.7869	-3.3564	0.5598	-0.2137	-1.0615	-1.3685
	[0.2119]	[0.3674]	[0.2061]	[1.2047]	[1.7935]	[7.8467]	[0.5878]	[1.5371]	[0.8227]	[1.2401]
Temperature <sub>t-12</sub>	0.0535	0.0259	0.3833 *	2.6338 **	0.7425	-3.0994	1.4463 **	-0.2194	-1.0011 *	-0.0499
	[0.1282]	[0.2507]	[0.1893]	[1.1856]	[1.4781]	[7.3760]	[0.5725]	[1.2692]	[0.5021]	[1.1940]
<i>Cumulative Precipitation (mm)</i>										
Precipitation <sub>t</sub>	-0.0045 *	0.0063	0.0000	-0.0033	0.0068	0.0106	0.0044	-0.0116	-0.0152	-0.0075
	[0.0024]	[0.0045]	[0.0038]	[0.0107]	[0.0097]	[0.0231]	[0.0129]	[0.0091]	[0.0114]	[0.0168]
Precipitation <sub>t-1</sub>	-0.0059 **	0.0068	-0.0037	0.0003	0.0020	0.0140	0.0007	-0.0001	-0.0203 *	0.0008
	[0.0028]	[0.0050]	[0.0027]	[0.0093]	[0.0104]	[0.0193]	[0.0150]	[0.0142]	[0.0115]	[0.0130]
Precipitation <sub>t-2</sub>	0.0034	0.0101 *	0.0052	0.0155	0.0070	0.0277	0.0048	0.0097	-0.0124	-0.0049
	[0.0029]	[0.0047]	[0.0040]	[0.0111]	[0.0134]	[0.0241]	[0.0197]	[0.0180]	[0.0115]	[0.0156]
Precipitation <sub>t-3</sub>	-0.0070 **	0.0095	0.0047	0.0196 *	-0.0014	0.0473	0.0015	0.0054	-0.0036	-0.0048
	[0.0031]	[0.0060]	[0.0040]	[0.0092]	[0.0112]	[0.0346]	[0.0182]	[0.0160]	[0.0155]	[0.0146]
Precipitation <sub>t-4</sub>	0.0018	0.0033	-0.0043	0.0276 **	0.0150	0.0482	0.0124	-0.0233	-0.0272 **	-0.0208
	[0.0055]	[0.0038]	[0.0038]	[0.0103]	[0.0171]	[0.0444]	[0.0139]	[0.0223]	[0.0130]	[0.0161]
Precipitation <sub>t-5</sub>	-0.0034	0.0063	0.0044	0.0214	0.0118	0.0454	0.0204	-0.0178	-0.0208	-0.0292
	[0.0030]	[0.0054]	[0.0053]	[0.0137]	[0.0231]	[0.0539]	[0.0202]	[0.0208]	[0.0148]	[0.0217]
Precipitation <sub>t-6</sub>	-0.0067 *	0.0009	-0.0021	0.0124	0.0187	0.0945	0.0122	-0.0379	-0.0400 **	-0.0328
	[0.0037]	[0.0086]	[0.0038]	[0.0138]	[0.0268]	[0.0650]	[0.0194]	[0.0261]	[0.0150]	[0.0214]
Precipitation <sub>t-7</sub>	-0.0103 ***	-0.0028	-0.0074	0.0287 *	0.0215	0.0948	-0.0013	0.0343	-0.0505 **	-0.0363
	[0.0027]	[0.0101]	[0.0044]	[0.0147]	[0.0283]	[0.0706]	[0.0194]	[0.0301]	[0.0177]	[0.0229]
Precipitation <sub>t-8</sub>	-0.0040	0.0052	-0.0016	0.0287 **	0.0173	0.1187	0.0118	-0.0261	-0.0291 **	-0.0414
	[0.0034]	[0.0098]	[0.0050]	[0.0094]	[0.0256]	[0.0771]	[0.0247]	[0.0374]	[0.0139]	[0.0315]
Precipitation <sub>t-9</sub>	-0.0087 **	0.0066	-0.0043	0.0327 **	0.0116	0.1104	0.0136	-0.0300	-0.0407 *	-0.0204
	[0.0033]	[0.0086]	[0.0051]	[0.0117]	[0.0263]	[0.0759]	[0.0275]	[0.0314]	[0.0229]	[0.0316]
Precipitation <sub>t-10</sub>	-0.0084 **	0.0066	0.0054	0.0507 **	0.0393	0.1123	0.0220	-0.0354	-0.0533 **	-0.0443
	[0.0027]	[0.0096]	[0.0042]	[0.0166]	[0.0347]	[0.0788]	[0.0280]	[0.0450]	[0.0214]	[0.0370]
Precipitation <sub>t-11</sub>	-0.0099 **	0.0044	-0.0036	0.0320 **	0.0107	0.1508	0.0282	-0.0562	-0.0677 **	-0.0232
	[0.0035]	[0.0118]	[0.0058]	[0.0120]	[0.0317]	[0.0730]	[0.0285]	[0.0390]	[0.0210]	[0.0336]
Precipitation <sub>t-12</sub>	-0.0072	0.0059	-0.0001	0.0452 **	0.0185	0.1554	0.0277	-0.0508	-0.0422 *	-0.0371
	[0.0045]	[0.0141]	[0.0049]	[0.0162]	[0.0352]	[0.0844]	[0.0315]	[0.0514]	[0.0215]	[0.0481]
Within R <sup>2</sup>	0.000	0.002	0.001	0.009	0.010	0.021	0.001	0.013	0.002	0.009
R <sup>2</sup>	0.025	0.032	0.035	0.067	0.135	0.148	0.053	0.074	0.034	0.057
Observations	396,242	94,971	46,113	6,842	4,926	1,231	20,678	3,132	16,098	5,828

