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Accounting for Climate When Determining the Impact of Weather on Retail Sales

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Abstract: In this paper, we explore the importance of accounting for climate when determining the impact of weather on product sales. Using a France-wide scanner panel dataset provided by our industry partner, we show that if climate is not accounted for, product categories may be misclassified as being weather sensitive when they are not, and vice versa. This is motivated by previous research and industry reports that suggest a relationship between weather and retail sales. However, these studies often fail to distinguish between weather and climate, leading to inaccurate conclusions. Our results highlight the need to control for climate in order to accurately assess the effects of weather on retail sales. We use ordinary least squares regression to estimate the relationship between temperature and sales for 29 different product categories. The regression models control for various factors, including shelf space allocation, week of observation, quantity purchased, promotion, store brand, store surface area, store competition, and consumer behavior measures. We find that when accounting for climate, only a subset of the product categories is sensitive to weather. Additionally, we show that climate can be approximated using a week index, eliminating the need for additional data collection and approximation efforts. Our findings have implications for both researchers and practitioners. Researchers should be aware of the importance of accounting for climate when studying the impact of weather on retail sales, as failing to do so may lead to erroneous conclusions. Practitioners can use our results to inform their marketing and sales strategies, taking into account the weather sensitivity of different product categories and the role of climate in shaping consumer behavior. Overall, our study emphasizes the need to consider climate when determining the impact of weather on retail sales, and provides practical insights for retailers and economists.

Keywords: weather; climate; retailing; scanner data; national

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1. Introduction

This paper investigates the importance of accounting for climate when determining the impact of weather on retail sales. While previous research has examined the relationship between weather and sales, there has been limited attention given to the role of climate in influencing sales. Climate refers to the long-term weather patterns in a given region, while weather refers to short-term atmospheric conditions. Understanding the impact of weather on retail sales requires considering the broader climate context, as weather conditions can vary greatly within different climate zones. By accounting for climate, researchers and practitioners can gain a more accurate understanding of the relationship between weather and sales, as well as its implications for retail strategy and decision making.

Previous studies have highlighted the influence of weather on retail sales, with various reports and academic research showcasing the significant impact of weather conditions on consumer behavior and purchasing decisions [1–5]. For instance, the National Retail Federation (NRF) reported that an 8° F drop in mid-April resulted in a 16% decrease in bicycle sales in Chicago, while the same temperature decrease led to a 22% increase in

bicycle sales in Phoenix [1]. However, it is important to note that weather and climate are distinct concepts, and climate plays a critical role in shaping weather conditions. The National Centers for Environmental Information (NCEI) of the National Oceanic and Atmospheric Administration (NOAA) defines climate as the expected long-term weather patterns, while weather refers to the actual short-term conditions [6]. Climate normals, which are derived from three-decade averages of weather observations, serve as a measure of climate in a given region [6].

Motivated by these observations, as well as an analysis carried out by our industry partner, we seek to clarify the importance of accounting for climate when evaluating the impact of weather on retail sales. Specifically, we compare the results obtained when climate is not accounted for with those obtained when climate is taken into consideration. By using a week index as a proxy for climate, we demonstrate that additional data collection and approximation of climate may not be necessary. Our research contributes to the existing literature by highlighting the significance of accounting for climate and providing a practical approach for incorporating climate factors into the analysis of weather impacts on retail sales. Moreover, our findings have implications for both researchers and practitioners seeking to understand and leverage the relationship between weather, climate, and retail sales.

The remainder of the paper is organized as follows: In Section 2, we review the relevant literature on the impact of weather on retail sales. Section 3 provides an overview of the data used in our analysis. Section 4 presents the results of our analysis, comparing the impacts of weather on retail sales with and without accounting for climate. Section 5 discusses the implications of our findings, and Section 6 concludes the paper.

2. Related Work

The related work in the field of weather's impact on retail sales has primarily focused on two main areas: meteorology and energy, and retailing. In the field of meteorology and energy, studies have examined the impact of weather on energy consumption, which can be considered a form of purchasing. For example, ref. [7] investigated the influence of weather on food and drink sales in the UK retail and distribution industry. Ref. [8] looked at the influence of daily temperature and public holidays on alcohol sales in the US. However, their study used surveys, while our study utilizes point of sale (PoS) data combined with public weather service records.

Another study by [9] explored the impact of weather on the entire US economy. Although their scale of data differs from ours, as they used indicator variables for temperature, while we use absolute temperature values, this work provides valuable insights into the broader economic implications of weather on consumption. Additionally, ref. [10] conducted a survey paper that covered various topics related to energy, including temperature-sensitive demand. While their work is not directly related to retail sales, it emphasizes the importance of considering climate change in our analysis. In all the studies cited, authors account for climate change, such as [11] (not cited in the survey paper); as the data we have are over two years, we only need to account for climate. In addition, we consider the retail sales of items that are far less essential than electricity that is used for heating, cooling, cooking, and lighting. Ref. [12] conduct a simulation study to show that due to weather in the near future, consumers will be able to choose their energy supplier, leading to losses for utility companies. In our study, we consider real-world retail data, and no simulation study is conducted.

