International Labour Organization

ILO Working Paper 26

March / 2021

Hurricanes and their implications for unemployment: Evidence from the Caribbean

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ISBN: 978-92-2-033585-7 (print)
ISBN: 978-92-2-033586-4 (web-pdf)
ISBN: 978-92-2-033587-1 (epub)
ISBN: 978-92-2-033588-8 (mobi)
ISSN: 2708-3446

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Authorization for publication: Dennis Zulu, Director

ILO Working Papers can be found at: www.ilo.org/global/publications/working-papers

Suggested citation:
Mohan, P., Strobl, E. 2021. *Hurricanes and their implications for unemployment: Evidence from the Caribbean*, ILO Working Paper 26 (Geneva, ILO).

Abstract

Although extreme climate events pose significant challenges to labour markets, there is a paucity of empirical literature studying their impacts. The aim of the study is to investigate the impact of hurricane strikes on unemployment across a sample of Caribbean countries. To do so we constructed a country- and time-varying database of unemployment, hurricane damages, and labour legislation. We then applied a time series cross section model to estimate the contemporaneous and lagged impacts of hurricane destruction. The role of country differences in labour legislation in dampening or exacerbating these effects, was also investigated. Our results suggest that hurricanes in the Caribbean have a downward impact on unemployment, with lagged impacts of up to four years after a disaster strikes. Part of the reason for this fall was a decline in labour force participation rate, however, there was no evidence that greater employment or migration played a role. In breaking down the unemployment data, our findings demonstrate that there is very little difference in the impact for adult males and females as well as male youth, however female youth may be slightly more disadvantaged. Finally, labour legislation appears to provide some mitigating impact from hurricane strikes.

About the authors

Eric Strobl is currently a Professor in Climate and Environmental Economics at the University of Bern. He is also a part-time Research Professor at the University of Birmingham and an External Professorial Fellow at the Sir Arthur Lewis Institute of Social and Economic Studies (SALISES) (Trinidad and Tobago). He holds a PhD from Trinity College Dublin, an MA from Georgetown University, and a BA from Pennsylvania State University. Previous employment includes posts at Trinity College Dublin, The University of the West Indies, University College Dublin, Universite Catholique de Louvain, University Paris X, Ecole Polytechnique, and Universite Aix-Marseille. He has published widely on topics related to the interaction between the natural environment and the economy, labour market functionings, industrial policy, and foreign direct investment. A particular focus of his recent research has been how extreme climate events, such as hurricanes, have affected Caribbean economies. His research has been published in over 130 international academic journal articles. He has also undertaken consultancy for the Irish Government, the Trinidad and Tobago Government, the International American Development Bank, and the World Bank.

Preeya Mohan is a Fellow at the Sir Arthur Lewis Institute of Social and Economic Studies (SALISES), the University of the West Indies, St. Augustine Campus. As a graduate of SALISES, with a PhD in Economic Development Policy (high commendation), she is an applied economist, skilled in the use of sophisticated econometric methods, and more generally, in data analysis. She has conducted research on, and is widely published in a range of topics that focuses around Caribbean growth and sustainable development including, natural disasters and climate change, diversification, innovation and knowledge economies, debt and public finance, and entrepreneurship. Food Policy, Entrepreneurship and Regional Development, Ecological Economics, and the International Journal of Disaster Risk Science are some of the international peer reviewed journals in which she has published.

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Introduction

Notwithstanding the widespread destruction brought about by extreme climate events on Gross Domestic Product (GDP) growth, the empirical evidence on their economic impact remains ambiguous.[1] These storms may lead to a reduction in the labour supply through the displacement of workers, migration to seek better living conditions, as well as the loss of life. However, labour demand could actually increase due to clean-up, recovery, and reconstruction activities, and from GDP growth as a result of the re-investment, replacement and upgrading of capital,[2] and there may even be a substitution effect towards human capital accumulation.[3] In the aftermath of a disaster strike, labour is an important factor that impacts productivity growth, and consequently, economic growth.[4] Nevertheless, there is a paucity of empirical evidence on the impact of natural disasters on the labour market. Moreover, the handful of existing studies, mainly for developed countries, provide ambiguous results on the impact.

The contrasting results of natural disasters on employment may however, not be surprising. The severity and nature of the impact of natural disasters depend on a range of factors, namely: the prevailing labour market conditions; the type and frequency of disaster experienced; the country's economic structure and policy and institutional environment; the level of economic development and the level of disaster preparedness and availability of formal and informal risks sharing mechanism.[5] In this paper, we have added to the limited literature available on the impact that natural hazard-induced disasters have on employment by studying hurricane strikes in Caribbean Small Island Developing States (SIDS).

Caribbean SIDS are a particularly fitting case study. Their economic and geographic characteristics, including their small size and location in the Atlantic hurricane belt, as well as their highly specialized economic structures and openness to external shocks, make them especially vulnerable to tropical storms,[6] along with their limited financial, human and institutional capacities for disaster prevention and mitigation.[7] In fact, the region is among the most disaster-prone in the world on account of the large number of hurricane strikes experienced, as well as hurricane damages equivalent to more than two per cent of GDP can be expected every two and a half years.[8] Moreover, there is growing evidence of increasing frequency and intensity of extreme weather events across the region, making their future potential destructive impact even greater.[9]

Caribbean SIDS face high and rising unemployment rates, particularly among vulnerable groups, although in recent times there has been some improvement. Labour markets continue to be affected by the current slowdown in regional economic growth and negative external shocks, together with the emigration of skilled labour, low levels of productivity, inadequate labour market information and a lack of harmonization of labour legislation. Moreover, labour market trends remain uncertain, and there is an urgent need to increase the speed at which the region generates more and better jobs.[10]

The average unemployment rate stands at 10.5 per cent.[11] The region faces high and rising unemployment levels among women and youth. The youth unemployment rate stands at 25 per cent versus an adult rate of 8 per cent,[12] and a female unemployment rate of 10 per cent compared to 7.3 per cent for males.[13]

1 Albala-Bertrand 1993; Skidmore and Toya 2002; Anbarci et al. 2005; Kahn 2005; Noy and Nualsri 2007; Raddatz 2007; and Noy 2009.
2 Horwich 2000.
3 Skidmore and Toya 2002.
4 Tol and Leek 1999; Crespo-Cuaresma et al. 2008; Okuyama 2003; and Skidmore and Toya 2002.
5 Hochrainer 2009; and Loayza et al. 2009.
6 Pelling and Uitto 2001; and Rasmussen 2004.
7 Kirton 2013.
8 Rasmussen 2004.
9 IPCC 2007; and Elsner et al. 2008.
10 ILO 2018.
11 World Bank 2019.
12 Caribbean Development Bank 2015
13 World Bank 2019.

Furthermore, most social protection systems in the Caribbean are inadequately prepared to respond to natural disasters and mainly take the form of public employment programmes and cash payments, with particular consequences for the poor and vulnerable.[14]

Informed policy making requires an expansion of research on labour markets and extreme weather events to improve labour market resilience, that is, the labour market's ability to resist, withstand or quickly recover from shocks, which is paramount to the survival of Caribbean island economies. This paper aims to investigate the impact of hurricane events on unemployment in the Caribbean, along with the intermediary role played by labour market institutions, social protection and legislation. The paper constructed a country- and time-varying database of unemployment, hurricane damages, and labour legislation and used a panel data econometric approach. The empirical model allowed us to estimate the contemporaneous, as well lagged impacts of extreme hurricane events, and the role of country differences in labour legislation / institutions in dampening or exacerbating these effects.

The rest of the paper is organized as follows:

1. Section 2 provides an overview of the literature;
2. Section 3 describes the various data sources used;
3. Section 4 provides the hurricane destruction modelling;
4. Section 5 outlines the empirical model used;
5. Section 6 gives the results of our empirical analysis; followed by
6. Conclusions.

[14] CCRIF 2019.

1 Foreword

In keeping with the ILO's longstanding commitment to enhance and strengthen labour market resilience in the Caribbean, the ILO Decent Work Team and Office for the Caribbean launched the Caribbean Resilience Project in 2019. A multi-disciplinary programme of targeted technical support for ILO Caribbean member States, the Caribbean Resilience Project is anchored by two important framework documents acceded to by ILO's constituents in recent years, namely: The 2015 Guidelines for a just transition towards environmentally sustainable economies and societies for all and ILO Recommendation No. 205 , 2017 (R205). Among the Project's stated objectives is "increasing the availability of empirical information and data, practical and suitable tools to facilitate policy development, decision-making and intervention design to support resilience" and "improving the capacity of governments, employers' organization and trade unions to develop and implement actions for climate change adaptation and greening of the economy".

As part of this undertaking, the ILO collaborated with the Sir Arthur Lewis Institute of Social and Economic Studies (UWI, St. Augustine Campus) and the Inter-American Development Bank (IADB) to launch a competitive call for research proposals. Among key criteria for the final selection was the potential and expectation that the proposed research would contribute to the expansion of the Caribbean knowledgebase and provide evidence-based policy recommendations for the promotion of the Decent Work Agenda.

The present paper, authored by Drs Preeya Mohan and Eric Strobl, originally fits into a large - but virtually absent from the Caribbean - body of literature on labour market institutions and labour market performance. It explores original interactions between extreme weather events, labour market outcomes, provides an originally constructed index of employment protection for the Caribbean, and befittingly combines meteorological and labour market data into a single, specific analysis.

I wish to thank the authors for their commitment and contributions. I also convey thanks to the technical panel composed of Dr Massimiliano la Marca and Mr Diego Rei from the ILO, and Dr Diether Beuermann Mendoza from the IADB, for the assistance provided and the peer review.

While the challenges to research on labour market and extreme weather events are sizable in the Caribbean, the research produced in the present paper is an important step in the right direction. The ILO remains fully committed to continue supporting the drive for knowledge generation as tools to develop and strengthen the long-term resilience of the Region, to the benefit of the Caribbean people.

