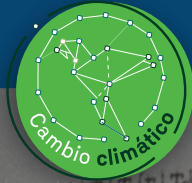


# BORRADORES DE ECONOMÍA



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By:

Juan Pablo Bermudez-Cespedes  
Luis Fernando Melo-Velandia  
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# Do natural disasters and the announcement of ENSO events have an impact on market-based measures of inflation expectations?

Juan Pablo Bermudez-Cespedes<sup>\*</sup>      Luis Fernando Melo-Velandia<sup>†</sup>  
Daniel Parra-Amado<sup>‡</sup>

The results and opinions are exclusive responsibility of the authors and those do not commit Banco de la República nor its board of directors.

## Abstract

This research investigates the influence of natural disasters and climate-related announcements, particularly those associated with the El Niño Southern Oscillation (ENSO), on inflation expectations within the Colombian economy. Employing an event study framework, we analyze daily data on inflation expectations derived from the Colombian public debt market spanning October 2004 to August 2022, in conjunction with the Emergency Events Database (EM-DAT) and ENSO announcements from international agencies. Our findings provide evidence that both types of events significantly influence the mean of the inflation expectations. Moreover, while natural disasters increase the volatility of inflation expectations, ENSO announcements do not exhibit a similar effect.

*JEL codes:* C58, C4, E31, Q54

*keywords:* Natural disasters, inflation expectations, GARCH, Event study

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<sup>\*</sup>Economist in the Financial Stability Department at the Banco de la República de Colombia.  
E-mail: jbermuce@banrep.gov.co

<sup>†</sup> Senior econometrician in the Econometric Unit at the Banco de la República de Colombia.  
E-mail: lmelovel@banrep.gov.co

<sup>‡</sup> Researcher in the Macroeconomic Models Department at the Banco de la República de Colombia.  
E-mail: dparraam@banrep.gov.co

# ¿Los desastres naturales y los anuncios de eventos ENSO tienen un impacto en las medidas de expectativas de inflación basadas en el mercado de deuda pública?

Juan Pablo Bermudez-Cespedes<sup>1</sup>      Luis Fernando Melo-Velandia<sup>2</sup>  
Daniel Parra-Amado<sup>3</sup>

Los resultados y opiniones contenidas en el presente documento son responsabilidad exclusiva de los autores y no comprometen al Banco de la República ni a su Junta Directiva.

## Resumen

Esta investigación analiza la influencia de los desastres naturales y los anuncios relacionados con el clima, en particular aquellos asociados con el fenómeno de El Niño-Oscilación del Sur (ENSO), sobre las expectativas de inflación en la economía colombiana. Empleando un enfoque de estudio de eventos donde se analizan datos diarios de expectativas de inflación derivadas del mercado de deuda pública de Colombia, abarcando el período de octubre de 2004 a agosto de 2022, en conjunto con la base de datos de eventos de emergencia (EM-DAT) y los anuncios de ENSO emitidos por agencias internacionales. Nuestros hallazgos evidencian que ambos tipos de eventos influyen significativamente en la media de las expectativas de inflación. Además, mientras que los desastres naturales aumentan la volatilidad de estas expectativas, los anuncios de ENSO no muestran un efecto similar.

*Clasificación JEL:* C58, C4, E31, Q54

*Palabras clave:* Desastres naturales, Expectativas de inflación, GARCH, Estudio de eventos

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<sup>1</sup> Economista del Departamento de Estabilidad Financiera del Banco de la República Colombia. E-mail: jbermuce@banrep.gov.co

<sup>2</sup> Econometrista Principal de la Unidad de Investigaciones del Banco de la República Colombia. E-mail: lmelo-vel@banrep.gov.co

<sup>3</sup> Investigador del Departamento de Modelos Macroeconómicos del Banco de la República Colombia. Email: dparraam@banrep.gov.co

# 1 Introduction

Climate change is being increasingly acknowledged as a major catalyst for natural disasters with profound implications for global safety and economic stability due to the increasing in the frequency and intensity of phenomena such as floods, droughts, storms, and heatwaves (Hoeppe (2016), Zhang and Managi (2020)). According to the World Bank, natural disasters have caused average annual losses of 2% of GDP in low-income economies from 2011 to 2023, five times the losses in middle-income nations. In 2023, over 400 natural disasters occur which resulted in a staggering \$250 billion loss and claimed 74,000 lives globally where developing countries were more exposed to that losses. Noy (2009) and Klomp and Valckx (2014) show that developing nations experience more substantial declines in output than their developed counterparts when faced with disasters of comparable severity. Those severe weather events often lead to higher prices by disrupting supply and increasing costs which presents a challenge for central banks aiming to control inflation.