In the field of retailing, there has been a significant increase in research on the impact of weather on sales in the last ten years. The years prior are nicely summarized by [13], in which the work of [14–27] is discussed in greater detail. In the interest of space, we will not discuss these papers here. Many recent studies, such as [2,3,5,28–37], have controlled for climate in their analyses. For example, ref. [38] was one of the first studies to consider the impact of weather on sales, focusing on the seven weeks prior to Easter over a nine-year

period. While the author did not explicitly account for climate, our analysis includes a week index that captures any cyclical aspects of retail business, including climate-related patterns.

Ref. [35] found that sunlight has a negative effect on consumer spending, but their study only considered a single store or laboratory setting. In contrast, our analysis utilizes countywide data, providing a broader understanding of the impact of weather on sales in brick-and-mortar retail settings. Similarly, ref. [36] examined inflatable-pool sales and investigated short-term and long-term weather uncertainty to account for long order lead times. In contrast, our study analyzes sales across multiple product categories and focuses solely on immediate sales rather than procurement considerations.

Ref. [39] explored the impact of weather on e-commerce retailing, while our study exclusively analyzes brick-and-mortar sales with unique attributes, such as store size and allocated shelf space. Ref. [34] considered nominal retail sales and controlled for weather using five- and ten-year moving averages of observed weather data. Their study included larger product categories and analyzed monthly and quarterly sales, while our study focuses on finer-grained product categories such as pasta and uses weekly sales data for more detailed analysis.

Ref. [33] built upon the model proposed by [34] and considered daily sales in the US. However, their analysis did not differentiate between product categories, which is a key aspect of our study. Additionally, our study demonstrates that climate can be accounted for using a week index, whereas [33] constructed a climate model from historical data due to the absence of exact location information. Refs. [40,41] considered climate, but considered monthly sales, while we consider weekly sales. In addition, the author was interested in determining any long-term sales effects due to weather. In this study, we are only interested in determining what is the immediate, weekly impact of weather, as measured by temperature, on sales. Ref. [42] considered a high-street retailer in the UK and determined what weather attributes impact sales. We only consider temperature in our study, and have information on shelf space and store size, while the authors have location information. Overall, one may view our study as a complement to [42] given the difference in the data and approaches used. The main objective of our study is to highlight the importance of accounting for climate, and doing so using a simple week index.

Ref. [31] focused on non-alcoholic beverages and constructed panel data for each product category. While this approach accounts for climate by nature of the panel data, our study takes a simpler approach by using ordinary least squares regression to account for climate and demonstrates the impact of weather on sales. Moreover, ref. [32] constructed a panel model and considered both linear and non-linear relationships but their analysis focused on non-consumable goods. As suggested by the NRF [1], the sensitivity of sales to weather varies greatly depending on the product type. Furthermore, the complexity of constructing panel data as performed by [31,32] makes it impractical for many real-world settings. Our study highlights the viability of using ordinary least squares regression to account for climate and analyze the impact of weather on sales across different product categories.

One key distinction of our approach is the use of the time of year as a proxy for weather, whereas previous studies often relied on historical climate data or weighted means of expected weather. These data are not readily available in our analysis, but we demonstrate that using a week index can adequately account for weather without resorting to historical climate data.

In summary, while the literature on weather's impact on retail sales has shown significant growth in recent years, our study expands on previous research by analyzing the immediate, the weekly impact of weather on sales across various product categories in brick-and-mortar retail settings. Furthermore, we demonstrate that climate can be effectively accounted for using a week index, providing a practical approach for studying weather's influence on retail sales. This research contributes both to the academic field by expanding our understanding of weather's impact on retail sales, and to the retail indus-

try by providing insights that can inform decision making and strategies for optimizing sales performance.

3. Data

Our data consist of point-of-sale (PoS) data collected from 200 stores in France. These stores are located in nine different regions throughout the country and belong to various hypermarket chains. The data span the years 2014 and 2015. We compile information on various variables that we believe are relevant to our analysis.

The main variable of interest in our study is sales, which represents the amount of money spent on a particular product over the course of a week. We also consider the quantity of units sold each week. Additionally, we have information on the frontage (measured in cm) allocated to the product in the store, updated every quarter. This variable, called "mesure_lineaire_cm", provides insight into how prominently the product is displayed.

We also include measures related to weather and promotion. The temperature variable represents the mean weekly temperature in Celsius degrees in the region where the sale occurred. We believe that weather conditions may have an impact on consumer behavior, and therefore it is important to account for this factor. The promo variable is an indicator denoting if the product was promoted that week via an end-cap location or in the store flyer. This variable allows us to examine the influence of promotional activities on sales.

Two additional variables, mdd and surface, are included in our analysis. The mdd variable is an indicator denoting if the product is a store brand. This variable allows us to investigate the effect of store branding on sales. The surface variable represents the surface area of the store in square meters. We believe that the size of the store may have an impact on consumer behavior, and therefore it is important to include this variable in our analysis.

Furthermore, we have information on the level of competition for each store, provided by our industry partner. This variable, called ipc, measures the intensity of competition, with higher values indicating more competition.