Dennis Zulu, Director, ILO Decent Work Team and Office for the Caribbean

2 Literature overview

Labour markets and natural disasters

In a series of papers, Ewing et al. (2003; 2004; and 2009) specifically investigated tornadoes strikes and employment growth in the United States (US) using pre and post event time series data together with an intervention model. According to the studies, it is a matter of practical importance for policymakers to understand how the local economy reacts to natural disasters. They used the labour market mean growth rate and volatility to measure regional economic activity, given the link between employment and production. The studies estimated time series models that allow for time-varying variance in employment growth that include two intervention variables to capture the tornado's initial and post-tornado impacts. Also, the authors took into account two important determinants of the employment growth rate in Oklahoma City - the overall state of employment growth rate and past changes in the city's employment growth rate. More specifically, Ewing et al. (2003) examined the 28 March 2000 tornado in Fort Worth, Texas, and found that the aggregate labour market experienced a decline in employment growth in the post-tornado period, together with the service, wholesale, and retail trade sectors, while the mining sector experienced a significant increase in employment growth. Following this, Ewing et al. (2004) examined changes in Nashville's labour market following the 16 April 1998 tornado and presented evidence that employment growth significantly increased in the transportation and public utilities sector, and decreased in finance, insurance, and real estate sectors. In a later study, Ewing et al. (2009) then probed the impact of the 3 May 1999 tornado on the Oklahoma City and found an increase in total employment growth following the disaster.

In a more comprehensive analysis of tornadoes in the US, Riesing (2018) used a generalized difference-in-difference approach and quarterly data from 1975 to 2016. Apart from a tornado strike, other factors that may affect local labour markets are controlled for including the impact of state business cycles, the spillover effects from counties that experienced a tornado, and the seasonal component of employment. The results uncovered no significant change in employment growth of a directly affected county for a two-year duration subsequent to the disaster. However, labour demand due to reconstruction efforts surpassed supply and led to a rise in wages, with stronger tornadoes having a larger impact. According to the author, the fall in employment growth may be because of potential out-migration and a fall in labour supply, while recovery and reconstruction efforts apply positive pressure on labour demand, leading to an insignificant change in employment and wage growth.

Belasen and Polachek (2008; and 2009) also used a generalized difference-in-difference method to compare changes in employment and earnings between counties hit and not hit by hurricanes in Florida. The results revealed a demand shock where employment decreased by 4.76 per cent and earnings increased by 4.35 per cent in counties directly affected. However, neighbouring counties faced an increased labour supply and decreased earnings of up to 4.5 per cent, with more severe storms having larger effects that lasted up to two years after the strike. Furthermore, employment in the construction and service sectors was positively affected, while employment in manufacturing, trade, transportation, and utility and finance, investment, and real estate, was negatively affected. The difference in results between individual sectors and aggregate labour market may be driven by the heterogeneity of the county-level labour market, where certain counties are more agrarian, industrialized counties or service oriented in that region.

In a study of floods in US municipalities, Sarmiento (2007) adopted panel data techniques and showed a decrease in employment in affected municipalities - by 3.4 per cent on average - while employment levels recovered after one year of the disaster occurrence. Leither et al. (2009) investigated the impact of floods on firms' employment growth in Europe using a difference-in-difference approach. The results suggest that firms in regions hit by flood showed, on average, a higher growth in employment than firms in regions that were unaffected. There was also greater positive effects for firms with larger shares of intangible assets such as research and development, patents, software, and trademarks. Focusing on the 6 April 2009 earthquake in L'Aquila, Italy, Pietro and Mora (2015) used quarterly data and a difference-in-difference estimator and concluded that there was a modest decline in the probability of participation in the labour force for a period of nine months after the disaster struck; while the employment likelihood initially fell, it increased in the next four quarters.

Garzón (2017) studied Jamaica to determine the causal effect of tropical storms and hurricanes on the probability of men in formal employment being pushed into informal employment. The empirical model estimated the variation arising from the storms' timing, intensity, and geographic locations within a panel random-effects endogenous choice model framework, and controlled for potential biases due to initial conditions, panel attrition, and employment selection, along with age, education, occupation and rural or urban location. The findings suggest that storms do not affect unemployment and positively affect the transition to informality probability, regardless of whether the individual was initially employed in a formal or an informal job. The probability of becoming informally employed ranged between 8.5 and 14.5 per cent depending on the employee's initial state at the time when storms occurred. Furthermore, the effects were mainly driven by the impact of hurricanes on the services sector.

Labour market institutions and legislation

The theoretical literature suggests that labour market institutions and legislation can have a positive or negative effect on the labour market. Labour market institutions can reduce labour market flexibility by forming wage and employment rigidities which distort price and wage setting mechanisms.[15] On the other hand, institutions that influence the reservation wage and job search intensity impact the adjustment process and may improve labour market outcomes through information dissemination and coordination.[16] The empirical evidence on employment and labour market legislation and institutions is similarly ambiguous and is provided by Scarpetta 1996; Bassanini and Duval 2006; Eichhorst et al. 2010; Gal and Theising 2015; and Bertola 2017. See Boeri and Van Ours (2013) for a detailed overview of the theoretical and empirical literature on unemployment and labour market institutions and legislation.

There are several labour market institutions with differential impacts. For instance, the unemployment insurance system increases the equilibrium unemployment rate. Unemployment protection changes the nature of unemployment, but has an ambiguous effect on the equilibrium unemployment rate. Employment protection decreases the number of workers entering the labour market, thereby increasing the duration of unemployment, and results in a higher proportion of long-term unemployment. Components of the tax wedge, such as payments for health benefits and retirement, do not have much effect on the rate or on the nature of unemployment and their incidence, and their effect is therefore minimal.

In terms of natural disasters, labour market institutions influence the transmission of external shocks by initially affecting the intensity of the shock on the labour market, and later, the adjustment process back to a steady-state level. Labour market institutions that influence job search intensity and the reservation wage of the unemployed affect only the adjustment process of the labour market back to the steady-state level after economic turbulence. The likelihood of taking up a job decreases when unemployment benefits are higher and when benefit entitlements are longer, since these factors lower the incentives to search for work. At the same time, due to lower opportunity costs of unemployment, a generous unemployment insurance pushes up the reservation wage. Employment protection legislation affects both the initial impact of an economic shock as well as its persistence on the labour market.

[15] Layard et al. 2005; and Blanchard and Wolfers 2000

[16] Traxler and Kittel 2000.

In the Caribbean, labour market legislation and institutions increase non-wage labour costs and further constrain labour market efficiency.[17] Social partnerships, which involve tripartite discussions among government, labour unions and employer associations, and regulations and institutions to protect workers' rights, are dominant in labour market arrangements and wage setting in the region.[18] The use of non-wage benefits makes the wage series inadequate to measure the degree of rigidity in Caribbean labour markets. Studies on wage indices in the Caribbean suggest a lower degree of labour market rigidity, but did not factor in non-wage labour costs.[19] Also, the high share of government employment of the labour force is a source of inflated wages and associated benefits for public civil servants. In addition, the wage setting of public servants may have forced a parallel accommodation in the private sector at the expense of increasing unemployment and informality. Downes et al. (2004) and Strobl and Walsh (2003) have documented inefficiencies of regulations and institutions for high levels of unemployment and constraints on the functioning of labour markets in the Caribbean. Many of the regulations are worthy of revision to increase labour mobility and labour market efficiency.

17 Kandil et al. 2014.
18 Kandil et al. 2014.
19 Rama 1995; and Marquez and Pages 1998.

3 Data and summary statistics

We compiled annual data sets for unemployment, hurricane destruction, and labour legislation for 14 Caribbean Small Islands Developing States (SIDS) over the period 1993 to 2014. More specifically, the four main data sets used were:

1. Time - and country varying longitudinal data on unemployment;
2. Time - varying local data on economic asset and population exposure;
3. Time - and country-varying longitudinal local data on hurricane events;
4. Time - and country-varying measures of labour market legislation.

A panel data econometric model was then constructed and estimated.

Unemployment, employment, labour force participation, and migration

Unemployment data was mainly taken from the World Bank's World Development Indicators (WDI) database. The database gives several estimates including national estimates from domestic Central Statistical Offices (CSOs) and the International Labour Organization (ILO) modelled estimates. In particular, ILO model estimates were used when national estimates were not available. Total unemployment rates were collected including youth unemployment and unemployment by gender. The unemployment rates were verified and missing observations filled in using other sources including the ILO Statistics (ILOSTAT) database (modelled estimates) and national sources, such as local CSOs and Central Banks. We similarly also constructed employment and labour force participation rates from these sources. To construct migration rates we followed Spencer and Urquhart (2018), and used migration to the US as a proxy for total migration. More specifically, these data come from the 1996–2006 Yearbook of Immigration Statistics, published by the US Department of Homeland Security, and are normalized by the population figures taken from the WDI database.

Exposure

It is now well established in the literature that tropical storms are inherently local in nature, where even distances of a few kilometres can make a big difference in their impacts.[20] This ultimately makes taking account of the differences in local exposure an important task in constructing country level measures of potential hurricane destruction. Unfortunately, statistical data on the distribution of economic assets or population over space and time for most countries is scarce, particularly for the Caribbean. There is wide literature that in the face of a lack of alternative proxies, nightlight can serve as a reasonable proxy of countries' GDP.[21] In terms of the VIIRS data, Li et al. (2013) showed that the derived nightlight images are highly correlated with regional GDP, capturing nearly 90 per cent of their variation. However, at the same time, it is likely that brightness at night better captures construction and the services sector, such as tourism, but to a lesser extent, agriculture. We thus followed a growing literature which states that population exposure within countries can be approximated using satellite derived nightlight data. Verification exercises were conducted to ensure that these are indeed correlated with GDP and population across the Caribbean.

[20] Bertinelli and Strobl 2013.
[21] Chen and Nordhaus 2011; and Henderson et al. 2012.

To derive local exposure weights we, as in Elliott et al. (2015), used DMSP and VIIRS nightlight intensity data, available at resolutions between 750-1000 m, as proxies. More specifically, we used measures of local nightlight intensity derived from the DMSP-OLS satellite, which provides normalized (vary between 0 and 63) annual nightlight intensity across the globe at roughly one km grid cell level size. The sample period for which these data are available is 1993 to 2013, however, we linearly interpolated these back to 1987 and forward to 2014 in order to be able to create weights, and thus allow for lagged effects for up to five years after a storm, without reducing our sample as restrained by the unemployment data.