While natural disasters disrupt supply chains and key economic sectors, no empirical research has established a strong link between these events and inflation in Colombia. Despite growing awareness of these effects, their impact on inflation remains insufficiently studied. In particular, understanding how natural disasters or ENSO announcements affect inflation is essential within the framework of monetary policy in Colombia due to primary activities, such as agriculture, are susceptible to weather conditions and natural disasters. Although our research does not provide a causal analysis, it is a pioneering attempt to explore this topic, specifically, we examine whether these events influence inflation expectations derived from the public debt market. Furthermore, in the Colombian context, it is widely agreed that the El Niño Southern Oscillation (ENSO) phenomenon significantly impacts food prices (Abril-Salcedo et al. (2016), Abril-Salcedo et al. (2020), Bejarano-Salcedo et al. (2020)), and through the expectations channel, indirectly influences the behavior of other prices and consequently monetary policy scenarios (Romero et al. (2023), Romero and Naranjo-Saldarriaga (2024)). Therefore, to the best of our knowledge, this is the first study to assess the impact of events related to natural disasters and ENSO announcements on inflation expectations.

Given that, this article investigates a key question: Do natural disasters and ENSO announcements influence market-based measures of inflation expectations in Colombia?. To answer this, we adopt an event study methodology, analyzing daily inflation expectations derived from the Colombian public debt market from 2004 to 2022. We integrate these data with records from the Emergency Events Database (EM-DAT) and ENSO announcements from international agencies. By measuring abnormal movements in inflation expectations following these events, we assess both their immediate impact on the mean of inflation expectations and their effects on their volatility. This approach is reasonable because event studies are well-suited for isolating the impact of discrete shocks, allowing us to control for broader economic trends. Furthermore, the methodology is

widely used in financial and macroeconomic research to assess the market response to exogenous events.

Our findings provide evidence that both natural disasters and ENSO announcements significantly influence inflation expectations in Colombia. However, their effects differ: natural disasters not only increase inflation expectations but also raise their volatility, whereas ENSO announcements affect expectations across all horizons but do not alter their volatility. This suggests that while markets adjust their inflation forecasts based on climate-related information, the uncertainty surrounding natural disasters is more disruptive than ENSO-related news. This paper contributes to economic research by highlighting the importance of climate-related shocks in shaping inflation expectations, a topic that has received limited attention in the literature. By demonstrating that markets respond to both physical disasters and climate forecasts, our study challenges traditional inflation modeling, which often overlooks environmental risks.

The structure of the paper is as follows: After this introductory section, Section 2 offers a brief review of the literature on the influence of natural disasters on inflation and its expectations. Also, we review the impacts of ENSO announcements. Subsequently, Section 3 outlines the data and methodology employed. Section 4 show the main findings of this research. Finally, Section 5 wraps up the article by discussing its limitations and offering recommendations for future research.

## 2 Literature review

The impact of natural disasters on inflation is a complex issue that has been understudied. Theoretically, the net effect depends on various economic factors. Two primary channels can be identified: First, an inflationary channel, where natural disasters lead to infrastructure damage and crop destruction, causing negative supply shocks (as highlighted by [Batten \(2018\)](#) and [Batten et al. \(2020\)](#)). In the case of weather-related natural disasters, there seems to be a consensus that events such as droughts or floods are associated with price increases. Second, a deflationary channel, where the destruction of physical capital reduces wealth and thus dampens consumption and investment, and a possible fall in prices due to low demand ([Keen and Pakko \(2011\)](#) and [Doyle and Noy \(2015\)](#)). [Dietrich et al. \(2021\)](#) analyze extreme disasters due to climate change and their relationship with expectations on inflation and output in United States by using a New Keynesian model. Based on survey data, they find that household expectations exhibit a pattern of overestimating the probability of extreme climate-related events compared to historical records. Simulating this bias, the model shows inflation and GDP falling by 0.3% and 0.2%, respectively. Their findings suggests the significant role of the expectations in the economic outcomes after rare natural disasters.