In order to understand the penetration of our product in the market, we consider three variables: Tauxdepenatration, Frequencedachat, and IndiceCRP. Tauxdepenatration represents the percentage of the population that purchases the product at least once per year. Frequencedachat measures the frequency at which households purchase the product annually. IndiceCRP is the product of Tauxdepenatration and Frequencedachat, providing an overall measure of consumer reach.

Finally, we have additional variables to help us identify the store and region where the sales occurred. The store variable is a unique store ID, while regiriname represents the name of the region. We also use the week52Index variable to indicate the week number, modulo 52, in order to handle seasonal effects.

In Table 1, we present the summary statistics of the data. It is important to note that not all variables are available for every purchase. The ipc, IndiceCRP, Tauxdepenatration, and Frequencedachat variables, in particular, may be missing from our tables due to the lack of available data for certain product categories. This does not indicate that these variables are not statistically significant but rather that they were not captured for all the products we considered.

Overall, our data allow us to examine the relationship between weather conditions, promotional activities, store characteristics, and various sales measures. By analyzing these data, we aim to understand how the weather impacts sales and to provide valuable insights for both research and practice in the retail industry.

We use the following variables in our analysis:

sales: The amount of sales, in euros, spent on a product over the past week.
mesure_lineaire_cm: the frontage, measured in cm, allocated to the product in the store, updated every quarter.
week: the week number the observation was observed, starting at a random integer.
qty: the number of units sold that week
temperature: the mean weekly temperature, in °C, in the region the week of the sale.

promo: an indicator denoting if the item is promoted via an end-cap location or in the store flyer the week of the sale.
mdd: an indicator denoting if the item is a store brand.
surface: the surface area of the store in m^2.
ipc: a measure of competition for the store, the higher the more competition, provided by industry partner.
Tauxdepenatration: the percentage of the population that purchased the product at least once per year.
Frequencedachat: the frequency a household purchases the product in question annually.
IndiceCRP: the consumer reach point, the product of Tauxdepenatration and Frequencedachat.
store: a unique store id.
regiriname: the region name.
week52Index: week modulus 52.

Table 1. Data summary statistics.

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
week	8,298,142	1868.551	45.279	1792	1830	1910	1949
store	8,298,142	3,101,283.000	1465.665	3,100,005	3,100,298	3,101,632	3,108,151
sales	8,298,142	51.010	228.905	0.000	7.560	40.200	93,612.550
qty	8,298,142	22.872	103.451	−322	3	18	48,030
mesure_lineaire_cm	8,298,142	29.053	34.394	0	14	30	1080
promo	8,298,142	0.040	0.195	0	0	0	1
mdd	8,298,142	0.306	0.461	0	0	1	1
regioniri	8,298,142	5.009	2.673	1	3	7	9
surface	8,298,142	6344.244	4553.558	400	2200	9900	17,121
ipc	8,038,265	0.805	0.226	0.024	0.729	0.984	0.999
temperature	8,298,142	18.053	7.318	0.300	12.100	23.700	35.400
IndiceCRP	1,933,997	111.772	56.543	47.000	61.000	148.000	224.000
Tauxdepenatration	1,933,997	62.343	15.115	29.100	49.500	74.600	85.200
Frequencedachat	1,933,997	6.207	1.965	3.100	4.700	8.200	9.700
week52Index	8,298,142	26.215	15.509	1	13	41	52

As the objective of our study is to highlight the importance of accounting for climate when studying weather, and one may do so using a simple week index, we only show our results in aggregate. However, for completeness, we list the 29 product categories available in our dataset: appetizers, deodorant, smoked fish, pre-made meals, multi-purpose household cleaner, whiskey, fresh fish, ice cream, shampoo, fruit juices, pre-cooked poultry, pre-cooked ham, oil, chocolate and fruit biscuits, canned tuna, soft pasta, yoghurt, chocolate bars, bottled water, eggs, face creams, pasta, salads, butter, laundry detergents, blonde beers, toilet paper, cereals, and soft drinks.

4. Results

In this section, we present the difference in the correlation between the number of units sold and weather, as measured by weather, when accounting for climate and when not accounting for climate. Below, we fit the following equation to determine the relationship between temperature and sales, the amount of euros spent:

$$\begin{aligned} sales = {} & \alpha + \beta_1 mesure\_lineaire\_cm + \beta_2 week + \beta_3 qty + \beta_4 temperature + \\ & \beta_5 promo + \beta_6 mdd + \beta_7 surface + + \beta_8 ipc + \beta_9 IndiceCRP + \\ & \beta_{10} Tauxdepenatration + \beta_{11} Frequencedachat + \\ & \beta_{12} as.factor(store) + \beta_{13} as.factor(regiriname) \\ & + \beta_{14} as.factor(week52Index) \end{aligned} \quad (1)$$

In the above equation, we are always controlling for the amount of shelf space allocated to the product; the week the data are observed; the number of items purchased; the mean temperature the week of purchase in degrees Celsius; whether the item was on sale (end cap of an isle); the total surface area of the store in square meters; the competition of the store; the popularity of the brand being purchased; the store in which the item was purchased; and the region in which the item was purchased. When we compare controlling for climate, we either include or exclude the following independent variable: $week52Index$. This variable is derived from the *week* variable. The *week* variable is a counter starting at an arbitrary value and increments by one for each successive week in the data. This variable captures the passage of time. However, the $week52Index$ variable is the *week* variable modulus 52, the number of weeks in a year, and now captures the climate. What we mean by capturing climate is that $week52Index$ is used to capture that it is colder in the winter than the summer, or that in late November, at least in the Untied States, turkey sales increase, and not due to a decrease in temperature. The $week52Index$ variable allows us to focus on variations from the expected temperature, as opposed to only the expected temperature.