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include: i) month-year fixed effects (FE); ii) establishments size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 and 3-digit NAICS for national and sector specifications, respectively, x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

**Table 14A (cont.) Service sectors 48-72: marginal cumulative effects of temperature and precipitation on real operative expend. for highly and low exposed municipalities**

Percentage points of growth per 1°C and 1 mm, respectively

Period	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.	Low Expos.	High Expos.
	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.	Municip.
	54 Professional, Scientific		56 Waste and Remediation		61 Education		62 Health		71 Arts, Entertainment		72 Accommodation, Food	
	Temperature 1°C											
Temperature <sub>t</sub>	1.0065 ***	1.3247	0.3763	1.0844 **	0.3763	-0.5841	0.5074	-0.3372	0.4278	-1.3278	0.3777 **	0.2360
	[0.2498]	[0.9557]	[0.4117]	[0.3667]	[0.4117]	[0.9329]	[0.4313]	[0.8015]	[0.6794]	[1.5857]	[0.1715]	[0.3194]
Temperature <sub>t-1</sub>	-0.1643	1.5258 *	-0.3614	0.6308	-0.3614	0.3887	-0.5936	-0.3912	-0.2046	0.3934	0.1831	0.2748
	[0.3090]	[0.8261]	[0.2871]	[0.7634]	[0.2871]	[0.9692]	[0.4094]	[0.5753]	[0.9153]	[1.5433]	[0.1181]	[0.2856]
Temperature <sub>t-2</sub>	0.2072	-0.2633	1.3471 ***	0.1117	1.3471 ***	0.1176	0.3810	-1.0777	0.6422	-2.4604	0.1721	0.1267
	[0.2358]	[0.8584]	[0.2304]	[0.6071]	[0.2304]	[0.5956]	[0.3608]	[0.9050]	[0.9518]	[1.7075]	[0.1383]	[0.3758]
Temperature <sub>t-3</sub>	0.3964	0.1871	-0.0510	0.8401	-0.0510	0.6922	0.4895	0.3359	-1.6477	-2.8345 *	0.2933 *	-0.7486 **
	[0.3292]	[0.7026]	[0.3817]	[0.7044]	[0.3817]	[0.6733]	[0.4188]	[0.7496]	[1.3967]	[1.3292]	[0.1585]	[0.2622]
Temperature <sub>t-4</sub>	-0.0206	0.3971	0.3217	-0.2350	0.3217	1.7360 **	-0.0860	-0.4788	-0.0911	-3.8347	0.1113	-0.4490
	[0.3712]	[0.6772]	[0.3722]	[0.7041]	[0.3722]	[0.7965]	[0.4546]	[0.8180]	[0.8286]	[2.3219]	[0.1854]	[0.2766]
Temperature <sub>t-5</sub>	0.4186	0.0264	0.1765	0.8752	0.1765	-0.1102	0.3084	-0.3631	0.1337	-3.0840	0.0740	-0.8209
	[0.4378]	[1.2372]	[0.3286]	[0.8027]	[0.3286]	[0.9815]	[0.3122]	[0.8418]	[1.1056]	[2.6894]	[0.2154]	[0.4854]
Temperature <sub>t-6</sub>	0.6407 *	1.3237	-0.4065	1.5948 *	-0.4065	-0.6481	0.0574	-1.7316 *	-0.3105	-3.9516 *	0.2112	-0.2207