[Parker \(2018\)](#)<sup>1</sup> reveals significant heterogeneity in the inflationary effects of natural disasters. While emerging economies suffer from a substantial and long-lasting impact, developed countries experience a much weaker or even negligible effect. In particular, for those countries where the impact is significant, inflationary effects could persist for one to three years after the natural disaster. In addition, in the specific case of climate disasters, evidence suggests increases in the prices of goods, while some earthquakes might reduce CPI inflation excluding food, housing and energy. [Heinen et al. \(2019\)](#) find a positive impact of hurricanes and floods on inflation using a sample of 15 Caribbean countries. Similar findings are reported [Laframboise and Loko \(2012\)](#) (for seven countries- advanced and developing) and [Abe et al. \(2014\)](#) in Japan. [Beirne et al. \(2022\)](#) find a significantly positive correlation between natural disasters and headline inflation. However, results diverge across different price categories. While food and beverage prices are particularly sensitive to disaster shocks, other prices tend to decrease. Country-specific analysis indicates that Italy and Spain experienced more pronounced inflationary pressures compared to Germany and France. A key finding is these inflationary effects are transitory, dissipating within six months.

Given the above, it is natural to ask how these events affect monetary policy. [Klomp \(2020\)](#) examines how earthquakes influence central bank interest rate decisions where there is a trade-off between stimulate the economy and control inflation after a earthquake. While countries with fixed exchange rates are more likely to raise rates to combat inflation, those with more flexible policies tend to cut rates to stimulate economic growth. [Cantelmo et al. \(2024\)](#) find that central banks lack a consistent response to natural disasters, despite their increasing frequency and severity. However, their findings suggests the inflation targeting scheme as the best strategy, rather than accommodating these shocks through monetary easing.

Regarding inflation expectations, [Baker et al. \(2020\)](#) examine how professional economic forecasters' disregard for disaster risk influences their predictions in light of actual disaster events. Their findings suggest a significant degree of forecast persistence where experts are reluctant to change their forecasts in the face of unexpected shocks. However, they show that forecast inertia is substantially reduced in the aftermath of natural disasters. [Meinerding et al. \(2023\)](#) find a negative correlation between climate change concern and inflation expectations over the next five years. Importantly, this relationship persists even after accounting for personal climate risk perceptions, distrust in the central bank, and a comprehensive set of demographic and socioeconomic factors.

### 3 Data and methodology

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<sup>1</sup>By using a panel regression over the period 1980-2012 for 212 countries.

### 3.1 Data

We use the Break-Even Inflation rate (BEI) as proxy of inflation expectations. The BEI is the difference between the nominal yield on a fixed-rate investment and the real yield (fixed spread) on an inflation-linked investment of similar maturity and credit quality. In our case, we take the BEI derived from the sovereign debt market for the short and medium term (from one year to five years). The sample we were able to obtain starts on October 10, 2004, and it ends on August 10, 2022. In Table 1, we present the descriptive statistics of the levels (BEI) and the first difference ( $\Delta$  BEI).

**Table 1:** Descriptive statistics

	BEI					$\Delta$ BEI				
	1y	2y	3y	4y	5y	1y	2y	3y	4y	5y
Minimum	-3.10	0.16	1.31	1.60	1.89	-5.60	-2.50	-1.78	-1.62	-1.79
Maximum	8.77	7.80	7.56	7.92	7.95	5.50	2.25	1.78	1.79	2.02
Mean	3.65	3.76	3.86	3.96	4.04	0.00	0.00	0.00	0.00	-0.00
Std. Dev	1.42	1.19	1.10	1.06	1.04	0.39	0.19	0.15	0.15	0.16
Skewness	0.64	0.81	0.93	1.00	1.04	-0.31	-0.21	0.00	0.14	0.24
Kurtosis	3.31	3.36	3.51	3.59	3.60	56.57	39.34	27.32	29.56	28.93

The table reports the summary descriptive statistics for BEI and its first difference ( $\Delta$  BEI) at different maturities (from one year to five years, i.e, 1y, 2y, ..., 5y).

Regarding the natural disasters data, we have opted to employ the internationally recognized Emergency Events Database (EM-DAT) published by the Centre for Research on the Epidemiology of Disasters (CRED)<sup>2</sup>. Our data collection focused on cataloging natural disasters occurring within the time frame spanning from October 10, 2004, to August 10, 2022 in Colombia which effect could be identified as short-term impact. Although the database include Biological and Climatological events, we removed those from the analysis due to their long-lived categorization. In particular, we take the geophysical disasters originate from solid earth processes, hydrological disasters stem from occurrences, movements, and distributions of surface and subsurface freshwater and saltwater, meteorological disasters are events categorized as **short-lived** by the Integrated Research on Disaster Risk (IDRD). In Table 9 we provide a breakdown of the disasters corresponding to each disaster type.