4.1. Not Accounting for Climate

In this section, we discuss the results of our regression analysis when we do not account for climate. The motivation behind this analysis is to understand the impact of weather on retail sales and how it is influenced by climate, and climate may be confounded with weather. We modify (1) not to account for climate by dropping the $week52Index$ variable:

$$\begin{aligned} sales = \alpha + \beta_1 mesure_l ineaire_c m + \beta_2 week + \beta_3 qty + \beta_4 temperature + \\ \beta_5 promo + \beta_6 mdd + \beta_7 surface + + \beta_8 ipc + \beta_9 IndiceCRP + \\ \beta_{10} Tauxdepenatration + \beta_{11} Frequencedachat + \\ \beta_{12} as.factor(store) + \beta_{13} as.factor(regiriname) \end{aligned} \tag{2}$$

We conduct regression analysis for each of the 29 product categories in our dataset. Table 2 presents the model fit results for product categories 1 to 4 when not accounting for climate. Similarly, Tables 3–8 present the results for the remaining product categories in sequential order.

The regression results reveal interesting trends and relationships between sales and various factors. We find that the allocated shelf space, quantity purchased, promotion, store brand, store competition, temperature, and, in some cases, annual frequency of purchase are the main factors that impact sales.

The allocated shelf space has a statistically significant impact on sales in all product categories except for four. However, the relationship between shelf space and sales is mixed, as the number of sales may actually decrease with an increase in the allocated shelf space. This finding is in line with previous research on the impact of shelf space on sales [43–45].

The relationship between the quantity of products purchased and sales is consistently positive across all product categories. It is anticipated that an increase in the quantity of products purchased will result in a corresponding increase in the total value of sales. This logical connection is based on the understanding that a higher quantity of products being sold will naturally lead to a higher overall sales figure. In other words, as customers purchase more products, the total value of sales generated will also increase. This positive relationship between quantity and sales is a fundamental principle in the world of commerce.

The impact of promotion on sales varies across product categories. In most cases, being on promotion has a positive relationship with sales, indicating that promotions drive more sales. However, there are four product categories where being on promotion has a negative relationship with sales. This may be due to store-imposed limits on the number of items customers can purchase during promotions, although we do not have this information in our dataset to validate the claim.

Store-brand products, which are products specifically created and sold by a particular retailer under their own brand name, tend to have lower sales figures when compared to national-brand products. This observation implies that customers generally exhibit a preference for national-brand products across a wide range of product categories. Despite the potentially lower price point and similar quality, consumers often gravitate towards national-brand products, indicating a perceived superiority or trust in these established brands. This preference may stem from various factors, such as brand recognition, marketing efforts, perceived prestige, or simply the belief that national-brand products offer better overall value.

The impact of store competition on sales, as measured by the ipc variable, is generally found to be not significant. However, this finding holds true only for the majority of product categories. It is important to note that there are a select few product categories, where the presence of competing stores does have a notable influence on customers' purchasing decisions. Specifically, pre-made meals, salads, and ice cream are among the product categories where store competition seems to play a more influential role in shaping consumer choices. In these particular categories, the presence of competing stores has a significant impact on sales. On the other hand, for the majority of products, store competition appears to have minimal effect on sales, suggesting that customers are not heavily influenced by the presence of competing stores in their purchasing decisions.

Table 2. Predicting sales for product categories 1 through 4 when not accounting for climate.

	Dependent Variable:			
	Sales			
	(1)	**(2)**	**(3)**	**(4)**
mesure_lineaire_cm	−0.028 ***	−0.547 ***	−0.021 ***	0.062 ***
	(0.003)	(0.021)	(0.008)	(0.018)
week	−0.007 ***	−0.045 ***	−0.001	0.029 ***
	(0.001)	(0.011)	(0.001)	(0.004)
qty	1.710 ***	3.822 ***	2.196 ***	2.362 ***
	(0.002)	(0.015)	(0.003)	(0.003)
temperature	0.003	−0.078	−0.003	−0.093 ***
	(0.006)	(0.068)	(0.008)	(0.020)
promo	3.170 ***	62.836 ***	0.578 **	38.728 ***
	(0.167)	(3.209)	(0.255)	(1.047)
mdd	−8.697 ***			
	(0.084)			
surface	0.0004	0.002	−0.0003	0.001
	(0.0004)	(0.006)	(0.001)	(0.002)
ipc	0.563	−14.394	3.365	−0.784
	(3.619)	(49.762)	(5.287)	(21.958)
IndiceCRP			−0.670 ***	−0.270 ***
			(0.010)	(0.029)
Tauxdepenatration				
Frequencedachat				
Constant	17.386 ***	102.806 ***	52.172 ***	5.703
	(2.354)	(28.439)	(3.480)	(15.755)
Observations	176,783	48,522	270,690	74,623
R^2	0.883	0.606	0.736	0.897
Adjusted R^2	0.883	0.605	0.736	0.896

Note: ** $p < 0.05$; *** $p < 0.01$.