Hurricane destruction

Hurricane destruction was modelled in the spirit of Strobl (2012), which entailed using tropical storm tracks available from the National Hurricane Centre (NHC) HURDAT database, and employing a tropical storm wind field model that is able to estimate maximum wind speeds at any point relative to the storm, together with a damage function (using nightlight data) to proxy local damages. The HURDAT data provides hurricane track data on all known storms in the North Atlantic Ocean Basin since 1850. For each storm, the database provides information on the time and location of the hurricane eye and the maximum wind speed for every six-hour interval of the storm's lifespan. We linearly interpolated these to three hourly positions. These wind measures were then used within a damage function to proxy local damages for each storm across the Caribbean. In conjunction with the exposure data, the wind measures allowed for the construction of country wide hurricane destruction indices.

Labour legislation

In order to construct country level, time-varying indicators of relevant labour legislation, the ILO's National Labour, Social Security and Related Human Rights Legislation (NATLEX) database was used to create a set of country level indicators concerning unemployment assistance, minimum wages, and employment protection, that arguably might affect resilience or persistence of unemployment as a result of damaging hurricane events. The database provides records of full texts and/or abstracts of legislation and citation information. In using them in our regression analysis, we create indicator variables that determine whether a country is above the mean level of legislation or not. This reduces the amount of correlation among them to less than 0.25 per cent.

Summary statistics

After compiling our available unemployment, hurricane and labour legislation data, we were left with a slightly unbalanced sample from 13 Caribbean countries (Antigua and Barbuda, The Bahamas, Belize, Barbados, Cuba, Dominica, The Dominican Republic, Grenada, Jamaica, Haiti, Saint Lucia, Trinidad and Tobago, and Saint Vincent and the Grenadines), over a period of 1993 to 2014.[22] We provided summary statistics for all our variables in Table 1. As can be seen, the mean unemployment rate is high in these Caribbean nations, on average, 12.1 per cent. However, this varies considerably with the lowest (1.6 per cent) observed unemployment in Cuba and the highest (26.9 per cent) in Grenada in 1994. Alarmingly, compared to the total population, youth unemployment in the region is on average more than double. The average female unemployment in our sample was about 4 percentage points higher than that of their male counterparts, whereas this figure is about 8 percentage points for the youth.

The employment rate in our Caribbean islands sample is on average 56 per cent, with some countries having as much as 75 per cent employed, and others as little as 36 per cent. Total mean participation rate is

[22] All countries except Antigua and Barbuda, The Dominican Republic and Grenada, have 22 years of data, while these nations have 3, 7, and 12 years of data, respectively.

64 per cent, but with a standard deviation of 5 percentage points. We also find that migration (to the US) is 0.4 per cent annually; however, this can be as high as 1.1 per cent.

Examining our hurricane destruction index shows that on average, a destruction rate of about 6.5 per cent annually of exposed assets, as measured by our nightlights and under our assumed damage function, demonstrating the importance of the impact of hurricanes in the region. When a hurricane occurs, it destroys about 10 per cent, but this can be as large as 81.2 per cent, the latter of which was found for Grenada due to Hurricane Ivan's impact in 2004.

The degree of labour legislation also differs across the Caribbean countries in our sample, where the average index is about 6.8, with a high of 12.8 (Barbados) and a low of 0.6 (Saint Vincent and Grenadines). Looking specifically at the legislation that are likely to be most relevant in terms of absorbing or encouraging labour market reactions to hurricanes, the raw figures show that there is considerable variation across countries both in terms of employment protection legislation and social security related existing laws. In terms of employment protection, workers are most protected as well as the most extensive social security legislation exists in Barbados, while social security protection is lowest in the the Dominican Republic and Saint Vincent and the Grenadines. Workers are offered the lowest employment security legal protection in Antigua and Barbuda, The Bahamas, Dominica, the Dominican Republic, Grenada, Haiti, and Saint Vincent and the Grenadines.

Table 1: Summary statistics

Variables	Mean	Standard deviation	Minimum	Maximum
UR: All	0.121	0.058	0.016	0.269
UR: Male	0.103	0.057	0.013	0.226
UR: Female	0.144	0.065	0.019	0.370
UR: Youth	0.247	0.109	0.033	0.466
UR: Youth male	0.212	0.104	0.032	0.441
UR: Youth female	0.293	0.123	0.033	0.588
H	0.065	0.148	0.000	0.812
$H \neq 0$	0.104	0.175	0.001	0.812
ER: All	0.562	0.056	0.361	0.758
LFPR: All	0.641	0.056	0.517	0.751
MR: All	0.004	0.002	0.001	0.011
L: General	6.779	3.728	0.609	12.783
L: Employment protection	3.590	6.464	0.000	22.000
L: Social security	27.810	24.530	0.000	86.000

Source: Authors' calculations.

4 Hurricane destruction modelling

As noted by Emanuel (2011), both the monetary losses of hurricanes as well as the power dissipation of these storms tend to rise roughly as the cube of the maximum observed wind speed rises. Consequently, he proposed a simplified power dissipation index that can serve to measure the potential destructiveness of hurricanes, which proxies the fraction of property damaged as a function of wind speed exposure, *v*:

$$H_{jk} = \frac{v_{jk}^3}{1 + v_{jk}^3}$$

(1)

where

$$v_{jk} = \frac{MAX\left[\left(W_{jk} - W_{thresh}\right), 0\right]}{W_{half} - W_{thresh}}$$

(2)

where W_{jk} is the maximum wind experienced at point *j* due to storm *k*; W_{thresh} is the threshold below which no damage occurs; and W_{half} is the threshold at which half of the property is damaged. Given the maximum wind speed, the functional form in (2) will depend on the choice of parameters W_{thresh} and $W_{half.}$ Emanuel (2011) notes that for W_{thresh} there is unlikely to be any damage for winds below 92 kilometre per hour; we also employed this cut-off point. For W_{half} we again follow Emanuel (2011) and use 203 km/hr.

Since (2) will be measured at points within countries and assets/population are unlikely to be homogenously distributed within these, we also need to take account of the differences in exposure when generating a country wide proxy of destruction. We also assumed that damages are cumulative across storms within a year *t*. Thus our country level potential destruction proxy is:

$$f_{it} = \Sigma_{k\epsilon t} \Sigma_{j=1}^{N} weight_{ijt-1} f_{ijk}$$

(3)

where $weight_{ikt-1}$ is the share of population at point *j* in year *t-1* of all points *N* in country *i*. We explicitly use the weight at *t-1,* rather than *t,* so as to avoid that our weights are influenced by the hurricane shocks and thus are potentially endogenous. One should note that *f*, in essence, measures the percentage of property destroyed, broadly defined. In order to operationalize (3), we thus need to have the measure of the local wind speed for each storm and a local exposure weights within countries.

Destruction due to tropical storms was traditionally measured using ex-post damage estimates, as, for instance, reported in the Emergency Events Database (EM-DAT); or fairly generic characteristics of hurricanes, such as a dummy variable for the incidence of landfall or total maximum wind speed.[23] However, these measures can produce biased results because of data quality issues and endogeneity concerns.[24]

[23] Loayza et al. 2009; Hochrainer 2009; Noy 2009; Raddatz 2007; Noy and Nualsri 2007; Rasmussen 2004; Skidmore and Toya 2002; and Albala-Bertrand 1993.

[24] Felbermayr and Groeschl 2013.

The more recent literature instead explicitly models damages in terms of the physical characteristics of a storm, as well as ex-ante economic exposure to damage. We followed the approach of Strobl (2012*)* by estimating the localized wind speeds using actual hurricane tracks and a wind field model was applied. The wind experienced due to hurricane *k* at any point *j*, i.e., W_{jk} during a storm is given by:

$$W_{j,k} = GF\left[V_k^{max} - S(1 - sin(T_{i,k}))\frac{V_k^h}{2}\right]\left[\left(\frac{R_k^{max}}{R_{j,k}}\right)^{B_{j,t}} exp\left(1 - \left[\frac{R_k^{max}}{R_{j,k}}\right]^{B_{j,t}}\right)\right]^{\frac{1}{2}}$$

(4)

where V^{max} is the maximum sustained wind velocity in the hurricane; *T* is the clockwise angle between the forward path of the hurricane and a radial line from the hurricane centre to the pixel of interest *j*, V^h, is the forward velocity of the hurricane; R^{max} is the radius of maximum winds; and *R* is the radial distance from the center of the hurricane to point *P*. The remaining ingredients in (4) consist of the gust factor *G* and the scaling parameters *F, S,* and *B*, for surface friction, asymmetry due to the forward motion of the storm, and the shape of the wind profile curve, respectively.

In terms of implementing (4), one should note that V^{max} is given by the storm track data described in the data section, V^h can be directly calculated by following the storm's movements between locations along its track, and *R* and *T* are calculated relative to the point of interest *P=j*. All other parameters have to be estimated or assumed. For instance, we have no information on the gust wind factor *G*, but a number of studies (e.g. Paulsen and Schroeder 2005) have measured *G* to be around 1.5, and we also use this value. For *S* we follow Boose et al. (2004) and assume it to be one. While we also do not know the surface friction to directly determine *F*, Vickery et al. (2009) noted that in open water the reduction factor is about 0.7 and reduces by 14 per cent on the coast and 28 per cent further 50 km inland. We thus adopted a reduction factor that linearly decreases within this range as we consider points *i* further inland from the coast. To determine *B* we employ Holland's (2008) approximation method, whereas we use the parametric model estimated by Xiao et al. (2009) to estimate R^{max}.