As the event study method's effectiveness hinges on the precise identification of the event's commencement date, we opted to exclude the outcomes pertaining to disasters lacking information about their initiation date and its duration. Table 2 presents the count and the proportion of each type and subtype of disaster within our sample. Notably, in the Colombian case the most prevalent

<sup>2</sup>This database can be accessed in the next link <https://www.emdat.be/>

type of disasters are hydrological, specifically on flood events which represent around 78.12% of the sample.

**Table 2:** Proportion of each disaster type.

Disaster Type	Disaster Subtype	Count	Proportion
Geophysical	Earthquake	2	6.25%
	Volcanic Activity	1	3.13%
	<b>Subtotal</b>	<b>3</b>	<b>9.38%</b>
Hydrological	Flood	25	78.12%
	Landslide	2	6.25%
	<b>Subtotal</b>	<b>27</b>	<b>84.37%</b>
Meteorological	Storm	2	6.25%
	Extreme temperature	0	0%
	<b>Subtotal</b>	<b>2</b>	<b>6.25%</b>
<b>Total</b>		<b>32</b>	<b>100%</b>

The table presents the count and proportion of each disaster type for Colombia.

Despite excluding climatological events from the EM-DAT database, it is important to analyze a weather event such as the El Niño Southern Oscillation (ENSO), which is highly relevant to food price behavior in Colombia, as described in the previous section. To examine the expectations channel, we compiled a series of announcements issued by international agencies including the National Oceanic and Atmospheric Administration (NOAA) and the Australian Government Bureau of Meteorology (BOM) regarding potential ENSO events (Table 3). The purpose is to assess whether climate news, rather than the event itself, affects Colombian inflation expectations.

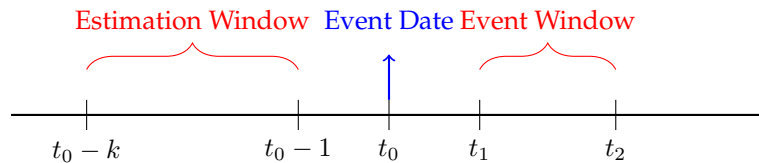
**Table 3: ENSO announcements**

El niño watch	El niño alert	El niño	La niña watch	La niña alert	La niña
30/06/2004	26/07/2004	06/09/2006	04/04/2007	02/05/2007	19/09/2007
23/03/2005	26/07/2006	19/08/2009	30/03/2016	29/10/2008	19/12/2008
28/06/2006	22/07/2009	29/04/2015	11/10/2017	28/04/2010	07/07/2010
18/02/2009	26/03/2014	-	10/06/2020	31/08/2011	28/09/2011
25/04/2012	05/11/2014	-	01/09/2021	08/11/2017	22/11/2017
15/01/2014	06/01/2015	-	-	05/08/2020	16/09/2020
16/07/2014	26/09/2018	-	-	29/09/2021	10/11/2021
18/02/2015	-	-	-	-	-
15/02/2017	-	-	-	-	-
06/06/2018	-	-	-	-	-

Source: National Oceanic and Atmospheric Administration (NOAA) and Australian Government Bureau of Meteorology (BOM). For more information visit [ENSO Outlook from BOM- an alert for the El Niño-Southern Oscillation](#)

### 3.2 Methodology

The Event Study Methodology is employed to measure both the influence of natural disasters El Niño-Southern Oscillation (ENSO) announcements on the Colombia’s expected inflation mean and their variance. These estimations use the break-even inflation rate at different maturities (1, 2, 3, 4 and 5 years) as proxy of inflation expectations. The methodology relies on a time series framework divided into two intervals: the estimation window and the event window. Based on the estimation window, the mean and the variance of the series are forecasted. During the event window, abnormal values are identified by calculating the discrepancy between these forecasts and the actual observed outcomes. As illustrated in Figure 1,  $t_0$  marks the event date, while  $t_1$  and  $t_2$  denote the start and end of the event window, respectively. The estimation window begins at  $t_0 - k$  and concludes at  $t_0 - 1$ , covering the interval  $[(t_0 - k), (t_0 - 1)]$ . Meanwhile, the event window spans  $[t_1, t_2]$ , capturing the period where deviations from the model’s predictions are analyzed. In our exercises, for the mean and the variance, the lengths of the estimation and event windows are 500 and 15 days, respectively.

