What Are the Impacts of Tropical Cyclones on Employment? An Analysis Based on Meta-Regression

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ABSTRACT

To investigate the general principle of the impact of tropical cyclones on employment, explore the reason for the divergence among existing research conclusions, and put forward some suggestions for post-disaster reconstruction, this paper employs meta-regression analysis to study the impacts of tropical cyclones on the quantity of labor employed and employee remuneration from four aspects: industry dimension, time dimension, income dimension, and tropical cyclone intensity. The results are as follows: 1) Tropical cyclones create an impact on the intensity of changes in employment remuneration in the primary industry, and the impact in the secondary industry is greater than that in the tertiary industry. 2) In the short term, the impact of tropical cyclones on employment is negative and the impact intensity is strong, whereas in the medium and long terms, the impact is positive and the intensity of impact decreases. 3) Although tropical cyclones increase the quantity of labor employed from low-income groups, they decrease their employment remuneration. In addition, the impact of disasters on the number of employed high-income groups is relatively small compared to that of low-income groups. 4) A higher category of tropical cyclone results in a greater positive impact on the employment of labor force. Accordingly, the following suggestions are made: 1) The government should issue corresponding policies to provide ''temporary disaster subsidies'' for disaster-stricken low-income groups. 2) Insurance companies should introduce commercial insurance concerning ''post-disaster employment'' for employers to purchase before any disaster occurs so as to offer disaster-stricken employees compensation.

1. Introduction

The fifth report of the IPCC (Intergovernmental Panel on Climate Change) states that the future impact of global warming on the climate system will continue and with a faster rate of change than previously estimated

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(Qin and Stocker 2014). The frequency and intensity of tropical cyclones will tend to increase further on account of global warming (Qin 2008; Qin and Luo 2008). On account of their high frequency and devastating effects, the United Nations has classified tropical cyclones as one of the most destructive environmental disasters, second only to floods (Baez and Santos 2008). Tropical cyclones pose a great threat to the construction and sustainable development of human society (Shi 1996) in that they not only destroy traffic grids, communication facilities, warehousing, and so on, causing large amounts of property damage, but they also cause human casualties, spread diseases, and jeopardize the physical and mental health of humans. Assessing the impact of tropical cyclones on the social and economic development and mastering the general principle of disasters' impacts on social development has become an important topic for the government, academia, and the public. However, in terms of the issue ''What are the impacts of tropical cyclones on employment?'' previous scholars' conclusions vary significantly because of the differences in the research samples and methods.

To fill the research gap about the general rule of the impact of tropical cyclones on the quantity of labor employed and employee remuneration, this paper puts forward several research hypotheses after analyzing the mechanism of tropical cyclones' impact on employment. Then, meta-regression analysis is adopted to study the sample data from four aspects, including industry dimension, time dimension, income dimension, and tropical cyclone intensity. The conclusions provide some suggestions for the medium- and long-term management of tropical cyclones. The differences between this paper and that by Belasen and Polachek (2013), which is an excellent previous study, are as follows. First, through meta-regression analysis, the paper reviews the literature related to the impact of tropical cyclones on labor employment using quantitative analysis. Second, based on labor market segmentation and disaster attributes, the paper analyzes the origin of the divergence in research conclusions in the existing literature from the perspectives of industry dimension, time dimension, income dimension, and tropical cyclone intensity. Third, the direction and intensity of tropical cyclones' impact on employment are investigated from multiple perspectives using a probit model and a multiple regression model.

The rest of this paper is organized as follows. Section 2 discusses the literature on the impacts of tropical cyclones on employment; section 3 is about the possible mechanism and research hypotheses of disaster impact on employment; section 4 gives the explanation for the research methods, data, and variables; section 5 gives the results of the meta-regression analysis, and section 6 presents the conclusions and discussion.

2. Literature about the impacts of tropical cyclones on employment

There is extensive literature about the impacts of tropical cyclones on employment, and it can be divided into two categories: positive impact and negative impact.

Some researchers held the view that tropical cyclones have brought a positive impact on employment. They explained their stance mostly from the following three aspects.

The first point concerns post-disaster reconstruction financing, technical assistance, and support. Guimaraes et al. (1992) took the example of Hurricane Hugo that struck South Carolina in the United States in 1989 and studied the impact of natural disasters on social wealth and income. They found that during the economic recovery of the afflicted area, billions of dollars of insurance and South Carolina's public funds had created a short-term economic boom in the area. The biggest beneficiaries were industries like construction, agriculture, trade, retail, transportation, and public services and facilities.

The second point is about the post-disaster reconstruction activities. Ewing et al. (2003, 2009) and Rodríguez-Oreggia (2013) thought that the post-disaster reconstruction of industrial areas, commercial areas, residential areas, and infrastructure would create many job opportunities, the soaring prices and labor costs would lead to rising costs of reconstruction and rehabilitation, and the surging demand would attract labor force flooding in, thus increasing the employment rate. Strobl and Walsh (2009) studied the impact of hurricanes on the employment of the American construction industry and found that hurricanes increased the employment rate by an average of 25%. Zissimopoulos and Karoly (2010) found that a year after Hurricane Katrina, Louisiana and Mississippi developed a relatively high rate of self-employment. The researchers believed that independent entrepreneurship was an important factor in post-disaster economic recovery. Rodríguez-Oreggia (2013) made use of microdata from 32 regions of Mexico to study the impact of hurricanes on workers with various educational backgrounds. The results indicated that hurricanes had a positive impact on employment and wages for workers who were less educated.

The third point is about Schumpeter's theory of ''creative destruction.'' Skidmore and Toya (2002) and Leiter et al. (2009) argued that natural disasters had a positive impact. Although disasters would undermine the existing social and economic foundations to some extent, they could provide opportunities for innovation.

Furthermore, enterprises would prioritize technology that was more disaster-resistant during their maintenance of the updated capital. In addition, disasters might also reduce the return on investment in material capital, thus increasing investment in human capital and accelerating the accumulation.

Other researchers believed tropical cyclones had a negative impact on employment. There were three main reasons.

First, the disaster caused a large-scale migration of population. Climate and environmental changes had led to the frequent occurrence of disasters and had become a driving force for migration. Areas with better conditions of employment opportunities, living environment, and risk protection became the relocation destinations (Zheng 2013). Belasen and Polachek (2007, 2008) studied the impact of hurricanes on the employment in Florida during the period from 1988 to 2005 and found that the composition of the workforce in the hurricane-affected areas changed. High-income groups moved to areas with low hazard potential and low-income workers were left behind in the disaster areas, resulting in a decrease in the rate of employment. Groen and Polivka (2008) found that 2 months after Hurricane Katrina, New Orleans' urban employment decreased by 35%. Ouattara and Strobl (2014) applied a vector autoregression model to study the impact of hurricanes on coastal urban migration in the United States and found that hurricanes increased the outward mobility of the wealthier population.

Second, the disaster led to a decline in the purchasing power of individuals. Disasters had reduced family property, affected people's health, and changed household consumption behavior. After analyzing the medium- and long-term effects of disasters on wages, Groen et al. (2015) pointed out that evacuees would face higher reemployment and relocation costs, which could lead to involuntary unemployment and changes in budget constraints. When addressing the impact of disasters on wages, Mueller and Quisumbing (2011) also argued that natural disasters reduced the purchasing power of people in rural areas for nonagricultural goods and services.