The annual frequency of purchase has mixed effects on sales. In some product categories, an increase in the frequency of purchase is associated with a decrease in the amount

spent per purchase, while in others, it is associated with an increase. This indicates that the purchasing behavior of customers can vary depending on the product category.

Overall, these findings demonstrate the importance of accounting for climate when analyzing the impact of weather on retail sales. Climate factors, such as temperature, play a significant role in consumer behavior and can mediate the relationship between weather variables and sales. Ignoring climate can lead to misleading conclusions and inaccurate predictions of sales.

The implications of our research are twofold. Firstly, from a research perspective, our study highlights the importance of considering climate as a factor when analyzing the impact of weather on retail sales. By accounting for climate, researchers can obtain a more accurate understanding of the relationship between weather variables and sales. Secondly, from a practical perspective, our findings provide valuable insights for retailers and marketers. By understanding the influence of weather and climate on consumer behavior, retailers can make informed decisions on inventory management, pricing strategies, and promotional activities.

In conclusion, our research demonstrates the significance of accounting for climate when determining the impact of weather on retail sales. Through regression analysis, we identified several factors that affect sales, including allocated shelf space, quantity purchased, promotion, store brand, store competition, temperature, and annual frequency of purchase. Next, we will see how the relationships we discussed above change when we account for climate.

Table 3. Predicting sales for product categories 5 through 8 when not accounting for climate.

	Dependent Variable:			
	Sales			
	(5)	**(6)**	**(7)**	**(8)**
mesure_lineaire_cm	−0.031 ***	−0.482 ***	1.109 ***	0.032 ***
	(0.007)	(0.025)	(0.022)	(0.004)
week	0.001	0.014 *	0.433 ***	−0.002 ***
	(0.001)	(0.008)	(0.073)	(0.0005)
qty	2.689 ***	3.134 ***	0.675 ***	2.473 ***
	(0.004)	(0.015)	(0.003)	(0.002)
temperature	−0.028 ***	−0.267 ***	2.462 ***	−0.067 ***
	(0.006)	(0.048)	(0.484)	(0.003)
promo	1.680 ***	108.041 ***	94.468 ***	5.462 ***
	(0.179)	(3.158)	(26.177)	(0.107)
mdd	−9.897 ***			
	(0.128)			
surface	0.001 **	−0.005	−0.010	−0.001 **
	(0.0005)	(0.004)	(0.012)	(0.0003)
ipc	−3.668	22.903	−106.119	11.364 ***
	(5.206)	(40.155)	(169.816)	(3.199)
IndiceCRP				0.411 ***
				(0.007)
Tauxdepenatration				−0.946 ***
				(0.009)
Frequencedachat				−6.212 ***
				(0.157)
Constant	1.462	−23.991	−838.623 ***	50.368 ***
	(3.282)	(24.716)	(208.318)	(2.084)
Observations	218,955	39,508	18,722	239,687
R^2	0.735	0.615	0.812	0.877
Adjusted R^2	0.735	0.613	0.810	0.877

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 4. Predicting sales for product categories 9 through 12 when not accounting for climate.

	Dependent Variable:			
	Sales			
	(9)	**(10)**	**(11)**	**(12)**
mesure_lineaire_cm	−0.060	0.392 ***	0.041 ***	0.029
	(0.050)	(0.006)	(0.006)	(0.025)
week	0.082 ***	−0.018 ***	−0.009 ***	−0.011
	(0.021)	(0.002)	(0.001)	(0.007)
qty	2.614 ***	2.336 ***	2.710 ***	3.588 ***
	(0.015)	(0.003)	(0.003)	(0.028)
temperature	0.018	0.003	0.019 ***	−0.089 ***
	(0.117)	(0.010)	(0.005)	(0.024)
promo	−1.481	−11.750 ***	3.527 ***	−3.811 **
	(6.307)	(0.258)	(0.175)	(1.558)
mdd			−15.250 ***	−5.705 ***
			(0.106)	(1.137)
surface	−0.004	−0.0004	0.001 **	−0.001
	(0.017)	(0.001)	(0.0004)	(0.001)
ipc	12.149	−5.675	−5.188	−18.575
	(194.925)	(6.211)	(4.154)	(27.696)
IndiceCRP	−0.736 ***	−1.783 ***		
	(0.149)	(0.080)		
Tauxdepenatration		2.789 ***		
		(0.127)		
Frequencedachat		22.904 ***		
		(1.040)		
Constant	−87.417	−97.902 ***	22.003 ***	43.723
	(113.517)	(7.298)	(2.575)	(30.368)
Observations	5225	244,336	240,691	293
R^2	0.894	0.797	0.832	0.993
Adjusted R^2	0.890	0.797	0.832	0.990

Note: ** $p < 0.05$; *** $p < 0.01$.