**Figure 1: Event Study Framework**

Given this methodology, we estimated the following model:

$$Y_{i,t} = \theta_0 + \theta_1 Y_{i,t-1} + \dots + \theta_p Y_{i,t-p} + \gamma_i Z_{i,t} + \epsilon_{i,t} \quad (1)$$

$$\epsilon_{i,t} = \eta_{i,t} \sigma_{i,t}, \quad \eta_{i,t} \stackrel{\text{iid}}{\sim} (0, 1) \quad (2)$$

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_1 \epsilon_{i,t-1}^2 + \beta_1 \sigma_{i,t-1}^2 \quad (3)$$

Here,  $Y_{i,t}$  represents the first difference of the break-even inflation rate, for the  $i$ -th event and the time period  $t$ , where  $i = 1, \dots, N$  and  $t = 1, \dots, T$ .  $Z_{i,t}$  denotes a matrix containing some control variables: i) a real activity index<sup>3</sup>, ii) the degree of de-anchoring of inflation expectations<sup>4</sup> and iii) the VIX index, as an uncertainty measure in global markets.<sup>5</sup>  $\epsilon_{i,t}$  represents the error term,  $\eta_{i,t}$  is the standardized error, and  $\sigma_{i,t}^2$  is the conditional variance of  $\epsilon_{i,t}$ .

The next step in the Event Study Methodology corresponds to calculating abnormal returns within the event window. This is expressed as  $AR_{i,t} = Y_{i,t} - E[Y_{i,t}]$ , where  $E[Y_{i,t}]$  represents the forecasted mean of the series based on information available up to  $t_0 - 1$ . Subsequently, the Cumulative Abnormal Return (CAR) is estimated as  $CAR_i = \sum_{t=t_1}^{t_2} AR_{i,t}$ . Finally, the Cumulative Average Abnormal Return (CAAR) is obtained by averaging the individual Cumulative Abnormal Returns, given by  $CAAR = \frac{1}{N} \sum_{i=1}^N CAR_i$ , where  $N$  denotes the total number of events

Following the approach outlined by [Savickas \(2003\)](#) and [Demirer and Kutan \(2010\)](#), we employ the following statistics to assess the aggregate impact of the announcements. The corresponding null and alternative hypotheses are expressed as  $H_0 : CAAR \leq 0$  and  $H_1 : CAAR > 0$ , respectively.

$$\tau = \sum_{i=1}^N S_{i,T} \cdot N^{-1} \left( N^{-1} \cdot (N-1)^{-1} \cdot \sum_{i=1}^N \left( S_{i,T} - \sum_{j=1}^N S_{j,T} \cdot N^{-1} \right)^2 \right)^{-\frac{1}{2}} \quad (4)$$

$$\tau \stackrel{H_0}{\sim} t(N-1) \quad (5)$$

$$S_{i,T} = \frac{AR_{i,t_1} + \dots + AR_{i,t_2}}{\sqrt{(\hat{\sigma}_{i,t_1}^2 + \dots + \hat{\sigma}_{i,t_2}^2) \cdot (t_2 - t_1 + 1)}} \quad (6)$$

Here,  $\hat{\sigma}_{i,t}^2$  denotes the variance forecasted by the GARCH model for the  $i$ -th event at time  $t$ , using information available up to  $t_0 - 1$ .

In the second part of the exercise, which examines the effect on volatility, we adopt the methodology outlined by [Mnasri and Nechi \(2016\)](#). This approach suggests that the variance of the residuals  $\epsilon_{i,t}$  from equation (1) during the event window is given by  $M_t \cdot E[\sigma_{i,t}^2 | \Omega_{t^*}]$ , where  $E[\sigma_{i,t}^2 | \Omega_{t^*}]$  de-

<sup>3</sup>We use as GDP expectations the rolling forecast of the Índice de Seguimiento a la Economía (ISE) which is a measure of Colombia's real economic activity.

<sup>4</sup>This variable is not public and is internally constructed by the Banco de la República and its measurement is based on the [Antunes \(2005\)](#) methodology.