Third, the disaster widened the income gap. On the one hand, poor areas were more vulnerable to disasters in that the losses caused by disasters were closely linked to the initial economic situation in the affected areas (Masozera et al. 2007). On the other hand, low-income individuals relatively lacked resilience to disasters and tended to reduce education expenditures to make up for the losses, which further hindered their effective improvement in abilities to prevent and mitigate the impact of disasters, thus becoming trapped in a vicious circle. However, high-income people tended to adopt various measures such as moving to low-risk areas, increasing insurance investment, and learning advanced knowledge and skills to mitigate the damage caused by natural disasters (Sadowski and Sutter 2005). Therefore, compared to high-income groups, low-income people suffered more losses. Kim and Marcouiller (2015) analyzed the impact of hurricanes on tourism from 1979 to 2004. From the perspective of vulnerability and resilience to disasters, the researcher pointed out that the material and capital losses caused by disasters were negatively correlated with income levels. The losses in developed areas were relatively less, and tropical cyclones had a negative impact on the local economy and people's income. Mottaleb et al. (2013) studied the impact of Typhoon Aila in 2009 on household income and expenditure of rural households in Bangladesh. The result showed that tropical cyclones caused a decrease in household income and in education expenditure.

It is evident that different scholars had different conclusions based on different research samples and methods for the impact of tropical cyclones on employment. For the purpose of finding out the general rules of tropical cyclones affecting employment, the mechanisms of disasters affecting employment are analyzed and research hypotheses are put forward in the next section. Then, the meta-analysis method is employed to collect relevant literature and conduct quantitative analysis from multiple dimensions.

3. Mechanism and research hypotheses of disasters affecting employment

Based on the research of Groen et al. (2015), we first analyzed the mechanism of tropical cyclones' impact on employment from the aspects of labor supply and demand. Then, from the perspectives of labor market segmentation and disaster attributes, we analyzed the impact of disasters on labor employment[1] (as shown in Fig. 1) and gave the assumptions of the study.

a. *Mechanism of disasters affecting employment*

1) CHANGES IN LABOR SUPPLY UNDER DISASTER CONDITIONS

Labor supply refers to the sum of labor ability the decision-making body of labor supply like individuals or families is willing to provide, under certain market conditions. It is mainly affected by factors such as labor ability, willingness, and employment environment (Li 2007). Disasters not only lead to casualties, evacuation of

[1] In this paper, the definition of "employment" not only includes employment quantity and labor remuneration but also labor supply and labor demand.

residents, and a direct reduction in the quantity of labor employed but also cause pessimistic emotions like anxiety and depression, which have a negative effect on people's mental health and job performance (Qin and Jiang 2011). In addition, disasters damage key lifelines such as transportation, communication, water supply, and power supply, deteriorating the living environment such as water quality and air quality. These impacts drive people to relocate in areas with low hazard potential and superior environment (Zheng 2013), thus resulting in a decline in the supply of labor force in affected areas.

2) Changes in labor demand under disaster conditions

Labor demand is derived demand, while the demand for material goods or services is direct demand. The demand for labor is influenced by the direct demand of the market as well as by the products and services it provides; besides, other factors such as national policies and capital supply also influence it (Li 2007). When a disaster strikes, the demand for labor is reduced due to the damage to traffic, water, power supply, and buildings, causing disruption to the production process and a decline in commercial services and retail sales (Groen et al. 2015). However, in the processes of disaster response and post-disaster reconstruction, the rehabilitation of industries like manufacturing, construction, and transportation demands a large amount of labor. During this time, government departments will also increase investment and promote the development of other industries, serving as an expanded indirect demand for labor (Rodríguez-Oreggia 2013). The two factors compete with each other, leaving the demand for labor in an uncertain state.

b. *Research hypotheses of disasters affecting employment*

1) Labor market segmentation theory

Labor market segmentation theory, put forward by American economists Dorlinger and Pioli in the 1960s, generally refers to the phenomenon of labor market stratification caused by social and institutional factors. Labor market segmentation falls into two categories: one is horizontal labor market segmentation, such as unit division of labor, industrial segmentation, urban–rural segmentation, and regional segmentation; the other is vertical labor market segmentation, which involves the objective boundary of the occupational level of labor force. The latter is also called technical division, originating from the gap in individual qualities of workers as well as their education and training backgrounds (Yang 2001). The impact of disasters on employment varies with labor market segmentation. Since the present study was an inductive analysis of the existing literature that had the limitation of indicators and data, the vertical study focused on industrial segmentation of labor market, while the division caused by income gap of the labor market was the main concern for horizontal study. It is generally acknowledged that people whose jobs require more skills and knowledge receive a relatively high wage compared with those whose jobs are not as skill-intensive. Therefore, from the aspect of technical division, income was taken as a substitute variable for technology. The research hypotheses were as follows:

H1: The impact of disasters on employment varies with different industrial sectors.

H2: The impact of disasters on employment varies with employees with different income.

2) Disaster attributes

Disasters are external factors that affect social and economic development. The perturbation to the employment system will stimulate imbalance between labor supply and demand. Nevertheless, the labor market is adaptive. Moreover, government intervention could facilitate its gradual restoration. This recovery process can be defined as a process whereby the labor market of disaster-stricken areas transits from one equilibrium state to another when faced with the destruction of disasters (Wu et al. 2013). As time passes, the disaster's impact featured different phase characteristics. The demand for labor is reduced at the beginning of the disaster, but it rises again during the response and post-disaster reconstruction phases. Therefore, the following hypothesis was proposed:

H3: The impact of disasters on employment varies with the time elapsed after the disaster.

Moreover, Skidmore and Toya (2002) believed that only the most destructive natural disasters had an impact on the economy, on the basis of which they proposed the fourth hypothesis:

H4: The impact of disasters on employment varies with their intensity.

To sum up, the mechanism and research hypotheses of the disaster's impact on the labor market could be described as in Fig. 1.

4. Explanation of research methods, data, and variables

a. *Research methods*

Meta-regression analysis was first put forward by Stanley and Jarrell (1989) and then introduced into the