5 Econometric analysis

After our annual data have been compiled for unemployment, hurricane destruction, and labour legislation, the following general econometric model is estimated:

$$UR_{it} = \alpha + \sum_{s=0}^{S} \beta_{t-s} H_{it-s} + \sum_{s=0}^{S} \gamma_{m,t-s} H_{it-s} * \sum_{m=1}^{M} L_{m,i} + \sum_{i=1}^{I} trend_{it} + \pi_t + \mu_i + \varepsilon_{it}$$

(5)

where the subscripts i and t indicate country *i* and year *t*. *UR* is the unemployment rate; *H* is our hurricane destruction index; *L* is a vector of legislation indices; *trend* is a country specific linear time trend[25]; π a vector of year dummies; μ a vector of country specific dummies; and ε is the error term. We allow for up to *s* lagged effects of the hurricane destruction index. One should note that since our vector of *L* are time invariant, their direct effect is absorbed by the country specific effects μ. Also, in order to allow for potential serial, which is likely a feature of unemployment rates, and cross-sectional correlation, likely due to the spatial extent of hurricanes, we calculated Driscoll and Kraay (1998) standard errors. In order to purge the country specific time invariant unobservable, that is, μ, we, in all specifications, ran a fixed effects estimator.

One should note that our empirical model allowed us to estimate (a) the contemporaneous, as well lagged impacts of extreme climate events; and (b) the role of country differences in labour legislation in dampening or exacerbating these effects. One should note that arguably, the coefficients on the hurricane destruction index, namely the β's, are unbiased from an economic decision-making perspective. More specifically, after controlling for country fixed effects, any shocks in *f* will simply be random realizations drawn from the hurricane damage distribution. Thus, while economic agents in countries may make location and other decisions, taking into consideration the local probability distribution of hurricane damages, the actual event will be unanticipated after controlling for firm fixed effects. In contrast, one needs to be more cautious about the causal interpretation of the coefficients (the γ's) of the interaction terms between the hurricane destruction index and the labour legislation indices, since the latter may be correlated with other country specific, time invariant factors that also result in heterogenous effects of hurricane damages on the unemployment rate.

25 There are a number of reasons for including country specific trends. Firstly, the unemployment rate for some countries tended to be trend stationary. Secondly, it is possible that there may be linear trends in hurricane destruction due to teleconnections that may coincide with changing trends in unemployment rates within countries.

6 Results

We first estimated equation (5) using a panel fixed effects estimator without allowing for the possibility of heterogeneity of impacts of hurricane damages on the unemployment rate, i.e., only including up to five lagged values of the hurricane index, as well as time dummies and country specific trends. The results for the total sample, as well as all sub-samples, are given in Table 2. For the sake of visual convenience, we also depict all results graphically. More specifically, Figure 1 shows the estimated coefficients on *H* and its lags, as well as the 95 per cent confidence intervals for the total unemployment sample. As can be seen, hurricane destruction causes an immediate negative impact on the total unemployment rate (total employment increased), which lasts up to four years after the strike, and then becomes insignificant.[26] Taking the estimated coefficients at face value, this implies that a hurricane strike causes an initial fall in the logged unemployment rate in the year that it occurred of 2.4 per cent, and then further decreases of 2.7, 3.1, 2.3, and 2.5 per cent for one, two, three and four years after the storm, respectively. This suggests a cumulative effect of about a 13.3 per cent reduction in unemployment (or an increase in employment). Several studies similarly provide empirical evidence that unemployment actually decreased after a natural disaster strike with lagged impacts.[27]

In order to determine whether this reduction in the unemployment rate might have been due to greater employment, we re-estimated our regression, now using the employment rate as the dependent variable. As can be seen in Figure 2, there is no immediate effect of a damaging hurricane on the rate of unemployment. However, three years later, employment increases and this rise lasts until the end of our lagged window of t-5. One may want to note however, that the quantitative impact is small, relative to the observed fall in unemployment.

We next examined what the impact was on the labour force participation rate in Figure 3. Accordingly, there was a fall in the labour force participation rate in the year of the storm. This suggests that part of the drop in unemployment was due to a rise in labour force participation, although again the quantitative size is small (only about 10 per cent) of the change in the unemployment rate after a storm. Finally, we investigated whether migration may have played some role in the observed patterns. However, as shown by Figure 4, where we displayed the estimated coefficients when using the migration rate as the dependent variable in Equation (5), there is no discernible impact on migration after a storm. One should note that this stands in contrast to Spencer and Urquart *(2018)*, who used a larger sample for a different time-period.

Looking separately at male and female unemployment, the corresponding estimates shown in Figures 5 and 6 respectively, indicate that there is little difference in the effect of storms on the rate of unemployment by gender, in that the pattern and magnitude follow that of the total unemployment rate. More specifically, both groups experienced declines in unemployment of up to four years after the event, and the quantitative effects are relatively similar. Hence, employment among males and females occurs relatively equally. In Figure 7, we next depict the estimated coefficients from (5) for the youth unemployment rate. As can be seen, the negative effect of hurricane damages on unemployment is similar to that of the total sample in magnitude, but only lasts up to three years after the strike. The increase in youth employment is therefore more short-lived. When we further focus on youth by gender in Figures 8 and 9, one can see that female youth experience a slightly shorter effect – three rather than four years after the storm – than their male counterparts.

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26 Unemployment is defined as the share of the labour force that is without work but available for and seeking employment.

27 Ewing et al. 2009; Banerjee 2007; Leiter et al. 2009; Pierto and Mora 2015; Kircheberger 2011; and Belasen and Polachek 2008; and 2009.

▶ **Table 2: Regression results – No legislation**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sample:	Total UR	ER	PR	MR	Male UR	Female UR	Youth UR	Male youth UR	Female youth UR
H_t		0.014	-0.012*	0.002	-.256***	-.246**	-.265***	-.297***	-.235**
	(.098)	(0.018)	(0.006)	(0.137)	(.081)	(.123)	(.093)	(.092)	(.112)
H_{t-1}	-.271***	-0.015	-009	0.002	-.272***	-.3***	-.258***	-.268***	-.282***
	(.065)	(0.025)	(0.006)	(0.086)	(.068)	(.068)	(.054)	(.07)	(.054)
H_{t-2}	-.31***	-0.023	-0.009	-0.074	-.343***	-.406***	-.306***	-.304***	-.31***
	(.083)	(0.076)	(0.007)	(0.116)	(.077)	(.088)	(.082)	(.087)	(.079)
H_{t-3}	-.227**	0.056**	-0.007	0.014	-.243**	-.259***	-.247***	-.276***	-.204**
	(.108)	(0.019)	(0.008)	(0.010)	(.108)	(.09)	(.087)	(.105)	(.096)
H_{t-4}	-.251*	0.080**	0.008	-0.259	-.265*	-.229*	-.223	-.285*	-.204
	(.139)	(0.029)	(0.008)	(0.210)	(.143)	(.132)	(.166)	(.159)	(.153)
H_{t-5}	-.185	0.085*	0.003	-0.095	-.12	-.161	-.162	-.178	-.115
	(.154)	(0.046)	(0.007)	(0.118)	(.161)	(.14)	(.148)	(.169)	(.13)
Obs.	195	195	195	195	195	195	195	195	195
R^2	.742	0.56	0.76	0.49	.751	.819	.723	.699	.729

Notes: (a) All specifications include time dummies and country specific trends, (b) Driscoll and Kraay (1998) standard errors in parentheses. (b) ***, **, * indicate significance at the 1%, 5%, and 10% level, (c) UR: unemployment rate, ER: employment rate, PR: labour force participation rate, MR: migration rate.

There are several possible reasons for the decrease in unemployment following hurricane strikes in Caribbean SIDS. The most obvious explanation, especially in the short term, is that there was an increase in economic activity, particularly in the construction sector, for the re-building of houses, businesses, and infrastructure, causing the demand for workers to rise. Consequently, the increased employment opportunities may be willingly taken up by persons who were previously inactive in the labour market in order to pay for physical damages and other losses due to the storms, given that the region has high unemployment co-existent with inadequate social protection[28] and limited disaster insurance.[29] Furthermore, social protection mechanisms and strategies in the region oftentimes are in the form of public works, in addition to cash payments to the affected population.[30] In fact, in a study of the sectoral impacts of hurricanes in the Caribbean, Hsiang (2010) found that output in the construction sector increased after storms. Also, Benson and Clay (2001), in a study of hurricanes in Dominica, stated that reconstruction activities created an increase in GDP and a growth catch-up effect. An expansion of the construction industry is also associated with significant indirect employment effects, accompanied by an increase in the demand for intermediate goods that are produced in the services and manufacturing sectors, which could further stimulate an increase in employment.[31]

In 2001, the United Nations Development Programme (UNDP) formed the Bureau for Crisis Prevention and Recovery (BCPR) for disaster risk reduction and recovery. Following Hurricane Ivan, which struck Grenada in 2004, 89 per cent of the housing stock was destroyed along with substantial damage to Government and commercial buildings, hospitals and schools, roads and bridges.[32] As a result, the BCRP carried out several initiatives which focused on expansion of the construction sector in Grenada. The Flash Appeal was launched to receive funding for reconstruction and several projects were implemented, including a national

28 ILO 2014.
29 Borensztein et al. 2009; and World Bank 2012.
30 CCRIF 2019.
31 Kircheberger 2011.
32 UNDP 2007.

reconstruction programme and a housing rehabilitation programme.[33] The Agency for Reconstruction and Development, with responsibility for the overall recovery and reconstruction effort, was also formed.[34]

Following Hurricane Ivan, additional capacity in Grenada's construction sector was built through training, with an emphasis on youth and women in carpentry, plumbing and masonry, to improve their employment prospects since it was the only booming sector following the disaster. Furthermore, classes for improving numeracy and literacy skills, to further build participants' capacity and effectiveness on the job, and even future job prospects outside of construction, were included in the training. Graduates of the programme were hired by the Government to work on low-income housing and to repair and refurbish community centres as well as to work for private construction contractors.[35] There have been other similar initiatives in the Caribbean to support the construction sector in the post-disaster period. In 2017, following Hurricanes Irma and Maria in Dominica, 488 buildings, 472 homes, 3 schools and 5 health care centres were restored, where over 400 persons were employed and where 42 per cent were women.[36]

The increase in employment in Caribbean SIDS, particularly the lagged impacts, may be as a result of positive GDP growth following hurricane strikes which could stimulate a rise in labour demand. A positive growth effect following a natural catastrophe is feasible if the loss capital is replaced by more productive and modern technologies or production methods that will push the economy to a newer, more efficient and higher growth path, leading to higher employment.[37] Mohan et al. (2018) used a panel Vector Autoregressive model in a study of GDP components for the Caribbean and found a 4.6 percentage increase in investment after a hurricane event which resulted in an overall increase in GDP of 3.1 percentage point. In another study of hurricanes in the Caribbean, Mohan et al. (2019) examined production efficiency using a stochastic frontier approach, and found a production efficiency boosted, especially after very large damaging storms.