	[0.3427]	[1.0762]	[0.3831]	[0.8656]	[0.3831]	[0.9456]	[0.5593]	[0.8911]	[1.1682]	[2.0898]	[0.1855]	[0.3972]
Temperature <sub>t-7</sub>	0.9203 **	1.3860 **	0.7452 *	1.3273 *	0.7452 *	0.7532	0.1336	-0.7080	-1.1336	-3.2973	0.4592 *	-0.4937
	[0.4267]	[0.4684]	[0.3887]	[0.6974]	[0.3887]	[0.4188]	[0.5638]	[0.9326]	[1.4599]	[2.2671]	[0.2441]	[0.5591]
Temperature <sub>t-8</sub>	1.0840 **	0.8808	-0.2981	0.5182	-0.2981	0.3129	0.4823	-0.8140	0.0992	-6.1691 **	0.2027	-0.4263
	[0.3910]	[0.9062]	[0.2889]	[1.1228]	[0.2889]	[1.1835]	[0.5187]	[1.1969]	[1.3075]	[1.9828]	[0.1528]	[0.3458]
Temperature <sub>t-9</sub>	0.3706	0.1985	-0.0444	0.0443	-0.0444	0.5390	0.4066	-0.1418	0.4620	-3.7574	0.2826	-0.7293
	[0.4222]	[0.7833]	[0.4535]	[0.9044]	[0.4535]	[1.0341]	[0.4587]	[0.9080]	[1.5133]	[3.3630]	[0.2044]	[0.4504]
Temperature <sub>t-10</sub>	-0.1175	-1.1205	0.1332	1.0972	0.1332	-0.1033	0.0278	-0.7287	-0.3906	-5.1021 **	0.1991	-1.0906 **
	[0.6389]	[1.1816]	[0.4758]	[1.3627]	[0.4758]	[0.9471]	[0.4944]	[1.0390]	[1.2483]	[2.1374]	[0.2232]	[0.3584]
Temperature <sub>t-11</sub>	1.1649 **	1.0277	-0.1970	1.0648	-0.1970	1.0526	1.1363	-0.9238	-0.2509	-4.7468 *	0.2266	-0.8087 *
	[0.4739]	[0.9671]	[0.3962]	[1.3231]	[0.3962]	[1.3477]	[0.4400]	[1.1189]	[1.2514]	[2.3806]	[0.2592]	[0.4090]
Temperature <sub>t-12</sub>	0.5470	0.7114	-0.3827	1.1051	-0.3827	-0.1324	0.2220	-0.3688	0.7248	-4.3986 **	0.1165	-0.1563
	[0.3685]	[0.7645]	[0.3183]	[1.1344]	[0.3183]	[0.8467]	[0.3701]	[0.7127]	[1.0565]	[1.7320]	[0.1410]	[0.4546]
	Cumulative Precipitation (mm)											
Precipitation <sub>t</sub>	-0.0053	0.0019	-0.0037	-0.0007	-0.0037	0.0139	-0.0007	0.0235 **	-0.0225	0.0087	-0.0086 *	0.0023
	[0.0064]	[0.0133]	[0.0119]	[0.0126]	[0.0119]	[0.0124]	[0.0072]	[0.0095]	[0.0213]	[0.0180]	[0.0044]	[0.0043]
Precipitation <sub>t-1</sub>	0.0023	0.0144	-0.0018	0.0088	-0.0018	-0.0059	-0.0188 **	-0.0008	-0.0156	-0.0003	-0.0074 *	0.0052
	[0.0095]	[0.0164]	[0.0098]	[0.0074]	[0.0098]	[0.0083]	[0.0077]	[0.0107]	[0.0199]	[0.0116]	[0.0038]	[0.0048]
Precipitation <sub>t-2</sub>	0.0221	0.0099	-0.0018	0.0226	-0.0018	0.0059	-0.0070	0.0038	-0.0207	-0.0011	-0.0007	0.0027
	[0.0134]	[0.0155]	[0.0091]	[0.0158]	[0.0091]	[0.0152]	[0.0089]	[0.0196]	[0.0229]	[0.0171]	[0.0050]	[0.0062]
Precipitation <sub>t-3</sub>	-0.0086	0.0278 *	-0.0089	0.0050	-0.0089	-0.0179 *	-0.0123	0.0050	-0.0363 *	0.0321	0.0006	0.0056
	[0.0183]	[0.0166]	[0.0084]	[0.0189]	[0.0084]	[0.0055]	[0.0087]	[0.0187]	[0.0288]	[0.0158]	[0.0044]	[0.0052]