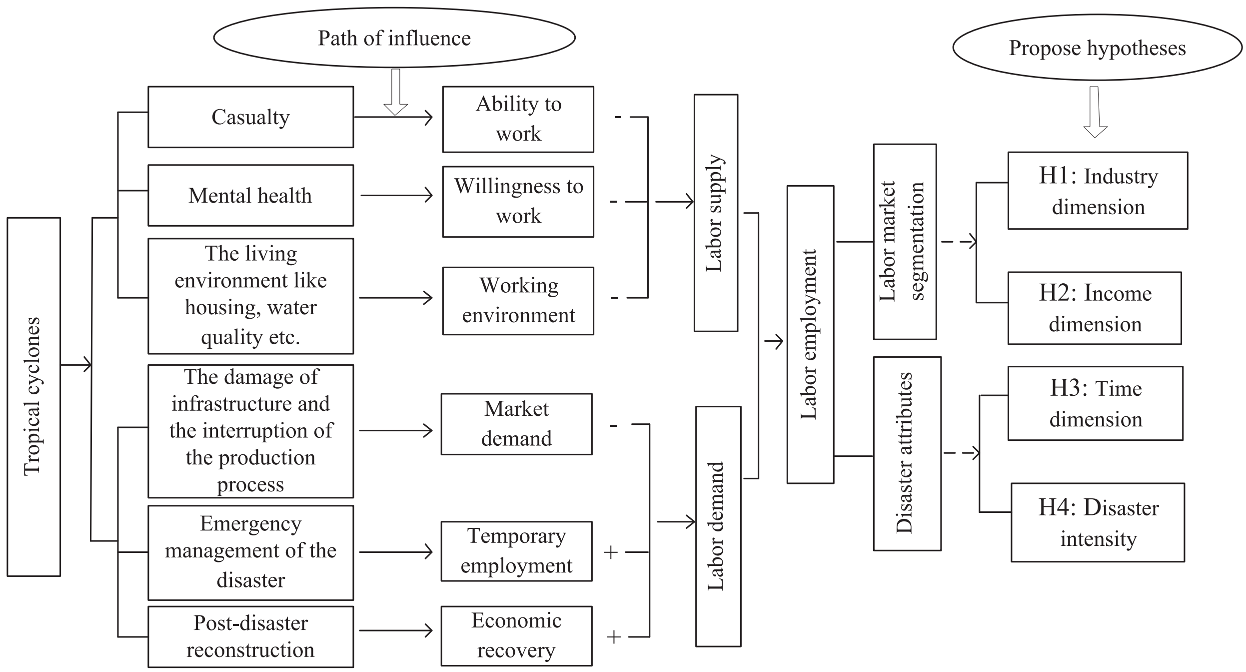

FIG. 1. The logical framework of the study. Note: The plus and minus signs indicate possible "positive" and "negative" impacts, respectively.

field of economics. It is a quantitative method of literature analysis that not only can synthesize all the research results but also can identify the source of the differences. At present, some scholars have applied meta-regression analysis to the field of natural disaster economics. For example, Klomp and Valckx (2014) synthesized 750 samples to study the relationship between natural disasters and economic growth using meta-regression analysis. Lazzaroni and van Bergeijk (2014) analyzed the direct and indirect effects of natural disasters on the macroeconomy through meta-regression analysis, and van Bergeijk and Lazzaroni (2015) combined the meta-regression analysis and the traditional literature review to study the macroscopic effect brought about by natural disasters and compared the advantages and disadvantages of the two research methods. Compared with traditional literature review, meta-regression analysis combines qualitative and quantitative analyses to achieve more objective results and identifies the impacts of different sample sources and methods on the conclusions (van Bergeijk and Lazzaroni 2015). Undoubtedly, meta-regression analysis does have limitations, such as that the coverage of the literature is relatively narrow, thus failing to analyze the literature outside the scope of the measurement method, that is, the literature that could be studied by using a computable general equilibrium model and input–output method.

To study the general law of the impact of tropical cyclones on employment, this paper adopted the method and framework of meta-regression analysis put forward by Klomp and Valckx (2014), Chen and Wang (2014), and Anandhi and Bentley (2018) to find out the causes of different conclusions and to clarify the direction and strength of the differences.[2] Taking the characteristic variables of the existing literature as the explanatory variable and the estimated results[3] as the explained variable, the basic model was as follows:

$$y_i = \beta + \sum_{k=1}^{k} \alpha_k Z_{ik} + e_i \quad (i = 1, 2, \ldots, N). \tag{1}$$

[2] As far as the existing relevant literature is concerned, there are few studies taking into account the direction and intensity of changes in the number of employed laborers and in employment remuneration. Since the impact of wind disasters on the change direction (increase or decrease) of the quantity and remuneration of employment has been controversial, and the impact of wind disasters with different attributes (different time, different geographical locations, etc.) on the changing intensity of employment remuneration is worthy of attention, the related study will be conducted separately so as to result in more detailed conclusions that will well complement the existing literature. Consequently, the impact of wind disasters on labor employment will be explored in terms of both change direction and change intensity.

[3] The estimation results of the selected literature were all significant at the level of 10%, 5%, or 1%. Finally, the results were all included in meta-regression analysis regardless of their significance to test their robustness.

In the model, y_i indicates the direction (the positive impact value is 1, otherwise was 0) and the value (the absolute value of the estimation coefficient in originally analyzed literature) of tropical cyclones' impact on the quantity of labor employed and the employee remuneration in the ith literature; Z_{ik} was the kth characteristic variable in the ith literature, which included the characteristic variable of the sample data appearing in the literature, the research method, and the publication situation; β represents the average estimate of y_i when Z_{ik} is 0; α_k is a regression coefficient, reflecting the influence coefficient of the kth characteristic variable on y_i; and e_i represents a random disturbance item.

On the basis of the model (1), the sample model (2), the method model (3), the publication model (4), and the total variable model (5) were established respectively, as shown below:

$$y_i = \beta_1 + \sum_{k_1=1}^{k_1} \alpha_{k_1} S_{ik_1} + e_i \quad (i = 1, 2, \ldots, N), \qquad (2)$$

where S_{ik_1} indicates the characteristic variable of the k_1th sample model in the ith literature, and the remaining variables are the same as in model (1);

$$y_i = \beta_2 + \sum_{k_2=1}^{k_2} \alpha_{k_2} M_{ik_2} + e_i \quad (i = 1, 2, \ldots, N), \qquad (3)$$

where M_{ik_2} shows the characteristic variable of the k_2th method model in the ith literature, and the remaining terms are as in model (1);

$$y_i = \beta_3 + \sum_{k_3=1}^{k_3} \alpha_{k_3} P_{ik_3} + e_i \quad (i = 1, 2, \ldots, N), \qquad (4)$$

where P_{ik_3} shows the characteristic variable of the k_3th publication model in the ith literature, and the remaining terms are as in model (1); and

$$y_i = \beta_4 + \sum_{k_1=1}^{k_1} \alpha_{k_1} S_{ik_1} + \sum_{k_2=1}^{k_2} \alpha_{k_2} M_{ik_2} + \sum_{k_3=1}^{k_3} \alpha_{k_3} P_{ik_3} + e_i \quad (i = 1, 2, \ldots, N). \qquad (5)$$

b. Data

Meta-regression analysis requires a comprehensive and complete collection of literature. Nevertheless, the literature collected in this paper was all in English, owing to the fact that tropical cyclones are mainly distributed in the United States, Mexico, Bangladesh, the Philippines, and so on. Besides, theoretical studies, review studies, and qualitative studies were excluded, but literature such as research reports, working papers, and dissertations were all included in the meta-analysis, due to the relatively small amount of research on the tropical cyclones' impact on employment. By searching titles, keywords, and abstracts, 22 documents were found, with a total of 357 sample observations,[4] 148 of which influenced the quantity of labor and 209 of which affected the employee remuneration. Detailed information about the literature is shown in Table 1.

c. Variable description

1) Explained variables

Based on the probit binary choice model, the effect of tropical cyclones on the quantity of labor or employee remuneration was taken as a binary explained variable. The value was 1 if it was positive; otherwise it was 0. By using the ordinary least squares (OLS), the absolute value of the influence coefficient of tropical cyclones on the quantity of labor or employee remuneration was taken as the explained variable to estimate the intensity of the impact of tropical cyclones on the quantity of labor or employee remuneration.