Alternatively, another explanation for the fall in unemployment following tropical storms in the Caribbean is that there may be a reduction in the number of persons who are actually searching for jobs. In the literature, migration is identified as a key measure used by individuals and households to adapt to environmental change, particularly in small islands which are highly exposed to climate related disaster risk.[38] The physical harm and loss of livelihood and homes create a strong desire for persons to want to migrate to avoid unfortunate experiences.[39] After storms, unemployed persons in the Caribbean may choose to migrate, and as a result, there are less persons searching for jobs and the unemployment rate appears to fall. In this regard, Spencer and Urquart (2018), in a panel data study of the movement of persons to the US, which is a top immigration choice for persons in the region, found that hurricanes increased migration by roughly 6 per cent, with an even greater impact for more damaging storms. Also, Caribbean countries actively encourage temporary migration to Canada, the US and the United Kingdom under schemes catering for farm workers, nurses and teachers.[40]

Caribbean SIDS have committed to the ILO's Decent Work Agenda with four strategic objectives including creating decent and productive jobs; guaranteeing rights at work; extending social protection; and promoting social dialogue; all of which can be threatened by a natural disaster shock. The implementation programmes are not uniform among Caribbean SIDS, reflecting differences in economic circumstances, government sector capacity and the relative importance attached to the individual strategic priorities.[41] Also, most social protection systems in the Caribbean are inadequately prepared to respond to natural disaster shocks, with particular consequences for the poor and vulnerable.[42] We, therefore, next investigated what

33 UNDP 2007.
34 UNDP 2007.
35 UNDP 2007.
36 UNDP 2018.
37 Skidmore and Toya 2001; and Cavallo and Noy 2011.
38 McLeman and Hunter 2010.
39 McLeman and Smit 2006; and Spencer and Urquart 2018.
40 ILO 2014.
41 ILO 2014.
42 CCRIF 2019.

role labour legislation might have played in mitigating or encouraging the impact of hurricanes in our sample. To this end, we took our three legislation indices and for each created a dummy when a country is above the median sample value (provided in Table 1).[43] For the general index (LEG_{GEN}), Antigua and Barbuda, Belize, Barbados, Cuba, Jamaica, and Trinidad and Tobago are above the median; for the employment security termination index (LEG_{EMP}), Belize, Barbados, Cuba, Saint Lucia, and Trinidad and Tobago are above the median sample value; and for the social security index (LEG_{SS}), Antigua and Barbuda, Belize, Barbados, Dominica, Jamaica, and Trinidad and Tobago are above the median sample value.

The results of the full estimation for the total and all sub-samples of the population with the interactions terms are shown in Table 3. One may want to note that we included all the legislation interaction terms simultaneously in (5) in our estimation. In Figure 10 we depict for the total unemployment rate, the estimated coefficients (the β's) on H (Panel a) and the coefficients (the γ's) on its interaction term with general legislation dummy (Panel b), the social security dummy (Panel c) and the employment protection dummy (Panel c). As can be seen from Panel (a), our results imply that having less than a median level of labour legislation - when all indices take on a zero value - produces a negative impact of hurricanes on the unemployment rate and lasts until four years after the storm. This effect only starts in the year after, until the three years after the event. One may want to note that these lagged effects are close to double of the average effects that were shown earlier in the specifications that did not include interaction terms. Labour legislation therefore appears to provide some mitigating impact starting from the year after a hurricane strikes.

Looking across the estimated interaction coefficients in the remaining panels of Figure 10, one can see that the average negative effects are driven by the general labour legislation, although these are more imprecisely estimated. In contrast, social security legislation increases the rate of unemployment in our sample when a damaging hurricane occurs. Moreover, this effect appears to last up to at least five years. For an average hurricane, such legislation can encourage the take up of unemployment by up to 5 per cent. Within five years after the storm, the cumulative effect would, on average, be about 42 per cent rise in unemployment. Finally, legislation protecting employment security does not have any significant impact.

Looking just at youth in Figure 11, the patterns are similar to the overall population in that no legislation reduces unemployment in response to a hurricane, social security legislation increases, and there is no effect of employment protection legislation. General legislation does also have a small negative effect for the youth, but this is rather imprecisely estimated. Comparing males and females in Figures 12 and 13, one finds that they are generally similar in their response to damaging storms when there is no legislation - a small negative effect at least in the few years after the storm - and no impact through employment security legislation. For females in contrast to males, general legislative protection does not seem to matter and the boosting impact of social security lasts for a shorter time-period. Finally, as can be seen from Figures 14 and 15, the youth respond similarly to hurricane shocks in terms of the non-legislation and legislation effects as their overall gender populations.

[43] An alternative would have been to interact the values per say with the hurricane destruction index. However, there are two drawbacks to this. Firstly, the interaction term of two continuous variables is generally hard to interpret and the standard errors difficult to calculate. Secondly, strictly speaking, it is not clear what a unit increase in the legislation means intuitively.

Table 3: Regression results – Legislation

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	Total	Male	Female	Youth	Male youth	Female youth
H_t	-0.221	-0.295	-.232*	-0.241	-0.296	-0.198
	(.151)	(.185)	(.128)	(.161)	(.199)	(.124)
H_{t-1}	-.398***	-.434***	-.443***	-.294*	-0.248	-.261*
	(.118)	(.177)	(.132)	(.158)	(.213)	(.147)
H_{t-2}	-.546***	-.637***	-.707***	-.479***	-.445***	-.461**
	(.186)	(.213)	(.232)	(.197)	(.187)	(.214)
H_{t-3}	-.557***	-.684***	-.588***	-.448***	-.5***	-.401***
	(.164)	(.212)	(.12)	(.12)	(.18)	(.091)
H_{t-4}	-.504**	-.594*	-.483**	-0.353	-0.489	-0.365
	(.251)	(.307)	(.225)	(.32)	(.358)	(.283)
H_{t-5}	-0.398	-0.275	-0.358	-0.303	-0.352	-0.253
	(.26)	(.297)	(.236)	(.266)	(.305)	(.237)
H_tLEG_{GEN}	-0.348	-0.173	-.436*	-0.336	-0.25	-0.406
	(.222)	(.197)	(.26)	(.256)	(.252)	(.291)
$H_{t-1}LEG_{GEN}$	-0.284	-0.257	-0.243	-0.156	-0.168	-0.062
	(.215)	(.223)	(.218)	(.221)	(.221)	(.24)
$H_{t-2}LEG_{GEN}$	-.393*	-0.306	-.395*	-0.317	-.301*	-0.338
	(.217)	(.189)	(.22)	(.204)	(.18)	(.248)
$H_{t-3}LEG_{GEN}$	-.594***	-.646***	-.428***	-0.461	-.603**	-0.457
	(.211)	(.249)	(.18)	(.289)	(.29)	(.279)
	-.415*	-.48*	-0.306	-0.42	-0.475	-0.349
$H_{t-4}LEG_{GEN}$	(.237)	(.258)	(.209)	(.273)	(.331)	(.273)
	-.389***	-.466***	-0.217	-.342**	-.449***	-0.186
$H_{t-5}LEG_{GEN}$	(.133)	(.135)	(.151)	(.158)	(.109)	(.264)
	.446**	0.349	.507**	.468**	.445*	.486*
H_tLEG_{SS}	(.21)	(.245)	(.247)	(.225)	(.247)	(.264)
	.565***	.556***	.587***	.408**	0.301	0.28
$H_{t-1}LEG_{SS}$	(.171)	(.169)	(.205)	(.205)	(.292)	(.307)
	.754***	.699***	.912***	.645***	.532***	.682***
$H_{t-2}LEG_{SS}$	(.236)	(.248)	(.247)	(.23)	(.213)	(.255)
	1.047***	1.13***	.97***	.774***	.844***	.855***
$H_{t-3}LEG_{SS}$	(.282)	(.334)	(.204)	(.32)	(.357)	(.272)
	.785**	.975***	.661**	0.626	0.794	0.561
$H_{t-4}LEG_{SS}$	(.338)	(.402)	(.304)	(.421)	(.492)	(.403)
	.692***	.68**	.499**	.591***	.74***	0.432
$H_{t-5}LEG_{SS}$	(.224)	(.296)	(.233)	(.25)	(.249)	(.28)
	-0.175	-0.171	-0.195	-0.228	-0.197	-0.225
H_tLEG_{EMP}	(.26)	(.314)	(.254)	(.242)	(.32)	(.23)
	-0.069	0.055	-0.184	-0.351	-0.4	-.652*
$H_{t-1}LEG_{EMP}$	(.309)	(.339)	(.313)	(.325)	(.43)	(.382)

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	Total	Male	Female	Youth	Male youth	Female youth
$H_{t-2}LEG_{EMP}$	0.119	0.263	0.083	-0.076	-0.025	-0.179
	(.337)	(.343)	(.311)	(.257)	(.277)	(.295)
$H_{t-3}LEG_{GEN}$	0.43	.708*	0.298	0.11	0.308	0.043
	(.3)	(.379)	(.195)	(.261)	(.302)	(.236)
$H_{t-4}LEG_{EMP}$	0.372	0.474	0.368	0.213	0.395	0.295
	(.386)	(.466)	(.349)	(.453)	(.503)	(.414)
$H_{t-5}LEG_{EMP}$	0.236	0.106	0.234	0.107	0.219	0.139
	(.299)	(.357)	(.334)	(.37)	(.368)	(.394)
Obs.	195	195	195	195	195	195
R^2	0.801	0.81	0.875	0.797	0.765	0.81

Notes: (a) All specifications include time dummies and country specific trends, (b) Driscoll and Kraay (1998) standard errors in parentheses; (c) ***, **, * indicate significance at the 1%, 5%, and 10% level. (d) LEG_{GEN} is a dummy for above median general legislation, LEG_{SS} is a dummy for above median social security protection legislation, and LEG_{EMP} is a dummy for above median employment security termination legislation.