Table 5. Predicting sales for product categories 13 through 16 when not accounting for climate.

	Dependent Variable:			
	Sales			
	(13)	**(14)**	**(15)**	**(16)**
mesure_lineaire_cm	0.782 ***	1.888 ***	1.059 ***	0.453 ***
	(0.033)	(0.110)	(0.025)	(0.005)
week	0.027 ***	−0.015 *	0.055	−0.009 ***
	(0.007)	(0.008)	(0.035)	(0.003)
qty	4.184 ***	3.859 ***	2.277 ***	2.615 ***
	(0.007)	(0.016)	(0.006)	(0.004)
temperature	−0.094 **	0.034	0.497 **	−0.038 **
	(0.042)	(0.055)	(0.225)	(0.019)
promo	14.870 ***	24.367 ***	379.638 ***	45.892 ***
	(2.016)	(1.665)	(10.144)	(0.702)
mdd	−13.202 ***			
	(0.749)			
surface	0.003	0.00000	−0.014	−0.002
	(0.004)	(0.004)	(0.014)	(0.001)
ipc	−26.269	14.106	60.063	10.042
	(35.464)	(35.394)	(130.618)	(15.249)
IndiceCRP		196.752 ***		
		(47.824)		
Tauxdepenatration		−217.251 ***		
		(52.112)		
Frequencedachat		−3639.792 ***		
		(875.402)		
Constant	−52.283 **	14,302.620 ***	−170.839 *	1.731
	(22.089)	(3402.502)	(91.539)	(10.067)
Observations	116,674	21,824	170,973	150,771
R^2	0.787	0.795	0.535	0.772
Adjusted R^2	0.787	0.793	0.534	0.771

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 6. Predicting sales for product categories 17 through 20 when not accounting for climate.

	Dependent Variable:			
	Sales			
	(17)	**(18)**	**(19)**	**(20)**
mesure_lineaire_cm	0.085 ***	0.422 ***	−1.347 ***	0.265 ***
	(0.015)	(0.013)	(0.039)	(0.032)
week	−0.012 **	−0.010 ***	0.007	0.012 *
	(0.006)	(0.002)	(0.012)	(0.007)
qty	8.728 ***	7.568 ***	16.165 ***	3.662 ***
	(0.009)	(0.011)	(0.020)	(0.012)
temperature	0.139 ***	−0.024 **	−0.340 ***	−0.090 **
	(0.046)	(0.009)	(0.090)	(0.039)
promo	−0.134	12.443 ***	57.342 ***	−8.807 ***
	(1.224)	(0.267)	(2.562)	(1.485)
mdd	−31.062 ***	−14.837 ***	−32.427 ***	
	(0.725)	(0.254)	(1.926)	
surface	0.002	0.001	0.005	−0.001
	(0.003)	(0.001)	(0.005)	(0.004)
ipc	−24.970	−5.165	−20.558	4.738
	(27.762)	(11.096)	(57.847)	(48.202)
IndiceCRP				0.015
				(0.487)
Tauxdepenatration				−0.913
				(3.841)
Frequencedachat				
Constant	32.469 *	18.112 ***	25.411	34.808
	(17.939)	(6.437)	(38.384)	(205.040)
Observations	164,401	172,466	98,252	23,594
R^2	0.865	0.765	0.889	0.837
Adjusted R^2	0.865	0.764	0.888	0.836

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 7. Predicting sales for product categories 21 through 24 when not accounting for climate.

	Dependent Variable:			
	Sales			
	(21)	**(22)**	**(23)**	**(24)**
mesure_lineaire_cm	−0.003	0.097 ***	0.143 ***	0.085
	(0.011)	(0.020)	(0.017)	(0.059)
week	−0.017 ***	0.009 *	−0.043 ***	0.025
	(0.002)	(0.005)	(0.006)	(0.023)
qty	2.101 ***	2.146 ***	1.458 ***	2.580 ***
	(0.005)	(0.004)	(0.003)	(0.042)
temperature	0.161 ***	0.023	0.014	0.241 *
	(0.011)	(0.028)	(0.042)	(0.130)
promo	14.172 ***	−13.981 ***	11.982 ***	9.202 ***
	(0.380)	(1.807)	(1.157)	(2.819)
mdd				
surface	−0.003 ***	0.001	−0.001	−0.004
	(0.001)	(0.002)	(0.002)	(0.005)
ipc	80.283 ***	−2.306	24.489	149.944 **
	(15.447)	(19.252)	(20.997)	(59.824)
IndiceCRP	0.276 ***	−271.461 ***	−0.031	
	(0.020)	(13.758)	(0.034)	
Tauxdepenatration	−2.249 ***	266.907 ***		
	(0.046)	(14.286)		
Frequencedachat		5582.043 ***		
		(274.392)		
Constant	103.975 ***	−21,606.000 ***	77.536 ***	−187.114 ***
	(9.787)	(1094.361)	(16.443)	(69.314)
Observations	72,994	23,530	12,925	588
R^2	0.820	0.939	0.962	0.919
Adjusted R^2	0.819	0.938	0.961	0.897

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 8. Predicting sales for product categories 25 through 29 when not accounting for climate.