2) Explanatory variables

The characteristics of the sample and data are as follows. The "developed country" was set as a dummy variable, suggesting whether the data were from the developed countries or developing countries; "macro data" was set as a dummy variable, indicating whether the data were macro data; "industry data" was set as a dummy variable, showing whether or not the research data belonged to the industry data. In the industry dimension, the "primary industry," "secondary industry," and "tertiary industry" were set as dummy variables respectively. In the time dimension, in order to study the dynamic change of the impact of tropical cyclones on employment, variables reflecting observation duration including "short-term effect," "medium-term effect," and "long-term effect" were set

[4] 1) The total sample size was 357. The "sample size" in the table below was the actual sample size applied in the analysis. 2) Owing to a limited amount of literature, four papers on tornadoes were included (see references of 1, 3, 4, and 19 in Table 1). Although tornadoes and tropical cyclones are different disasters, due to a relatively large number of studies on tropical cyclones, the object of this paper was still referred to as "tropical cyclones." 3) In Table 1, though nine papers researched Hurricane Katrina, they could be regarded as different research samples because the durations of these studies varied.

TABLE 1. The literature analyzed through meta-regression.

Number	Author	Region	Tropical cyclone	Impacts on the quantity of employment	Impacts on employee remuneration	Time period
1	Ewing et al. (2003)	Fort Worth	Tornadoes on 27 Mar 2000	Negative	Not given	1980–2002
2	Ewing et al. (2005b)	Corpus Christi	Hurricane Bret in August 1999	Positive	Not given	1990–2003
3	Ewing et al. (2005a)	Oklahoma City	Tornadoes on 3 May 1999	Positive	Not given	1990–99
4	Ewing et al. (2004)	Nashville	Tornadoes on 16 Apr 1998	Positive	Not given	1981–2002
5	Anttila-Hughes and Hsiang (2013)	Philippines	411 tropical cyclones	Not given	Negative	1985–2000
6	Kim and Marcouiller (2015)	Southeastern United States	Hurricane Allen, Diana, Elena, Emily, Charley, Gloria, Hugo, Andrew	Not given	Uncertain	1979–2004
7	Kugler and Yuksel (2008)	United States	Hurricane Mitch in October 1998	Negative	Positive	2000–05
8	Chaganti and Waddell (2015)	New Orleans	Hurricane Katrina on 29 Aug 2005	Uncertain	Not given	2006–07
9	Andrade (2013)	Houston	Hurricane Katrina on 29 Aug 2005	Negative	Not given	2005–06
10	Deryugina et al. (2018)	New Orleans	Hurricane Katrina on 29 Aug 2005	Negative	Not given	1999–2010
11	Liliedahl (2009)	Houston and Baton Rouge	Hurricane Katrina on 29 Aug 2005	Positive	Positive	2003–08
12	Yaya and Redburn (2013)	Louisiana	Hurricanes Lili, Cindy, Humberto, Gustav Ike, Katrina, and Rita	Negative	Positive	2001–10
13	Akter and Mallick (2013)	Bangladesh	Typhoon Aila on 25 May 2009	Negative	Negative	2009–10
14	Strobl and Walsh (2009)	United States	Several tropical cyclones from the HAZUS software database	Positive	Not given	1988–2005
15	Rodríguez-Oreggia (2013)	Mexico	Hurricanes Keith, Juliette, Isidore, Kenna, Claudette, Ignacio, Emily, Wilma, John, Lane, Norbert, Alex, and Karl	Uncertain	Positive	2000–11
16	Mottaleb et al. (2013)	Bengal	Typhoon Aila on 25 May 2009	Not given	Negative	2000–10
17	Mcintosh (2008)	Houston	Hurricane Katrina on 29 Aug 2005	Negative	Negative	2000–06
18	Groen and Polivka (2008)	New Orleans	Hurricane Katrina on 29 Aug 2005	Negative	Not given	2004–06
19	Ewing et al. (2009)	Oklahoma City	Tornadoes on 3 May 1999	Negative	Not given	1980–2002
20	Belasen and Polachek (2008)	Florida	19 tropical cyclones	Negative	Positive	1988–2005
21	De Silva et al. (2010)	Houston	Hurricane Katrina on 29 Aug 2005	Not given	Negative	2004–07
22	Groen et al. (2015)	United States	Hurricanes Katrina and Rita	Not given	Uncertain	2003–06

according to the division method proposed by Groen et al. (2015). In terms of disaster intensity, Nordhaus (2006) argued that losses caused by hurricanes were related to wind speed, and set the tropical cyclone rating variable with the Saffir–Simpson hurricane wind scale. Moreover, the variable "wind speed" was set with the maximum wind speed of the tropical cyclone center (knots; $1\,\mathrm{kt} \approx 0.51\,\mathrm{m\,s^{-1}}$). In the income dimension, in order to detect whether the impact of disasters varies with different income groups, dummy variables like "low-income groups," "middle-income groups," and "high-income groups" were set.

For research methods, the dummy variables of panel data, OLS, and autoregressive moving average models (ARMA) were set. For the publication of the literature, the variables "year of publication" and "whether published" were set as dummy variables. Finally, the logarithm of the observed number of samples (lnobs) was taken as a control variable. The explanatory variables are described in Table 2.[5]

5. Results of meta-regression analysis

a. Impact of tropical cyclones on direction of employment quantity change

For the purpose of conducting meta-regression analysis,[6] a sample variable was added in models (1) and (2), a method variable in model (3), and a literature variable in model (4). To further test the stability of the model results, model (5) was used for regression of the whole variable model. The results showed the following:

1) From the sample aspect, "developed country" and "macro data" had no significant impact on the positive and negative effects of employment quantity. In terms of industry dimension,[7] industry disparities had no significant impact on the positive and negative effects of the employment quantity under hurricane conditions. In the time dimension, the "short-term effects" tended to be negative, whereas "medium-term effects" and "long-term effects" tended to be positive. Generally, it is clear that tropical cyclones could cause a series of damages, such as casualties, massive evacuation, transportation paralysis, communications failure, infrastructure damage, business interruption, and suspension from work, thereby influencing employment quantity in the short term. However, in the medium and long term, sufficient manpower, material, and financial resources are needed due to the post-disaster reconstruction work, which will lead to a surge in labor demand. With regard to disaster intensity, the higher the category of the tropical cyclone, the greater its positive impact on the employment of the labor force. Specifically, a higher category indicated a greater wind speed, which would result in a greater destructive force. Therefore, post-disaster reconstruction required a greater amount of human, capital, and material resources, leading to an increase in the number of available jobs. In terms of the income dimension, low-income groups were more likely to experience a positive effect. On the one hand, in the aftermath of a tropical cyclone, people tended to cut the household budget (Groen et al. 2015). For low-income families, household expenditure was mostly on food and medical treatment, and relocation and reemployment costs were higher, so they bore a relatively heavier financial burden. However, workers with high-paying jobs or high skills had relatively sufficient money at disposal and were more likely to evacuate to safer areas, while low-paid workers had no choice but to stay in local areas (Belasen and Polachek 2007, 2008). On the other hand, although the relocation of some people reduced labor supply, post-disaster reconstruction required a large amount of labor. The gap between labor supply and demand led to an increase in employee remuneration, thus attracting a large number of low-income groups (Rodríguez-Oreggia 2013).
2) From the method aspect, OLS was used to adjust the negative employment.