Conclusion

The rising frequency and intensity of extreme climate events and their escalating social and economic impact have heightened public awareness and increased the urgency for policy action. Informed policy making requires an expansion of research in this area, to improve labour market resilience, that is, the labour market's ability to resist, withstand or quickly recover from climate shocks, which is paramount to the survival of Caribbean islands' economies. Although these natural disasters pose significant challenges and even opportunities to labour markets, there is a paucity of empirical evidence, particularly for the Caribbean and developing countries more widely. This research expanded the literature on labour markets and extreme weather events by analyzing the impact of hurricanes on unemployment, together with the intermediary role played by labour legislation on Caribbean countries using panel data techniques.

Our results suggest that in the Caribbean, hurricane destruction causes an immediate negative impact on total unemployment, which lasts up to four years after the disaster strikes, with a cumulative effect of about 13.3 per cent. We also show that while this is partly due to a fall in labour force participation, it is not because of greater employment opportunities or migration from affected islands. There is little difference in the effect of storms on the rate of unemployment by gender; both groups experienced declines in unemployment of up to four years after the event, and the quantitative effects are relatively similar. For the youth, the negative impact on total unemployment is shorter and lasts up to three years after the storm. However, when we further focus on youth by gender, female youth experience a slightly shorter effect than their male counterparts – three years rather four. Labour legislation also appears to provide some mitigating impact from hurricane strikes. The reduction in unemployment may be the result from an increase in economic activity, and consequently GDP growth, particularly in the construction sector and social assistance through public works. There may also have been an increase in migration following a hurricane occurrence, reducing the number of persons searching for jobs, thereby reducing the unemployment rate.

Our results highlight the importance of employment-centred recovery immediately following natural disaster strikes. If managed well, the clean-up and recovery period can act as a strong driver of job creation, as well as the reduction of inequalities and skills gaps. Employment creation programmes can play an important role in reducing unemployment as well as increasing productivity. The employment offered after a disaster can contribute to building capabilities of participants and can target vulnerable groups such as women and youth for inclusion. Nevertheless, a holistic approach is needed to ensure that disaster prevention, mitigation, preparedness and recovery also focus on employment creation.