<sup>5</sup>The control variables are expressed as first differences and match the same maturity as the BEI being analyzed (e.g., the 1-year GDP forecast corresponds to the 1-year BEI).

notes the conditional variance predicted by the GARCH model,<sup>6</sup> and  $M_t$  is a multiplicative effect. According to the authors,  $M_t$  is estimated as follows:

$$\widehat{M}_t = \frac{1}{N-1} \cdot \sum_{i=1}^N \frac{\left(N \cdot \hat{\epsilon}_{i,t} - \sum_{j=1}^N \hat{\epsilon}_{j,t}\right)^2}{N \cdot (N-2) \cdot E\left[\sigma_{i,t}^2 | \Omega_{t^*}\right] + \sum_{j=1}^N E\left[\sigma_{j,t}^2 | \Omega_{t^*}\right]}, \quad (7)$$

Here,  $\hat{\epsilon}_{i,t}$  represents the residuals during the event window,  $t_1$  marks the start of the event window, and  $t_2$  denotes its end. Under this framework, the null hypothesis states that, for a day  $t > t^*$ , there is no increase in volatility, implying  $M_t = 1$ . Extending this idea, the Cumulative Abnormal Volatility (CAV) under the null hypothesis for the entire event window ( $t_1, t_2$ ) is given as:

$$CAV(t_1, t_2) \equiv \left(\widehat{M}_{t_1} + \dots + \widehat{M}_{t_2}\right) - (t_2 - t_1 + 1) = 0. \quad (8)$$

To evaluate the significance of this statistics, the bootstrapping algorithm proposed by [Mnasri and Nechi \(2016\)](#) is used.

## 4 Results

We split the results into the effects of the study events on average inflation expectations and the impacts on their volatility. Simultaneously, for both exercises, we evaluate the the impacts of both events related to natural disasters (32 events) and those related to announcements and alerts about the dynamics of the ENSO weather phenomenon (39 events). As mentioned earlier, we excluded climatic events from the EM-DAT database because it was difficult to identify and determine their duration, and most were categorized as long-lived events, while our analysis focuses on the short term. Additionally, the ENSO exercise is based on the expectations generated by the possibility of an ENSO event, rather than the climatic event itself.

As shown in [Table 4](#), our empirical results provide evidence that both natural disasters and ENSO announcements significantly influence the mean of the market-based inflation expectations. Natural disasters are found to primarily impact medium-term expectations (three and five years), whereas ENSO announcements affect expectations across all horizons. Despite the typical short-term effects of ENSO on observed inflation, our results highlight its unique importance in Colombia, where it exerts significant influence and, surprisingly, leads to influence the mean in the medium-term inflation expectations. Furthermore, both types of events lead to increases in inflation expectations since the reported CAARs are positive.

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<sup>6</sup>The information set  $\Omega_{t^*}$  includes all data available up to  $t^* = t_0 - 1$ .

**Table 4:** Reaction of market-based inflation expectations to natural disaster and ENSO announcements  
(Test in mean)

Type of disaster \Series	BEI (1 year)	BEI (2 years)	BEI (3 years)	BEI (4 years)	BEI (5 years)
<b>Natural Disasters</b>				<b>0.0327</b>	<b>0.0677</b>
BMP test (p-value)				(0.0972)*	(0.0367)**
Wilcoxon test (p-value)					(0.0107)**
<b>ENSO Announcements</b>	<b>0.1365</b>	<b>0.0915</b>	<b>0.1565</b>	<b>0.08</b>	<b>0.0712</b>
BMP test (p-value)	(0.0382)**	-	(0.0205)**	(0.0573)*	-
Wilcoxon test (p-value)	(0.0303)**	(0.0236)**	(0.0052)***	(0.0478)**	(0.0459)**

The table reports the CAARs of the test in mean (section 3) in response to geophysical, hydrological and meteorological disasters. The values for ENSO announcements are described in Table 3.

The p-values are calculated using the BMP and Wilcoxon test.

\*\*\*, \*\*, \* indicate statistical significance at 1%, 5% and 10%, respectively.

Conducting the same event analysis but now assessing the impact on the second moment of these market-based inflation expectations (their variance, Table 5), the results indicate that ENSO announcements do not affect the volatility of inflation expectations across any term. However, events related to natural disasters have a significant impact, especially in the medium term (from three to five years).