[5] A note on the choice of explanatory variables: After the analysis object (literature) was studied and summarized, 20 explanatory variables (see Table 2) were set from four dimensions. However, because of the sample sizes (the maximum of which was 148) in this paper, it was impossible to list all the explanatory variables; otherwise insufficient degrees of freedom would result. Therefore, not too many explanatory variables were introduced in the paper.

[6] The results of meta-regression analysis were obtained by the software Stata11. In addition, dummy variables including "short-term effects," "medium-term effects," and "long-term effects" were also highly correlated. Therefore, the "medium-term effects" were regarded as the base variables. The "short-term effects" and "medium-term effects" were set as one group, and the "medium-term effects" and "long-term effects" were set as another for the implementation of the regression analysis. The analysis was also performed within the group consisting of the "short-term effects" and "long-term effects." The results showed that in the short term, the impact of tropical cyclones on employment quantity was enormous, while the impact was marginal in the long term. This was consistent with the conclusions of the study.

[7] In this section, because the literature on the change direction of the employment quantity affected by tropical cyclones did not include data on the primary industry, the variable "industry dimension" merely consisted of the secondary industry and the tertiary industry.

TABLE 2. Descriptions of the explaining variables.

Level	Dimension	Variables	Description
Sample data		Developed country	If the research sample is from developed countries, then the value is 1; otherwise 0
		Macro data[a]	If the research sample belongs to macro data, then the value is 1; otherwise 0
		Industry data	If the research sample belongs to industry data, then the value is 1; otherwise 0
	Industry dimension	Primary industry	If the research sample is from primary industry (i.e., agriculture, fishery), then the value is 1; otherwise 0
		Secondary industry	If the research sample is from secondary industry (e.g., construction, manufactory, mining), then the value is 1; otherwise 0
		Tertiary industry	If the research sample is from the tertiary industry (e.g.,finance and insurance, real estate, wholesale and retail trade, services), then the value is 1; otherwise 0
	Time dimension[b]	Observation period	The time span of the study period; if the study period is from 1980 to 2002, then the observation period is 23 years
		Short-term effects	The lower limit of the time span of the study period: if the year of disaster occurrence < 3, then the value is 1; otherwise, it is 0
		Medium-term effects	The lower limit of the time span of the study period: if $3 \leq$ the year of disaster occurrence < 6, then the value is 1; otherwise 0
		Long-term effects	The lower limit of the time span of the study: if the year of disaster occurrence ≥ 6, then the value is 1; otherwise, it is 0
	Disaster intensity	Disaster level	Rated according to the Saffir–Simpson hurricane wind scale
		Wind speed	The maximum wind speed of tropical cyclone center after landing (kt)
	Income dimension[c]	Low-income groups	If the sample of literature research objects are of low skill, low education, and with earnings $\leq$ \$28,500, then the value is 1; otherwise 0
		Middle-income groups	If the sample of literature research objects are of medium skill, medium education, and \$28,500 $\leq$ earnings $<$ \$50,000, then the value is 1; otherwise 0
		High-income groups	If the sample of the literature research objects are of high skill, high education, and with earnings $\geq$ \$50,000, then the value is 1; otherwise 0
Method characteristics		Panel data	If the sample data belong to panel data, then the value is 1; otherwise 0
		OLS	If OLS is employed, then the value is 1; otherwise 0
		ARMA	If ARMA is employed, then the value is 1; otherwise 0
Publication characteristics		Publication year	The year in which the document was published or publicly released
		Whether published	If the literature is published in a journal, then the value is 1; otherwise (e.g., work papers and research reports) 0

[a] Here the term ''macro data'' refers to the data that take region as a statistical unit; ''micro data'' refers to the data that take individual or household as a statistical unit.
[b] The division of time period is based on Groen's et al. (2015) criteria for short-, medium-, and long-term division.
[c] The division of income dimension is based primarily on literature's verbal and numerical description of income. The numerical descriptions of the lower limits of the low, middle, and high income refer to Groen's et al. (2015) criteria for division; the low-income group is taken to be of low-skill and low-education background, the middle-income group is of medium-skill and medium-education background, and the high-income group of high-skill and high-education background.

TABLE 3. The positive and negative meta-regression results of tropical cyclones' impact on employment quantity. The numbers in the parentheses are the corresponding regression coefficient robust standard error. One asterisk indicates a significance level of 10%, two asterisks indicate a significance level of 5%, and three asterisks indicate a significance level of 1%.

Variables	Model 1 Sample aspect	Model 2 Sample aspect	Model 3 Method aspect	Model 4 Publication aspect	Model 5 Robustness test	Model 6 Robustness test
Control variable	0.0778	0.0778	0.195***	0.0719**	0.0908	0.0908
	(0.0753)	(0.0753)	(0.0674)	(0.0366)	(0.178)	(0.178)
Developed country	−0.290	−0.290	—	—	−1.068	−1.068
	(0.491)	(0.491)	—	—	(0.970)	(0.970)
Macro data	0.282	0.282	—	—	−5.484***	−5.484***
	(1.068)	(1.068)	—	—	(1.532)	(1.532)
Secondary industry	0.611	0.611	—	—	0.217	0.217
	(0.656)	(0.656)	—	—	(0.823)	(0.823)
Tertiary industry	0.534	0.534	—	—	−0.0702	−0.0702
	(0.634)	(0.634)	—	—	(0.768)	(0.768)
Observation period	−0.0081	−0.0081	—	—	0.0162	0.0162
	(0.0407)	(0.0407)	—	—	(0.0892)	(0.0892)
Short-term effects	−0.847**		—	—	−1.009**	—
	(0.384)		—	—	(0.439)	—
Medium-term effects	−0.233	0.614*	—	—	−0.181	0.828**
	(0.375)	(0.341)	—	—	(0.408)	(0.372)
Long-term effects	—	0.847**	—	—	—	1.009**
	—	(0.384)	—	—	—	(0.439)
Cyclone intensity	0.350***	0.350***	—	—	0.319**	0.319**
	(0.127)	(0.127)	—	—	(0.147)	(0.147)
Low income	1.057**	1.057**	—	—	1.387**	1.387**
	(0.492)	(0.492)	—	—	(0.621)	(0.621)
Middle income	0.331	0.331	—	—	0.613	0.613
	(0.619)	(0.619)	—	—	(0.685)	(0.685)
High income	−0.145	−0.145	—	—	0.0113	0.0113
	(0.519)	(0.519)	—	—	(0.575)	(0.575)
Panel data	—	—	−0.184	—	−0.640	−0.640
	—	—	(0.533)	—	(1.138)	(1.138)
OLS	—	—	−1.354***	—	−6.283***	−6.283***
	—	—	(0.472)	—	(0.724)	(0.724)
ARMA	—	—	−0.0952	—	−0.680	−0.680
	—	—	(0.599)	—	(1.822)	(1.822)
Year of publication	—	—	—	−0.0355	−0.131	−0.131
	—	—	—	(0.0500)	(0.112)	(0.112)
Whether published	—	—	—	−0.185	−1.357	−1.357
	—	—	—	(0.249)	(0.881)	(0.881)
Constant	−2.042**	−2.889***	−1.084**	70.78	270.1	269.1
	(1.028)	(1.000)	(0.473)	(100.5)	(227.2)	(227.1)
Pseudo R^2	0.1657	0.1657	0.0635	0.0203	0.2399	0.2399
Sample size	135	135	148	148	135	135

3) From the literature aspect, ''year of publication'' and ''whether published'' had no significant influence. The results of the probit analysis are shown in Table 3.

b. *Impact of tropical cyclones on intensity of employment quantity change*

The impact of tropical cyclones on the intensity of employment quantity change was analyzed by multiple regression model and the results are shown in Table 4.