Precipitation <sub>t-4</sub>	0.0176	-0.0137	-0.0008	0.0246	-0.0008	-0.0102 *	-0.0179 **	0.0078	0.0049	-0.0011	-0.0065	0.0001
	[0.0166]	[0.0253]	[0.0157]	[0.0195]	[0.0157]	[0.0089]	[0.0085]	[0.0189]	[0.0249]	[0.0153]	[0.0060]	[0.0058]
Precipitation <sub>t-5</sub>	0.0115	0.0041	-0.0174	0.0185	-0.0174	-0.0042	-0.0191 **	-0.0029	-0.0203	0.0353 **	-0.0048	-0.0001
	[0.0167]	[0.0237]	[0.0162]	[0.0234]	[0.0162]	[0.0274]	[0.0093]	[0.0200]	[0.0339]	[0.0260]	[0.0076]	[0.0086]
Precipitation <sub>t-6</sub>	0.0097	-0.0188	-0.0172	0.0236	-0.0172	-0.0222	-0.0120	0.0082	0.0130	-0.0103	-0.0087	-0.0017
	[0.0118]	[0.0270]	[0.0163]	[0.0232]	[0.0163]	[0.0195]	[0.0082]	[0.0137]	[0.0313]	[0.0233]	[0.0071]	[0.0080]
Precipitation <sub>t-7</sub>	0.0093	-0.0177	-0.0199	0.0203	-0.0199	-0.0213	-0.0328 **	-0.0066	0.0149	0.0061	-0.0069	-0.0070
	[0.0139]	[0.0248]	[0.0153]	[0.0290]	[0.0153]	[0.0188]	[0.0088]	[0.0178]	[0.0317]	[0.0259]	[0.0061]	[0.0093]
Precipitation <sub>t-8</sub>	0.0133	-0.0210	-0.0234	0.0335	-0.0234	-0.0143	-0.0262 **	0.0002	0.0203	0.0415	-0.0022	0.0021
	[0.0167]	[0.0327]	[0.0162]	[0.0234]	[0.0162]	[0.0274]	[0.0093]	[0.0200]	[0.0339]	[0.0260]	[0.0076]	[0.0086]
Precipitation <sub>t-9</sub>	0.0123	-0.0190	-0.0171	0.0263	-0.0171	-0.0316	-0.0287 **	-0.0052	0.0035	0.0496	-0.0085	0.0066
	[0.0184]	[0.0340]	[0.0195]	[0.0266]	[0.0195]	[0.0250]	[0.0078]	[0.0186]	[0.0322]	[0.0284]	[0.0062]	[0.0099]
Precipitation <sub>t-10</sub>	0.0135	-0.0201	-0.0236	0.0279	-0.0236	-0.0305	-0.0344 **	0.0038	0.0281	0.0773 *	-0.0106	0.0063
	[0.0155]	[0.0358]	[0.0184]	[0.0296]	[0.0184]	[0.0300]	[0.0098]	[0.0194]	[0.0280]	[0.0397]	[0.0062]	[0.0087]
Precipitation <sub>t-11</sub>	0.0169	-0.0026	-0.0256	0.0223	-0.0256	-0.0273	-0.0360 **	-0.0048	0.0117	0.0556	-0.0127 **	0.0053
	[0.0203]	[0.0350]	[0.0154]	[0.0275]	[0.0154]	[0.0273]	[0.0097]	[0.0192]	[0.0324]	[0.0356]	[0.0062]	[0.0095]
Precipitation <sub>t-12</sub>	0.0171	-0.0191	-0.0289	0.0225	-0.0289	-0.0278	-0.0304 **	-0.0026	0.0279	0.0731	-0.0094	0.0087
	[0.0207]	[0.0374]	[0.0194]	[0.0306]	[0.0194]	[0.0298]	[0.0101]	[0.0201]	[0.0370]	[0.0463]	[0.0060]	[0.0108]
Within R <sup>2</sup>	0.001	0.007	0.001	0.004	0.001	0.004	0.001	0.005	0.004	0.019	0.001	0.003
R <sup>2</sup>	0.044	0.074	0.024	0.050	0.024	0.033	0.017	0.043	0.042	0.128	0.035	0.090
Observations	85,227	9,006	56,540	10,794	56,540	8,693	28,578	7,997	12,728	3,548	64,636	37,900