Annex

Figure 1: Impact on all persons unemployment rate

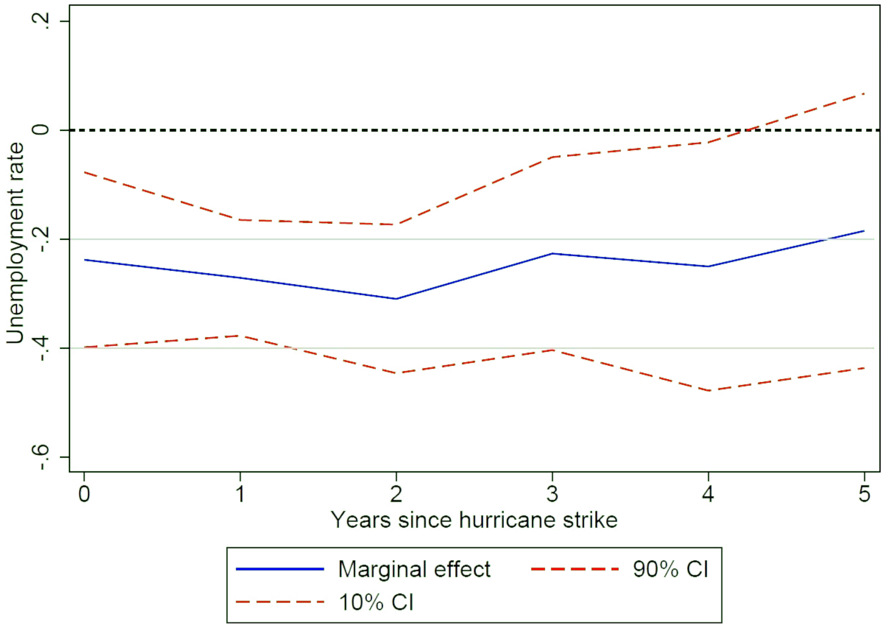


Figure 2: Impact on all persons employment rate

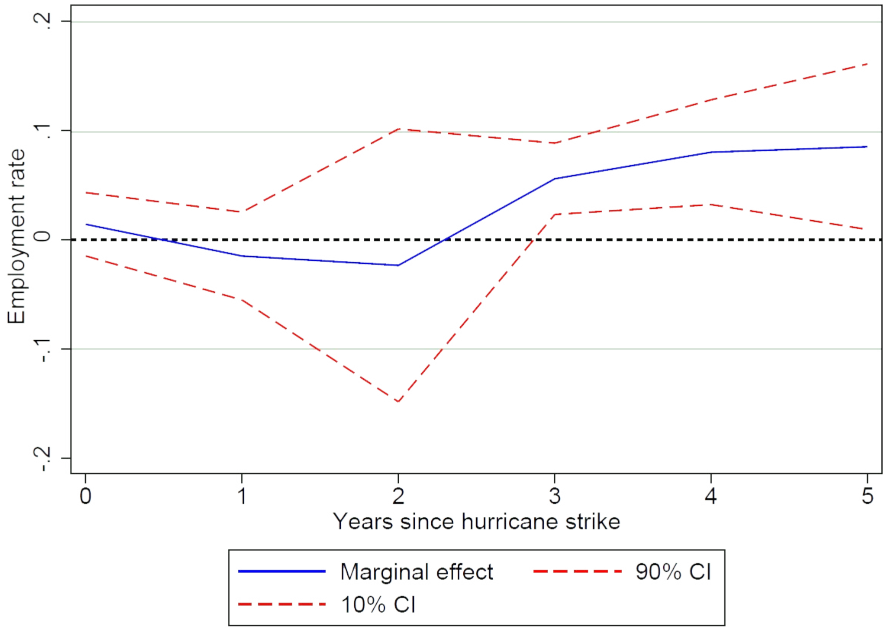


Figure 3: Impact on all persons labour force participation rate

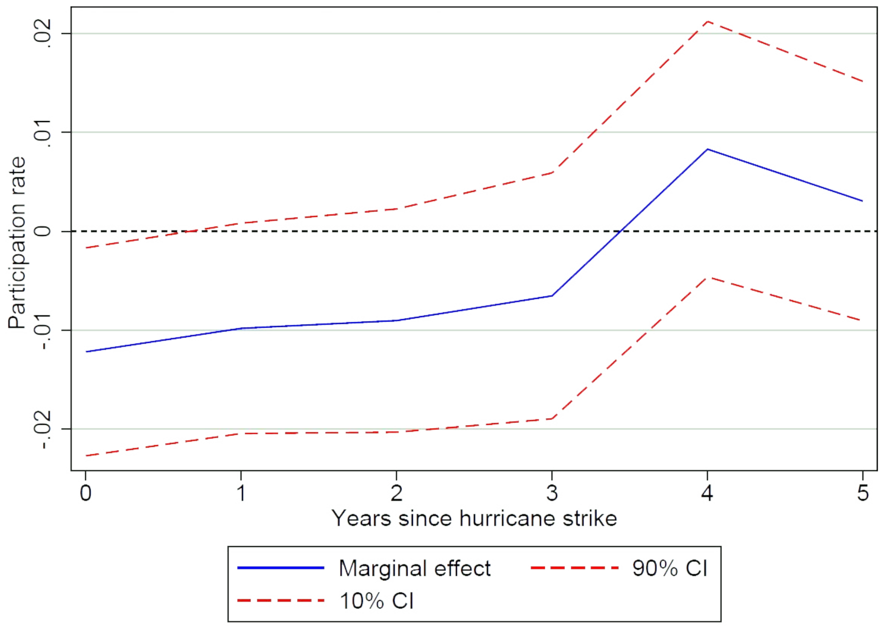


Figure 4: Impact on all persons migration rate

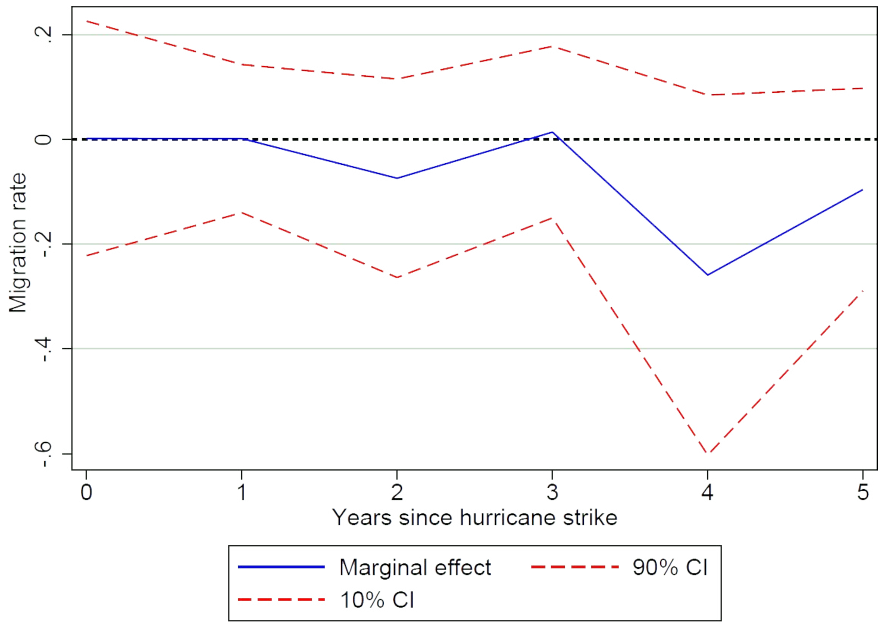


Figure 5: Impact on male unemployment rate

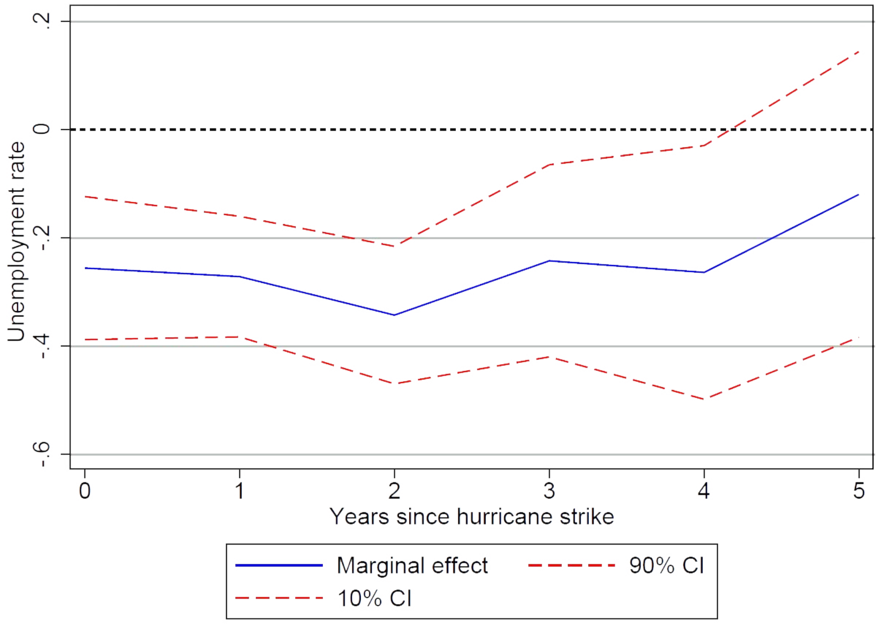


Figure 6: Impact on female unemployment rate

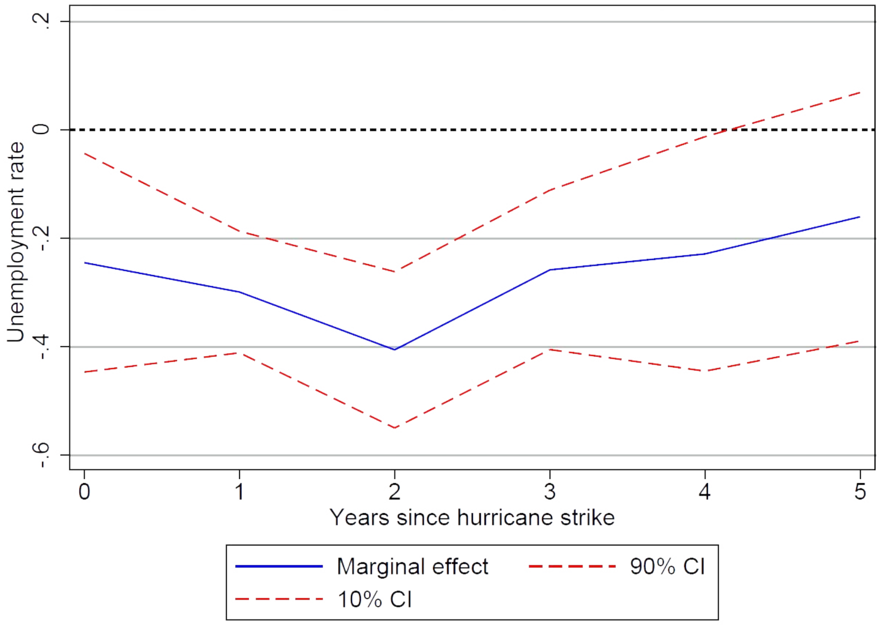


Figure 7: Impact on all youth unemployment rate

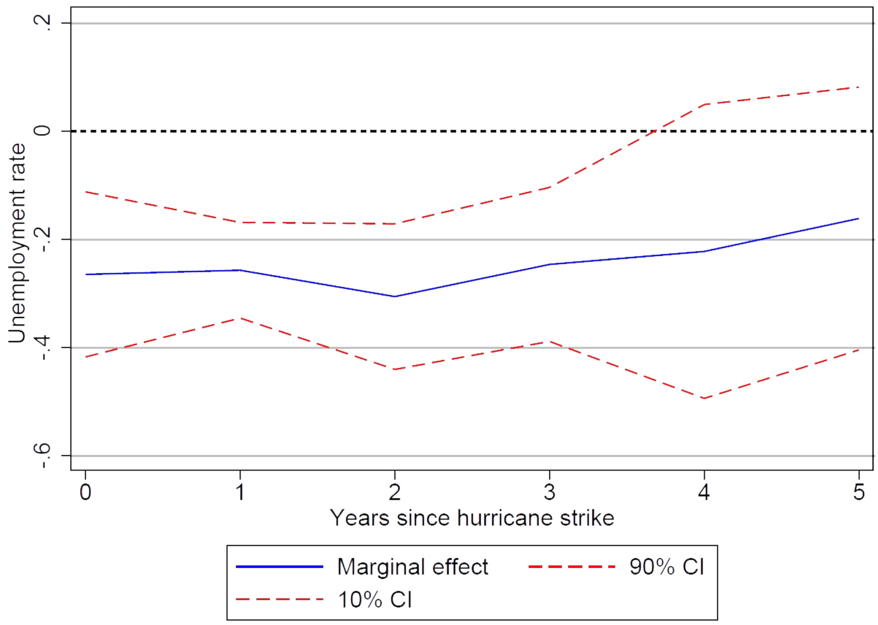


Figure 8: Impact on male youth unemployment rate

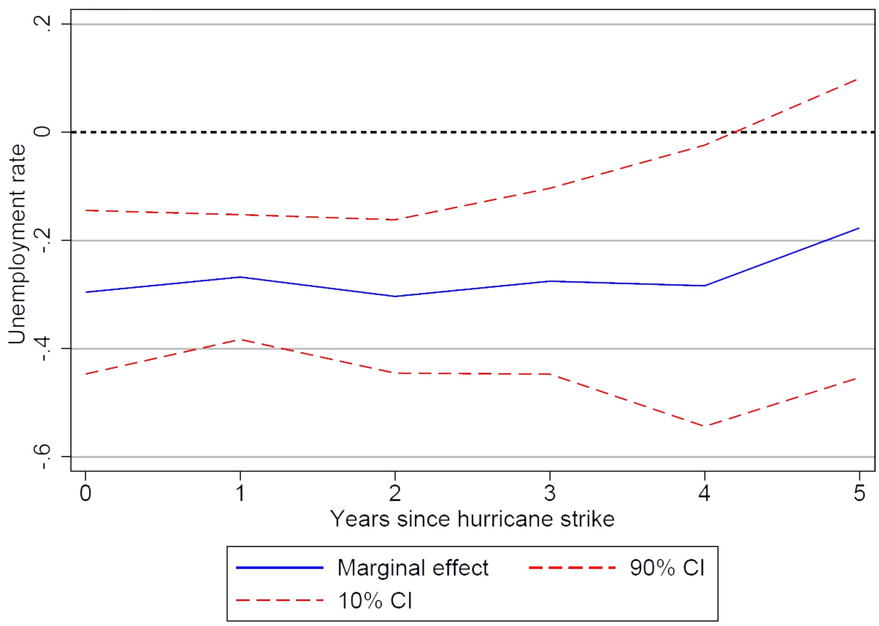


Figure 9: Impact on female youth unemployment rate