1) From the sample aspect, developed countries had no significant influence on the intensity of employment quantity change. However, when the macro data were employed, the change of the employment quantity was then relatively mild. In the industry dimension,[8] the industry differences led to a relatively significant change in intensity of employment quantity, and the second industry employment intensity was greater than that of

[8] In this section, because the literature on the change intensity of employment quantity affected by tropical cyclones did not include data on the primary industry, the variable ''industry dimension'' merely consisted of the secondary industry and the tertiary industry.

TABLE 4. The meta-regression results of the tropical cyclone's impact on the intensity of employment change. The numbers in the parentheses are the corresponding regression coefficient robust standard error. One asterisk indicates a significance level of 10%, two asterisks indicate a significance level of 5%, and three asterisks indicate a significance level of 1%.

Variable	Model 7 Sample aspect	Model 8 Sample aspect	Model 9 Method aspect	Model 10 Publication aspect	Model 11 Robustness testing	Model 12 Robustness testing
Control variable	−0.109***	−0.109***	0.009 83	−0.0465**	−0.0475	−0.0475
	(0.0378)	(0.0378)	(0.0171)	(0.0189)	(0.0717)	(0.0717)
Developed country	−0.0781	−0.0781	—	—	0.0865	0.0865
	(0.119)	(0.119)	—	—	(0.318)	(0.318)
Macro data	−1.246**	−1.246**	—	—	−1.381**	−1.381**
	(0.531)	(0.531)	—	—	(0.560)	(0.560)
Secondary industry	0.993**	0.993**	—	—	1.324***	1.324***
	(0.410)	(0.410)	—	—	(0.475)	(0.475)
Tertiary industry	0.602*	0.602*	—	—	0.984**	0.984**
	(0.331)	(0.331)	—	—	(0.433)	(0.433)
Observation period	0.0655**	0.0655**	—	—	0.0876***	0.0876***
	(0.0261)	(0.0261)	—	—	(0.024)	(0.024)
Short-term effects	0.238*	—	—	—	0.144*	—
	(0.125)	—	—	—	(0.0863)	—
Medium-term effects	0.0647	−0.174	—	—	0.008 12	−0.136
	(0.105)	(0.177)	—	—	(0.0753)	(0.139)
Long-term effects	—	−0.238*	—	—	—	−0.144*
	—	(0.125)	—	—	—	(0.0863)
Cyclone intensity	0.0547*	0.0547*	—	—	0.0141	0.0141
	(0.0323)	(0.0323)	—	—	(0.026)	(0.026)
Low income	−0.160	−0.160	—	—	−0.107	−0.107
	(0.119)	(0.119)	—	—	(0.0953)	(0.0953)
Medium income	−0.248**	−0.248**	—	—	−0.174*	−0.174*
	(0.115)	(0.115)	—	—	(0.0954)	(0.0954)
High income	−0.226*	−0.226*	—	—	−0.103	−0.103
	(0.114)	(0.114)	—	—	(0.0956)	(0.0956)
Panel data	—	—	−0.357***	—	−0.790**	−0.790**
	—	—	(0.121)	—	(0.384)	(0.384)
OLS	—	—	−0.224	—	−0.0921	−0.0921
	—	—	(0.195)	—	(0.165)	(0.165)
ARMA	—	—	0.706	—	−1.158**	−1.158**
	—	—	(0.460)	—	(0.464)	(0.464)
Year of publication	—	—	—	−0.0678**	−0.0718	−0.0718
	—	—	—	(0.0336)	(0.073)	(0.073)
Whether published	—	—	—	0.000 057 9	0.144	0.144
	—	—	—	(0.0968)	(0.403)	(0.403)
Constant	0.773***	1.012***	0.492***	137.1**	145.0	145.2
	(0.268)	(0.309)	(0.151)	(67.64)	(147.7)	(147.7)
R^2	0.429	0.429	0.323	0.223	0.492	0.492
Sample size	135	135	148	148	135	135

the tertiary industry. On the one hand, the sensitivity of various sectors to the disaster intensity and their ability of disaster prevention and mitigation varied. On the other hand, post-disaster reconstruction and industrial rehabilitation included rebuilding damaged buildings, roads, bridges, and other facilities (Jiang 2012), which would inevitably result in a greater demand for labor in the secondary industry. Nevertheless, due to the lack of primary industry data, the change of the employment intensity in the primary industry could not be observed. In the time dimension, the impact of the disaster on short-term employment quantity was greater, whereas the changes in medium-term and long-term employment were insignificant and mild respectively. Along with the post-disaster reconstruction, the society and economy gradually returned to normal, facilitating the restoration of normal labor market conditions. Thus, the impact of the hurricanes on employment quantity was gradually abated. In terms of the disaster intensity, the higher the hurricane's category, the greater its impact on employment quantity, although the statistics were not robust. In the income dimension, the change in employment quantity of high-income groups was relatively mild, while the statistics of high-income groups were not robust [the results of models (7) and (8) were inconsistent with the significant results of the robustness testing models (11) and (12)].

2) From the method aspect, the panel data model was employed to reduce the intensity of employment quantity change.
3) From the literature aspect, there were differences between the model (10) and models (11) and (12), indicating that "year of publication" and "whether published" were not significant.

c. *Impact of tropical cyclones on direction of employee remuneration*

A probit model was used to analyze the impact of tropical cyclones on employee remuneration. The results are shown in Table 5.

1) From the sample aspect, developed countries were more likely to experience a positive effect on employee remuneration because they had higher resilience to disasters. For example, their construction of disaster mitigation facilities, infrastructure, and houses was more efficient and solid than that in developing countries. Moreover, enterprises and residents there possessed richer disaster mitigation knowledge and defensive measures compared with those in developing countries. Therefore, disasters were relatively less destructive and more conducive to the recovery of the labor market in developed countries. In the industry dimension,[9] there was no significant change in employee remuneration of the primary industry.[10] The reason might be that its impact was not reflected due to the limited data from the primary industry. However, the coefficient of the tertiary industry that mainly consists of the tourism industry, retail trade, and others was negative. Hurricanes led to a slump in the tourism industry and tropical cyclones disrupted the normal operation of enterprises. In addition, a drop in output would also affect export trade, so employee remuneration in the tertiary industry was relatively reduced. In the time dimension, tropical cyclones decreased the employee remuneration in the short term but increased it in the long run. Olsen and Porter (2013) also pointed out that prices and labor costs would rise after a large-scale natural disaster, which might explain why employee remuneration increased. From the cyclone intensity aspect, a higher category of the tropical cyclone would cause a greater positive impact on the employment of the labor force. In the income dimension, the employee remuneration of the middle- and low-income groups was even lower. The low-income people relatively had the poor resilience to disasters and tended to reduce education expenses to make up for the losses caused by disasters. This, in turn, weakened their capability of disaster prevention and mitigation, and their corresponding endurance was also diminished, putting them into a vicious circle. Moreover, the places where the majority of low-income groups live were disaster-prone regions. By contrast, high-income groups tended to take various measures to mitigate the damage caused by natural disasters (Sadowski and Sutter 2005). Consequently, disasters would cause more damage to low-income people.
2) From the method aspect, the research method employed had no significant influence on positive and negative regulation of employee remuneration.
3) From the literature aspect, neither "year of publication" nor "whether published" had statistical significance.

d. *Impact of tropical cyclones on intensity of employee remuneration change*

The impact of tropical cyclones on the intensity of employee remuneration change was analyzed by multiple regression models. The results are shown in Table 6.