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

The highly exposed municipalities are located in the following states: Baja California Sur, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, Puebla, Quintana Roo, Sinaloa, Tamaulipas, Veracruz and Yucatán.

All specifications include: i) month-year fixed effects (FE); ii) establishments size FE; iii) subsector (3-digit NAICS) FE; iv) state FE, v) low-exposed municipalities FE; vi) 2 and 3-digit NAICS for national and sector specifications, respectively x year FE; vii) year x month FE; viii) state x year FE. Robust standard errors are in brackets, adjusted for state clustering, so standard errors are robust to spatial correlation by state. \*\*\* Significant at the 1 percent level. \*\* Significant at the 5 percent level. \* Significant at the 10 percent level.

## Appendix B

### Estimation of the lag length in the distributed lag model selection

In this section, we show the Bayesian (BIC) and Akaike information (AIC) criteria as well as the Hannan and Quinn information criterion (HQ) to select the optimal lag specification. The specification with the lowest BIC and AIC criteria is the selected one, (see Maddala, 2009). All other results are available upon request to the authors.

**Table 1B. Dependent Variable Volume Production Index, 1994-2017**

National					National Low-exposure Municip.					National High-exposure Munic.				
Lags	Obs.	AIC <sub>corr</sub>	BIC	HQIC	Lags	Observ.	AIC <sub>corr</sub>	BIC	HQIC	Lags	Observ.	AIC <sub>corr</sub>	BIC	HQIC
1	753,420	1,383,418	1,390,694	1,505,273	1	714,402	1,442,641	1,449,883	1,441,440	1	63167	134216	139907	132994
2	753,420	1,383,417	1,390,727	1,505,288	2	710,859	1,434,261	1,441,512	1,433,084	2	62842	133606	139303	132399
3	749,617	1,375,810	1,383,129	1,497,365	3	707,332	1,426,776	1,434,035	1,425,614	3	62514	132908	138610	131715
4	745,813	1,367,828	1,375,155	1,488,715	4	703,797	1,418,684	1,425,951	1,417,541	4	62179	132184	137892	131007
5	741,992	1,359,947	1,367,282	1,480,138	5	700,248	1,410,463	1,417,738	1,409,344	5	61848	131476	137190	130313
6	738,197	1,351,419	1,358,763	1,471,132	6	696,730	1,402,116	1,409,400	1,401,025	6	61524	130613	136332	129467
7	734,445	1,342,335	1,349,687	1,461,465	7	693,257	1,393,140	1,400,432	1,392,081	7	61205	129679	135403	128553
8	730,707	1,333,694	1,341,054	1,452,485	8	689,785	1,384,563	1,391,863	1,383,519	8	60885	128897	134627	127786
9	727,002	1,325,675	1,333,043	1,443,495	9	686,334	1,375,987	1,383,295	1,374,957	9	60576	128117	133853	127025
10	723,322	1,318,148	1,325,524	1,435,239	10	682,899	1,368,302	1,375,618	1,367,289	10	60270	127208	132949	126131
11	719,640	1,310,564	1,317,948	1,427,061	11	679,480	1,360,707	1,368,032	1,359,722	11	59948	126445	132192	125382
12	<b>715,977</b>	<b>1,301,995</b>	<b>1,309,365</b>	<b>1,418,308</b>	12	<b>676,072</b>	<b>1,352,222</b>	<b>1,359,533</b>	<b>1,351,264</b>	12	<b>59633</b>	<b>125675</b>	<b>131409</b>	<b>124631</b>

Source: Estimated by authors based on the Monthly Industrial Survey (1994-2005), the Extended Monthly Industrial Survey (2005-2006), and the Monthly Survey of Manufacturing Industry class (2007-2017).