**Table 5:** Reaction of market-based inflation expectations to natural disaster and ENSO announcements  
(Test in variance)

Type of disaster \Series	BEI (1 year)	BEI (2 years)	BEI (3 years)	BEI (4 years)	BEI (5 years)
<b>Natural Disasters</b>	-	-	<b>13.94</b>	<b>11.939</b>	<b>6.961</b>
P-value			(0.0177)**	(0.0216)**	(0.0569)*
<b>ENSO Announcements</b>	-	-	-	-	-
P-value					

The table reports the CAV of the test in variance (section 3) in response to geophysical, hydrological and meteorological disasters. The values for ENSO announcements described in Table 3.

The p-value of the test is calculated using the bootstrap algorithm proposed by [Mnasri and Nechi \(2016\)](#).

\*\*\*, \*\*, \* indicate statistical significance at 1%, 5% and 10%, respectively.

Given the limited number of observations for each disaster type and ENSO announcement, we have less confidence in the robustness of our results when we try to analyze by type of disaster (Table 6 and 7). However, we conducted a granular analysis by categorizing results according to disaster type. This approach allowed us to pinpoint which classifications exhibit the highest sensitivity. Our findings indicate that geophysical disasters have a more pronounced effect on

expectations compared to other event types. Additionally, *La Niña* announcements, especially those declaring a strong *La Niña* event, tend to have a greater influence than *El Niño* announcements.

**Table 6:** Reaction of the market-based inflation expectations mean to natural disasters by type. (Test in mean)

Type of disaster \Series	BEI (1 year)	BEI (2 years)	BEI (3 years)	BEI(4 years)	BEI (5 years)
<b>Geophysical</b>	-	-	<b>0.1415</b>	-	-
BMP test (p-value)			(0.0836)*		
Wilcoxon test (p-value)			-		
<b>Hydrological</b>	-	-	-	-	<b>0.0529</b>
BMP test (p-value)					-
Wilcoxon test (p-value)					(0.0402) **
<b>Meteorological</b>	-	-	-	-	-
<b>All</b>	-	-	-	<b>0.0327</b>	<b>0.0677</b>
BMP test (p-value)				(0.0972) *	(0.0367) **
Wilcoxon test (p-value)				-	(0.0107)**

The table reports the CAARs of the test in mean (section 3) in response to geophysical, hydrological and meteorological disasters. The values for ENSO announcements are described in Table 3.

The p-values are calculated using the BMP and Wilcoxon test.

\*\*\*, \*\*, \* indicate statistical significance at 1%, 5% and 10%, respectively.

**Table 7:** Reaction of the market-based inflation expectations mean to ENSO announcements. (Test in mean)

Type of disaster \Series	BEI(1 year)	BEI(2 years)	BEI (3 years)	BEI (4 years)	BEI (5 years)
<b>El niño</b>	-	<b>0.1491</b>	-	-	-
BMP test (p-value)		(0.0618)*			
Wilcoxon test (p-value)		-			
<b>El niño alert</b>	-	-	-	-	-
BMP test (p-value)					
Wilcoxon test (p-value)					
<b>El niño watch</b>	-	-	-	-	-
BMP test (p-value)					
Wilcoxon test (p-value)					
<b>La niña</b>	-	<b>0.2308</b>	<b>0.2801</b>	<b>0.2543</b>	<b>0.2165</b>
BMP test (p-value)		(0.0792)*	(0.0480)**	(0.0379)**	(0.0496)**
Wilcoxon test (p-value)		(0.0781)*	(0.0938)*	(0.0625)*	-
<b>La niña alert</b>	<b>0.3210</b>	<b>0.2514</b>	<b>0.2289</b>	<b>0.1886</b>	<b>0.2553</b>
BMP test (p-value)	(0.099)*	(0.0405)**	(0.0465)**	(0.0677)*	(0.0794)*
Wilcoxon test (p-value)	-	(0.0156)**	(0.0313)**	(0.0625)*	(0.0625)*
<b>La niña watch</b>	<b>0.3143</b>	-	-	-	-
BMP test (p-value)	(0.0259)**				
Wilcoxon test (p-value)	(0.0625)*				
<b>All</b>	<b>0.1365</b>	<b>0.0915</b>	<b>0.1565</b>	<b>0.08</b>	<b>0.0712</b>
BMP test (p-value)	(0.0382)**	-	(0.0205)**	(0.0573)*	-
Wilcoxon test (p-value)	(0.0303)**	(0.0236)**	(0.0052)**	(0.0479)*	(0.0459)**

The table reports the CAARs of the test in mean (section 3) in response to geophysical, hydrological and meteorological disasters. The values for ENSO announcements are described in Table 3.

The p-values are calculated using the BMP and Wilcoxon test.