1) From the sample aspect, the impact of tropical cyclones on employee remuneration in developed countries was relatively mild. In the industrial dimension,[11]

[9] In this section, because the literature on the change direction of employment remuneration affected by tropical cyclones included data on the primary industry, the variable "industry dimension" consisted of the primary industry, the secondary industry, and the tertiary industry.

[10] When using the binary selection model to analyze the positive and negative effects on employee remuneration, we found that the estimation coefficient of the primary industry was missing, which could be explained by two reasons. First, there was a serious collinearity problem between the primary industry and other explanatory variables in the model. Correlation analysis showed that the primary industry was highly correlated with industry variable, which had already been excluded from all the models. Second, the positive and negative regression coefficients between the primary industry and wage were very small and thus ignored by the Stata program automatically. Therefore, in the first industry, the regression coefficient was so small that it had been ignored by the Stata program. It was classified as the second reason. The same was true with the panel data variables. Since the literature involving the impact of disasters on employee remuneration did not employ an autoregressive moving average model, there were no ARMA variables in Tables 5 and 6.

[11] In this section, because the literature on the change intensity of employment remuneration affected by tropical cyclones included data on the primary industry, the variable "industry dimension" consisted of the primary industry, the secondary industry, and the tertiary industry.

TABLE 5. The meta-regression results of positive and negative effects of tropical cyclones on employee remuneration. The numbers in the parentheses are the corresponding regression coefficient robust standard error. One asterisk indicates a significance level of 10%, two asterisks indicate a significance level of 5%, and three asterisks indicate a significance level of 1%.

Variables	Model 13 Sample aspect	Model 14 Sample aspect	Model 15 Method aspect	Model 16 Publication aspect	Model 17 Robustness testing	Model 18 Robustness testing
Control variable	0.459***	0.459***	0.209***	0.174***	0.286	0.286
	(0.157)	(0.157)	(0.0442)	(0.0418)	(0.200)	(0.200)
Developed country	2.124*	2.124*	—	—	2.213**	2.213**
	(1.102)	(1.102)	—	—	(1.101)	(1.101)
Macro data	0.769	0.769	—	—	0.065	0.065
	(1.069)	(1.069)	—	—	(1.399)	(1.399)
Primary industry	0	0	—	—	0	0
	(0)	(0)	—	—	(0)	(0)
Secondary industry	−0.127	−0.127	—	—	0.189	0.189
	(0.921)	(0.921)	—	—	(0.826)	(0.826)
Tertiary industry	−1.555**	−1.555**	—	—	−1.195*	−1.195*
	(0.766)	(0.766)	—	—	(0.656)	(0.656)
Observation period	0.425**	0.425**	—	—	0.427***	0.427***
	(0.166)	(0.166)	—	—	(0.161)	(0.161)
Short-term effects	−0.778*	—	—	—	−0.855*	—
	(0.424)	—	—	—	(0.442)	—
Medium-term effects	1.568***	2.346***	—	—	1.348***	2.203***
	(0.514)	(0.529)	—	—	(0.441)	(0.485)
Long-term effects	—	0.778*	—	—	—	0.855*
	—	(0.424)	—	—	—	(0.442)
Cyclone intensity	0.267*	0.267*	—	—	0.403**	0.403**
	(0.148)	(0.148)	—	—	(0.189)	(0.189)
Low income	−0.973**	−0.973**	—	—	−0.991*	−0.991*
	(0.493)	(0.493)	—	—	(0.536)	(0.536)
Middle income	−1.353**	−1.353**	—	—	−1.328**	−1.328**
	(0.574)	(0.574)	—	—	(0.570)	(0.570)
High- income	−0.363	−0.363	—	—	−0.196	−0.196
	(0.616)	(0.616)	—	—	(0.630)	(0.630)
OLS	—	—	−0.517	—	−0.341	−0.341
	—	—	(0.344)	—	(0.536)	(0.536)
Year of publication	—	—	—	−0.0078	−0.0604	−0.0604
	—	—	—	(0.0574)	(0.190)	(0.190)
Whether published	—	—	—	0.0201	1.073	1.073
	—	—	—	(0.239)	(0.796)	(0.796)
Constant	−10.02***	−10.80***	−1.384***	14.24	112.9	112.1
	(3.351)	(3.221)	(0.446)	(115.4)	(385.1)	(385.2)
Pseudo R^2	0.3717	0.3717	0.0954	0.0931	0.3812	0.3812
Sample size	171	171	208	209	170	170

employee remuneration in the primary industry suffered a relatively greater loss because the primary industry mainly includes agriculture and fisheries, which are of weak resilience and thus vulnerable to tropical cyclones. Nevertheless, the change intensity of employee remuneration of the secondary industry was slighter than that of the primary industry, although the result was not stable; the change of employee remuneration in the tertiary industry was not significant. In the time dimension, the change intensity of employee remuneration in the short and long term was not significant, while the change of the midterm employee remuneration was relatively mild. From the perspective of cyclone intensity, the category of hurricanes had no significant impact on change intensity of employee remuneration. In the income dimension, the employee remuneration of the low-income groups changed greatly but had no statistical significance. The middle-income groups' remuneration changed mildly, although the result was not stable.

2) From the method aspect, model (21) was different from models (23) and (24), so the adoption of the research method had no significant influence on the positive and negative regulation of employee remuneration.
3) In the literature aspect, neither ''year of publication'' nor ''whether published'' had statistical significance.

TABLE 6. Meta-regression results of tropical cyclones' impact on the intensity of employee remuneration change. The numbers in the parentheses are the corresponding regression coefficient robust standard error. One asterisk indicates a significance level of 10%, two asterisks indicate a significance level of 5%, and three asterisks indicate a significance level of 1%.