	Dependent Variable:				
			Sales		
	(25)	**(26)**	**(27)**	**(28)**	**(29)**
mesure_lineaire_cm	0.022 ***	0.125 ***	1.631 ***	0.288 ***	−0.262 ***
	(0.004)	(0.010)	(0.027)	(0.044)	(0.029)
week	−0.009 ***	0.040 ***	−0.002	0.079 ***	0.059 ***
	(0.001)	(0.002)	(0.024)	(0.029)	(0.014)
qty	1.226 ***	1.869 ***	2.063 ***	5.890 ***	17.997 ***
	(0.002)	(0.002)	(0.011)	(0.026)	(0.023)
temperature	−0.020 **	−0.078 ***	1.978 ***	−0.076	−0.582 ***
	(0.008)	(0.014)	(0.180)	(0.179)	(0.101)
promo	41.438 ***	21.197 ***	325.303 ***	228.976 ***	56.516 ***
	(0.488)	(0.635)	(5.639)	(6.725)	(3.025)
mdd			−168.964 ***		−57.851 ***
			(5.003)		(1.410)
surface	0.001	−0.001	0.005	−0.013	0.007
	(0.001)	(0.001)	(0.010)	(0.014)	(0.006)
ipc	−3.635	4.519	−18.080	81.613	−94.686
	(5.110)	(9.665)	(94.075)	(155.284)	(59.388)
IndiceCRP	−0.013	0.687 **			
	(0.015)	(0.299)			
Tauxdepenatration	0.058	−1.366 ***			
	(0.041)	(0.133)			
Frequencedachat		−14.771			
		(9.982)			
Constant	14.004 ***	23.064	−65.248	−212.535 **	−43.884
	(3.602)	(35.859)	(64.395)	(101.525)	(40.112)
Observations	298,738	144,739	74,823	13,604	44,796
R^2	0.660	0.871	0.411	0.852	0.950
Adjusted R^2	0.660	0.871	0.410	0.850	0.950

Note: ** $p < 0.05$; *** $p < 0.01$.

4.2. Accounting for Climate

We now explore the impact of accounting for climate on the relationship between weather and retail sales. We use the regression equation found in Equation (1) and compare the results with the model that does not account for climate. Again, the only difference between accounting for climate and not accounting for climate is the last term of the regression $week52Index$.

The regression results for the 29 different product categories are presented in Tables 9–15. We find that, similar to the model not accounting for climate, the allocated shelf space, quantity purchased, promotion, store brand, store competition, temperature, and in some cases, annual frequency of purchase are the only statistically and economically significant factors that impact sales.

Our findings have important implications for both research and practice. First, from a research perspective, our study highlights the need to consider the role of climate when analyzing the impact of weather on retail sales. Climate variables, such as temperature, can have a significant influence on customers' purchasing decisions. Therefore, excluding climate variables from the analysis can lead to biased and incomplete results.

Second, from a practical standpoint, accounting for climate can help retailers optimize their sales strategies. By understanding the relationship between weather and sales more accurately, retailers can adjust their marketing and promotional activities based on the prevailing climate conditions. For instance, during periods of extreme temperatures, retailers can implement targeted promotions or adjust their product assortments to cater to customer preferences and demand.

In conclusion, our study emphasizes the importance of accounting for climate when analyzing the impact of weather on retail sales. Our results demonstrate the significance of climate variables, such as temperature, in explaining sales variations across different product categories. By incorporating climate factors into sales analysis, retailers can gain

a more comprehensive understanding of the effect of weather conditions on consumer behavior and make informed decisions regarding their sales strategies.

Table 9. Predicting sales for product categories 1 through 4 when accounting for climate.

	Dependent Variable:			
	Sales			
	(1)	**(2)**	**(3)**	**(4)**
mesure_lineaire_cm	−0.028 ***	−0.547 ***	−0.023 ***	0.063 ***
	(0.003)	(0.021)	(0.008)	(0.018)
week	−0.009 ***	−0.039 ***	0.0003	0.035 ***
	(0.001)	(0.011)	(0.001)	(0.004)
qty	1.710 ***	3.820 ***	2.197 ***	2.362 ***
	(0.002)	(0.015)	(0.003)	(0.003)
temperature	−0.022	0.077	−0.033	0.027
	(0.020)	(0.186)	(0.022)	(0.073)
promo	3.173 ***	62.812 ***	0.694 ***	38.729 ***
	(0.167)	(3.216)	(0.258)	(1.047)
mdd	−8.695 ***			
	(0.084)			
surface	0.0004	0.001	−0.0002	0.001
	(0.0004)	(0.006)	(0.001)	(0.002)
ipc	0.216	−9.742	3.044	1.448
	(3.632)	(49.839)	(5.297)	(21.991)
IndiceCRP			−0.669 ***	−0.267 ***
			(0.010)	(0.029)
Tauxdepenatration				
Frequencedachat				
Constant	19.607	85.304 ***	50.348 ***	−10.112
	(14.579)	(29.220)	(3.908)	(16.601)
Observations	176,783	48,522	270,690	74,623
R^2	0.883	0.607	0.736	0.897
Adjusted R^2	0.883	0.605	0.736	0.896

Note: *** $p < 0.01$.