\*\*\*, \*\*, \* indicate statistical significance at 1%, 5% and 10%, respectively.

Lastly, concerning the variance of expectations, our aggregate analysis revealed no significant impact of ENSO announcements on the variability of these indicators. Further disaggregation by announcement type yielded no significant results. However, when analyzing natural disaster types, hydrological events demonstrated the highest significance (Table 8). Given the link between these events, the *La Niña* phase in ENSO, and floods, it is not surprising that ENSO announcements during *La Niña* phases are also significant in shaping inflation expectations. This is particularly relevant for Colombia due to its abundant water resources and limited infrastructure for handling large-scale flood events.

**Table 8:** Reaction of BEI series' variance to natural disasters. (Test in variance)

Type of disaster \Series	BEI(1 year)	BEI(2 years)	BEI (3 years)	BEI (4 years)	BEI (5 years)
<b>Geophysical</b>	-	-	-	-	-
<b>Hydrological</b>	-	-	<b>16.912</b>	<b>14.227</b>	<b>7.722</b>
P-value			(0.0239)**	(0.0265)**	(0.0718)*
<b>Meteorological</b>	-	-	-	-	-
<b>All</b>	-	-	<b>13.94</b>	<b>11.939</b>	<b>6.961</b>
P-value			(0.0177)**	(0.0216)**	(0.0569)*

The table reports the CAV of the test in variance (section 3) in response to geophysical, hydrological and meteorological disasters. The values for ENSO announcements described in Table 3.

The p-value of the test is calculated using the bootstrap algorithm proposed by [Mnasri and Nechi \(2016\)](#).

\*\*\*, \*\*, \* indicate statistical significance at 1%, 5% and 10%, respectively.

## 5 Final remarks

In this study, we analyze the relationship between both natural disasters and ENSO announcements events, and the inflation expectations from the Colombian sovereign debt market. Our analysis aimed to discern whether such natural events and ENSO news exert an influence on both the mean and the volatility of these expectations. To achieve this, we used an event study methodology spanning from October 2004 to August 2022. Our findings provide evidence that both types of events significantly influence the mean of inflation expectations. Additionally, while natural disasters increase the volatility of inflation expectations, ENSO announcements do not exhibit a similar effect.

While Colombian food inflation is more correlated with the El Niño phase (droughts), where price increases are widely expected, uncertainty is higher during La Niña (rainy) phases. This is because the severity of rainfall can either boost agricultural productivity and lower food prices or, conversely, lead to floods and production losses, causing prices to rise. Our findings indicate a non-linear relationship between ENSO and expectations, suggesting a promising avenue for future research to explore the significance of these nonlinearities. While this paper presents statistical evidence consistent with the study of stylized facts, a structural model is necessary to delve deeper into the transmission mechanisms through which these shocks impact inflation expectations and to examine their broader macroeconomic interactions.

Our results highlight the need for policy interventions to address the vulnerabilities exposed by our findings. Colombia's development challenges, infrastructure limitations, and tropical geography converge to create a high degree of vulnerability to ENSO events and extreme weather, a situation likely to be intensified by climate change. Moreover, Colombia's heavy reliance on hydropower makes it particularly vulnerable to hydrological fluctuations. Given these factors, a

priority should be to strengthen disaster prevention measures, especially those related to flood prevention. Additionally, addressing deforestation, which increases the risk of floods, is crucial. Promoting reforestation, given Colombia's vast forest resources, is essential to mitigate climate change impacts.

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## A Disasters Database

**Table 9:** List of disasters for each type of disaster

Disaster Group	Sub-	Disaster Type	Disaster Sub-Type	Disaster Sub-sub Type
Geophysical		Earthquake	Ground Movement Tsunami	
		Volcanic Activity	Ash fall Lahar Pyroclastic Flow Lava Flow	
		Mass movement		
Meteorological	Storm		Tropical Storm Extra-tropical Storm Convective Storm	Derecho Hail Lightning/Thunderstorm Rain Tornado Sand-dust Storm Winter Storm/Blizzard Storm/Surge Wind Severe storm
		Extreme temperature	Cold wave  Heat wave Severe wind conditions	Snow-ice  Frost/Freeze
		Fog		
Hydrological	Flood		Coastal flood Riverine flood Flash flood Ice jam flood	
		Landslide	Avalanche (snow,debris, mudflow, rock fall)	
		Wave action	Rogue wave Seiche	