	Model 19	Model 20	Model 21	Model 22	Model 23	Model 24
Variable	Sample aspect	Sample aspect	Method aspect	Publication aspect	Employee remuneration	Employee remuneration
Control variable	−0.0108***	−0.0108***	−0.0227	−0.0542	−0.011**	−0.011**
	(0.003 04)	(0.003 04)	(0.0189)	(0.0414)	(0.004 36)	(0.004 36)
Developed country	−0.0527***	−0.0527***	—	—	−0.0445*	−0.0445*
	(0.0125)	(0.0125)	—	—	(0.0254)	(0.0254)
Macro data	−0.0411**	−0.0411**	—	—	−0.0742***	−0.0742***
	(0.0204)	(0.0204)	—	—	(0.0272)	(0.0272)
Primary industry	0.0652***	0.0652***	—	—	0.0664***	0.0664***
	(0.0114)	(0.0114)	—	—	(0.0125)	(0.0125)
Secondary industry	0.0265*	0.0265*	—	—	0.028	0.028
	(0.0151)	(0.0151)	—	—	(0.0173)	(0.0173)
Tertiary industry	−0.009 97	−0.009 97	—	—	−0.007 66	−0.007 66
	(0.008 79)	(0.008 79)	—	—	(0.0124)	(0.0124)
Observation period	−0.002 52	−0.002 52	—	—	0.000 509	0.000 509
	(0.001 62)	(0.001 62)	—	—	(0.001 75)	(0.001 75)
Short-term effects	−0.003 15	—	—	—	0.006 38	—
	(0.008 56)	—	—	—	(0.008 23)	—
Medium-term effects	−0.0145**	−0.0114	—	—	−0.008 34	−0.0147*
	(0.005 75)	(0.007 89)	—	—	(0.005 93)	(0.007 77)
Long-term effects	—	0.003 15	—	—	—	−0.006 38
	—	(0.008 56)	—	—	—	(0.008 23)
Cyclone intensity	0.003 23	0.003 23	—	—	0.003 73	0.003 73
	(0.002 67)	(0.002 67)	—	—	(0.002 56)	(0.002 56)
Low income	0.006 22	0.006 22	—	—	0.001 81	0.001 81
	(0.009 72)	(0.009 72)	—	—	(0.0116)	(0.0116)
Middle income	−0.0177*	−0.0177*	—	—	−0.0187	−0.0187
	(0.0103)	(0.0103)	—	—	(0.0117)	(0.0117)
High income	−0.003 89	−0.003 89	—	—	−0.004 86	−0.004 86
	(0.0117)	(0.0117)	—	—	(0.0124)	(0.0124)
Panel data	—	—	0.0286	—	−0.0598	−0.0598
	—	—	(0.148)	—	(0.0479)	(0.0479)
OLS	—	—	−0.200	—	−0.0343**	−0.0343**
	—	—	(0.305)	—	(0.0141)	(0.0141)
Year of publication	—	—	—	0.0198	−0.001 83	−0.001 83
	—	—	—	(0.0206)	(0.003 87)	(0.003 87)
Whether published	—	—	—	0.221	−0.003 19	−0.003 19
	—	—	—	(0.200)	(0.024)	(0.024)
Constant	0.247***	0.244***	0.547*	−39.26	3.996	4.002
	(0.0457)	(0.0452)	(0.311)	(41.04)	(7.808)	(7.809)
R^2	0.302	0.302	0.032	0.044	0.359	0.359
Sample size	174	174	209	209	174	174

e. *Robustness analysis*

To test the stability of the results of meta-regression analysis, robustness analysis was applied to all the regression results from both variables and data aspects. Explanatory variables were added, and the sample size was also increased for analysis.

1) The regression of the total variables was conducted, meaning that the characteristic variables from the sample aspect, the method aspect, and the publication aspect were all included in the meta-regression model. The estimated results are shown in the last two columns of Tables 3–6.
2) The estimated values, regardless of whether they were statistically significant or not, were put into the meta-regression analysis. The results are shown in Tables S1–S4 in the online supplemental material. It can be seen that part of the results was not robust. The conclusions drawn in this paper were consistent with the robustness analysis. However, some results showed that tropical cyclones exerted no impact on employee remuneration.

Variables such as "short-term effect," "medium-term effect," and "long-term effect" showed the insignificant effect on the intensity of employee remuneration change when judging from the time dimension, and the variable "primary industry" presented no significant effect on employee remuneration when judging from the industrial dimension.

The reasons for such phenomena might include the following three aspects:

1) According to the original literature (see Table 1), the effect per se of these variables on employee remuneration was not significant, thus resulting in insignificant regression results during the meta-analysis.
2) Samples in the existing analysis object (literature) were collected from different countries (regions) and different industries at different time stages, and there were both positive and negative regression coefficients originally. Therefore, the statistical results might be insignificant during the meta-analysis.
3) The small amount of existing analysis object (literature) led to the insignificant regression results.

To solve the problem and obtain a general statistic rule, a feasible way is to expand the sample size (research literature) for more sample information. Nevertheless, this method could not guarantee that all variables have statistically significant effects on employment of labor force and employee remuneration.

6. Conclusions and discussion

Through reviewing the literature concerning impacts of disasters on the mechanism of the labor market, this paper has explored the impacts of tropical cyclones on the quantity of labor employed and employee remuneration from the following four dimensions: industry, time, income, and cyclone intensity. Meta-regression analysis has been employed. The final conclusions are as follows.

1) In the industry dimension, industry differences have shown a significant impact on the change intensity of the quantity of labor employed and employee remuneration. The quantities of labor employed in the secondary and tertiary industries have varied greatly due to tropical cyclones, and the change in the secondary industry has been greater than that in the tertiary industry. In addition, the employee remuneration of the primary industry has been strongly influenced by tropical cyclones. Therefore, the employee remuneration of the primary industry has suffered a great loss.
2) In the time dimension, the impact of tropical cyclones on labor employment has been negative, and the impact intensity has been large in the short term. The long-term impact, however, has been positive and decreased gradually. Therefore, it can be seen that the negative impact of tropical cyclones on labor employment has been gradually restored through post-disaster reconstruction.
3) In the income dimension, the disaster has promoted the employment rate of low-income groups but reduced their remuneration. Moreover, the change in the quantity of labor employed caused by disasters in the medium- and high-income groups has been relatively mild. Therefore, it suggests that low-income people have been more vulnerable to tropical cyclones, while the disaster has exerted less impact on high-income groups.
4) In the disaster intensity dimension, a higher category of a tropical cyclone has resulted in a greater positive impact on the quantity of labor employed and employee remuneration.

According to the above research findings, the following recommendations are proposed for the reconstruction in the aftermath of the natural disasters like tropical cyclones.

1) Post-disaster assistance policy should favor low-income groups. Investment in health care and education for low-income people should be increased in order to improve their consciousness of disaster prevention and mitigation and to enhance their anti-disaster ability (Wu et al. 2017).
2) Take low-income groups as the key protected target. Great attention must be paid to assist and support industries in less-developed areas, especially the primary industry. Furthermore, the government should issue corresponding policies to provide "temporary disaster subsidies" for disaster-stricken low-income groups.
3) Build a sound employment insurance system against natural disasters. In the short term, the disaster insurance system can reduce the huge risk caused by tropical cyclones and alleviate the economic burden of afflicted people and enterprises through economic compensation. In the long term, it can realize full potential in financing, which can inject funds into post-disaster restoration activities, thus accelerating the reconstruction work in the aftermath of disasters (Wu et al. 2018).
4) During the post-disaster reconstruction, attention should be paid to the development of the secondary industry such as construction and housing. Normal operation of key lifelines, such as roads, water, and electricity, should be restored as soon as possible.

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