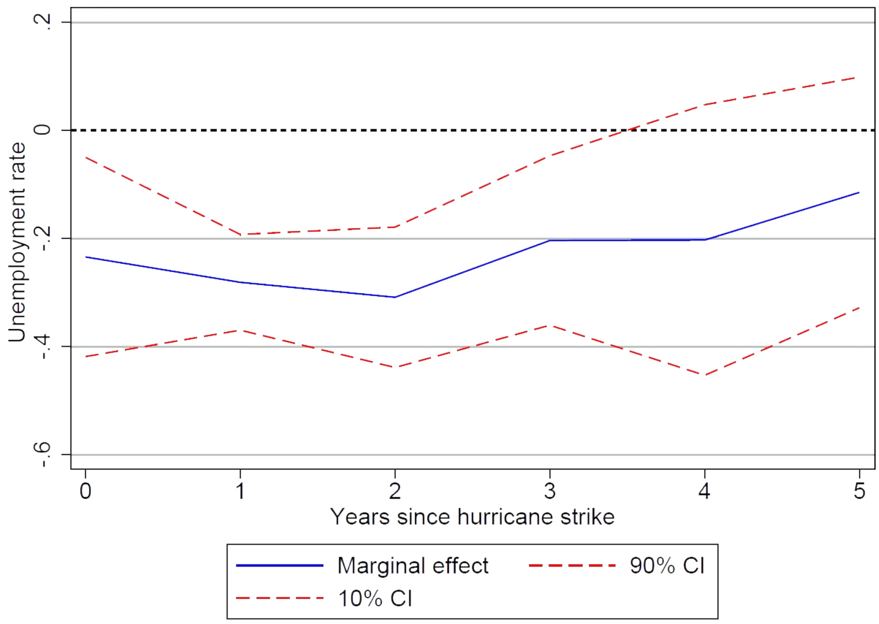
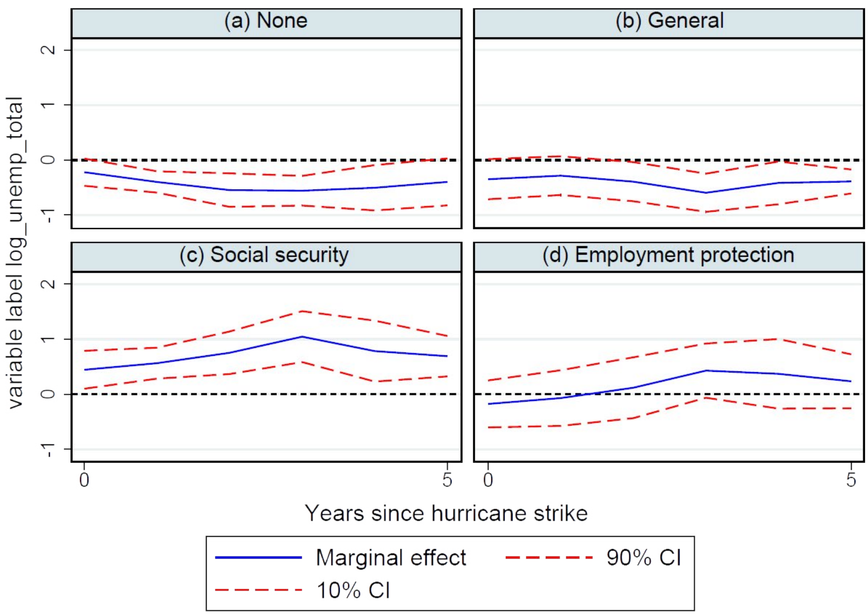
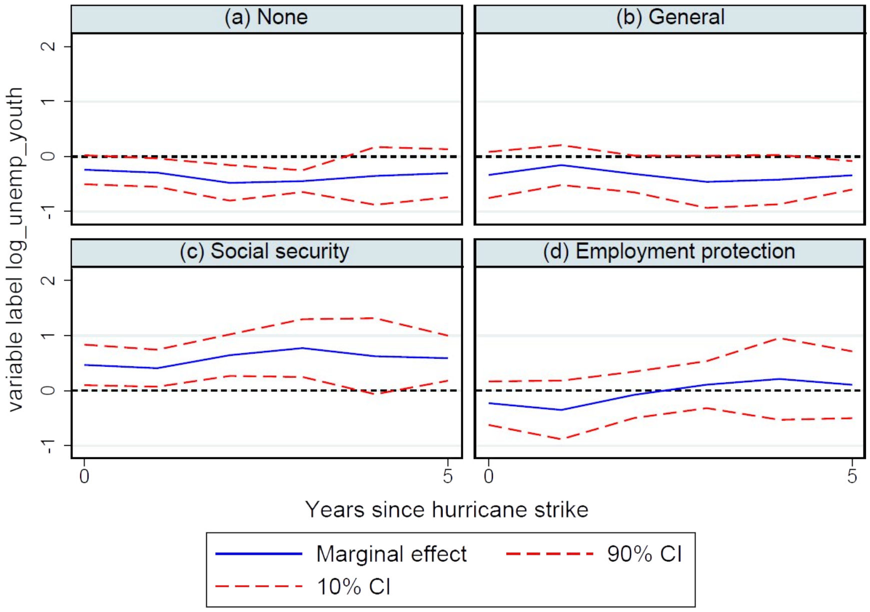


Figure 10: Impact on all persons unemployment rate – Legislation



▶ **Figure 11: Impact on youth unemployment rate – Legislation**



▶ **Figure 12: Impact on male unemployment rate – Legislation**

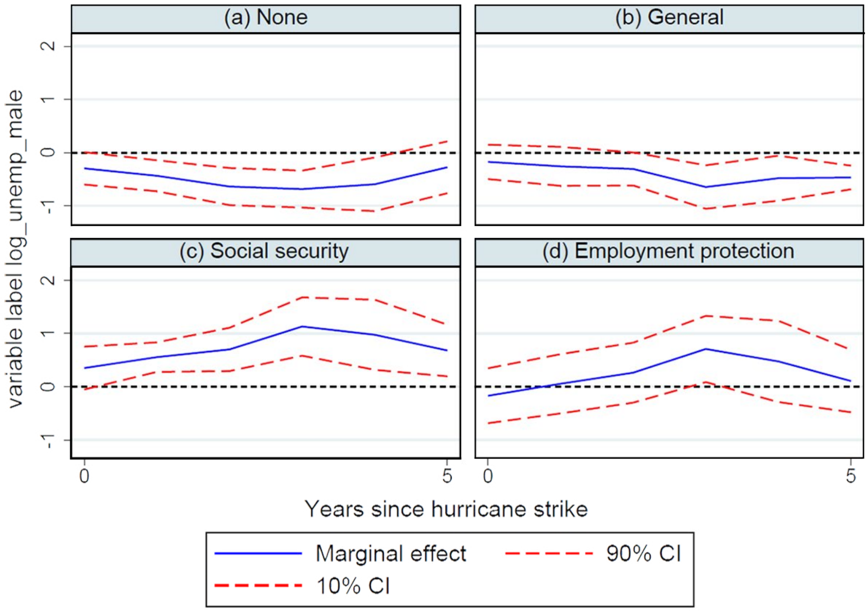


Figure 13: Impact on female unemployment rate – Legislation

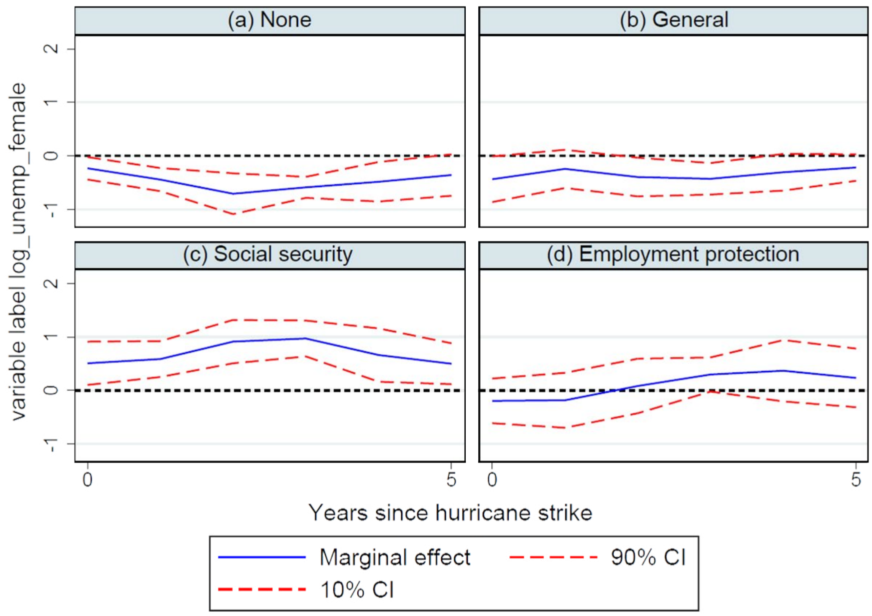


Figure 14: Impact on male youth unemployment rate – Legislation

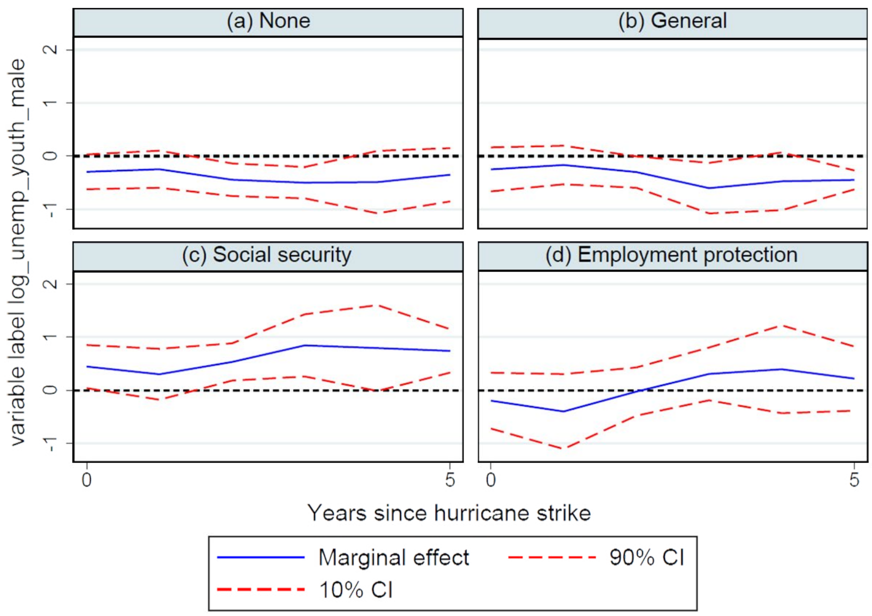
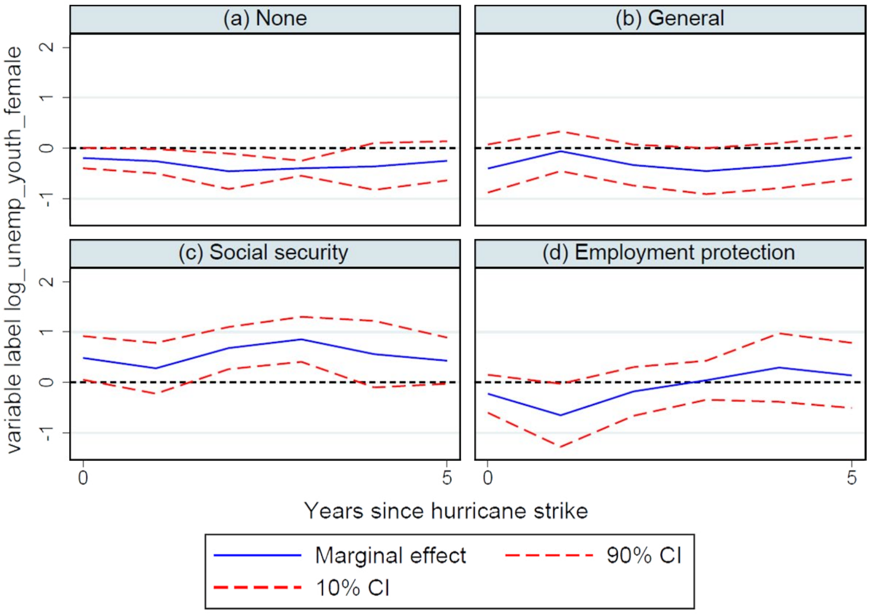


Figure 15: Impact on female youth unemployment rate – Legislation



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ISBN 978-92-2-033585-7