**Table 2B. Dependent Variable Revenue Index Total Sample, 2008-2015**

National					National Low Exposure Municip.					National High Exposure Municip.				
Lags	Observations	AIC <sub>corr</sub>	BIC	HQIC	Lags	Observations	AIC <sub>corr</sub>	BIC	HQIC	Lags	Observations	AIC <sub>corr</sub>	BIC	HQIC
1	515102	-6220793	-6217794	-6220722	1	415630	-5128463	-5125533	-5128476	1	99472	-1142467	-1139920	-1142831
2	509364	-6148233	-6145225	-6148098	2	411007	-5068148	-5065209	-5068070	2	98357	-1129433	-1126880	-1129775
3	503593	-6074774	-6071758	-6074552	3	406356	-5008281	-5005334	-5008102	3	97237	-1115874	-1113315	-1116189
4	497798	-6001873	-5998850	-6001553	4	401674	-4947343	-4944389	-4947084	4	96124	-1102473	-1099907	-1102750
5	492003	-5862865	-5859826	-5927461	5	396994	-4835558	-4832588	-4886578	5	95009	-1075752	-1073174	-1088907
6	486509	-5798204	-5795157	-5862392	6	392548	-4783384	-4780407	-4835137	6	93961	-1063346	-1060761	-1075959
7	481034	-5724598	-5721543	-5797692	7	388117	-4723260	-4720275	-4782961	7	92917	-1049740	-1047149	-1063500
8	475265	-5798204	-5795157	-5724046	8	383466	-4783384	-4780407	-4722807	8	91799	-1063346	-1060761	-1049870
9	469472	-5724598	-5721543	-5651167	9	378796	-4723260	-4720275	-4662263	9	90676	-1049740	-1047149	-1036593
10	463692	-5651705	-5648642	-5598921	10	374139	-4662739	-4659746	-4630399	10	89553	-1036466	-1033870	-1022712
11	457954	-5599411	-5596340	-5525880	11	369519	-4630800	-4627800	-4570838	11	88434	-1022599	-1019996	-1008913
12	452231	-5526423	-5523344	-5453375	12	364913	-4571257	-4568249	-4511013	12	87318	-1008838	-1006229	-995702

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).

**Table 3B. Dependent Variable Real Operative Expenditures Total Sample, 2008-2015**

National					National Low Exposure Municip.					National High Exposure Municip.				
Lags	Observations	AIC <sub>corr</sub>	BIC	HQIC	Lags	Observation	AIC <sub>corr</sub>	BIC	HQIC	Lags	Observations	AIC <sub>corr</sub>	BIC	HQIC
1	566449	1010726	1013751	1010248	1	457042	842836	845793	842347	1	109407	162193	164765	161716
2	559586	995300	998333	994853	2	451495	830031	832995	829564	2	108091	159645	162224	159187
3	552730	980089	983130	979678	3	445951	817372	820344	816928	3	106779	157182	159767	156746
4	545872	964368	967416	963976	4	440403	804285	807244	803843	4	105469	154653	157244	154238
5	539016	933473	936537	948272	5	434881	779258	782253	791051	5	104155	148624	151227	151314
6	532155	917887	920958	933139	6	429309	766399	769401	778879	6	102846	145947	148556	148249
7	525334	902367	905447	917594	7	423796	753499	756509	766044	7	101538	143392	146008	145601
8	518510	917887	920958	902100	8	418281	766399	769401	753171	8	100229	145947	148556	143075
9	511679	902367	905447	886963	9	412763	753499	756509	741105	9	98916	143392	146008	139861
10	504858	887213	890300	873446	10	407257	741415	744431	730066	10	97601	140166	142787	137335
11	498025	873664	876758	859864	11	401740	730358	733381	718988	11	96284	137611	140238	134800
12	491213	<b>860044</b>	<b>863146</b>	<b>843676</b>	12	<b>396242</b>	<b>719263</b>	<b>722294</b>	<b>705705</b>	12	<b>94971</b>	<b>135042</b>	<b>137674</b>	<b>131964</b>

Source: Estimated by authors based on the Monthly Services Survey (2008-2015).