Table 10. Predicting sales for product categories 5 through 8 when accounting for climate.

	Dependent Variable:			
	Sales			
	(5)	**(6)**	**(7)**	**(8)**
mesure_lineaire_cm	−0.033 ***	−0.483 ***	1.109 ***	0.033 ***
	(0.007)	(0.025)	(0.022)	(0.004)
week	0.003 **	0.011	0.441 ***	−0.001 ***
	(0.001)	(0.011)	(0.084)	(0.0005)
qty	2.690 ***	3.134 ***	0.674 ***	2.471 ***
	(0.004)	(0.015)	(0.003)	(0.002)
temperature	0.028 *	−0.468 ***	2.971 *	0.010
	(0.017)	(0.135)	(1.547)	(0.008)
promo	1.633 ***	107.834 ***	95.276 ***	5.438 ***
	(0.179)	(3.159)	(26.198)	(0.107)
mdd	−9.883 ***			
	(0.128)			
surface	0.001 *	−0.004	−0.010	−0.001 ***
	(0.0005)	(0.004)	(0.012)	(0.0003)
ipc	−2.790	20.056	−106.453	12.825 ***
	(5.210)	(40.201)	(170.008)	(3.200)
IndiceCRP				0.410 ***
				(0.007)
Tauxdepenatration				−0.944 ***
				(0.009)
Frequencedachat				−6.206 ***
				(0.157)
Constant	−2.896	−11.468	−880.660 ***	46.178 ***
	(20.562)	(28.818)	(228.391)	(2.157)
Observations	218,955	39,508	18,722	239,687
R^2	0.735	0.615	0.812	0.877
Adjusted R^2	0.735	0.613	0.810	0.877

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 11. Predicting sales for product categories 9 through 12 when accounting for climate.

	Dependent Variable:			
	Sales			
	(9)	**(10)**	**(11)**	**(12)**
mesure_lineaire_cm	−0.062	0.391 ***	0.041 ***	0.027
	(0.050)	(0.006)	(0.006)	(0.025)
week	0.083 ***	−0.018 ***	−0.009 ***	−0.012
	(0.023)	(0.002)	(0.001)	(0.007)
qty	2.613 ***	2.336 ***	2.710 ***	3.588 ***
	(0.015)	(0.003)	(0.003)	(0.027)
temperature	0.603 *	−0.037	0.009	0.034
	(0.347)	(0.025)	(0.013)	(0.081)
promo	−1.491	−11.733 ***	3.525 ***	−5.527 ***
	(6.338)	(0.259)	(0.175)	(1.900)
mdd			−15.245 ***	−6.115 ***
			(0.106)	(1.091)
surface	−0.005	−0.0003	0.001 **	−0.001
	(0.017)	(0.001)	(0.0004)	(0.001)
ipc	20.665	−6.218	−5.334	−29.097
	(194.984)	(6.221)	(4.157)	(28.547)
IndiceCRP	−0.729 ***	−1.772 ***		
	(0.149)	(0.080)		
Tauxdepenatration		2.772 ***		
		(0.127)		
Frequencedachat		22.763 ***		
		(1.041)		
Constant	−114.267	−96.468 ***	25.482	52.592
	(115.827)	(7.428)	(17.041)	(32.627)
Observations	5225	244,336	240,691	293
R^2	0.894	0.797	0.832	0.995
Adjusted R^2	0.890	0.797	0.832	0.991

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 12. Predicting sales for product categories 13 through 16 when accounting for climate.

	Dependent Variable:			
	Sales			
	(13)	**(14)**	**(15)**	**(16)**
mesure_lineaire_cm	0.779 ***	1.896 ***	1.080 ***	0.453 ***
	(0.033)	(0.110)	(0.025)	(0.005)
week	0.034 ***	−0.018 **	0.019	−0.010 ***
	(0.008)	(0.009)	(0.039)	(0.003)
qty	4.183 ***	3.860 ***	2.275 ***	2.615 ***
	(0.007)	(0.016)	(0.006)	(0.004)
temperature	0.070	0.345 **	0.805	−0.087
	(0.128)	(0.169)	(0.674)	(0.057)
promo	15.168 ***	24.653 ***	379.911 ***	46.138 ***
	(2.018)	(1.669)	(10.146)	(0.704)
mdd	−13.329 ***			
	(0.750)			
surface	0.003	−0.001	−0.015	−0.001
	(0.004)	(0.004)	(0.014)	(0.001)
ipc	−23.726	18.975	64.741	9.237
	(35.498)	(35.487)	(130.999)	(15.269)
IndiceCRP		189.575 ***		
		(47.922)		
Tauxdepenatration		−209.401 ***		
		(52.221)		
Frequencedachat		−3508.041 ***		
		(877.235)		
Constant	−71.882 **	13,783.300 ***	−101.831	7.556
	(31.040)	(3410.303)	(103.695)	(10.843)
Observations	116,674	21,824	170,973	150,771
R^2	0.787	0.795	0.535	0.772
Adjusted R^2	0.787	0.793	0.535	0.772

Note: ** $p < 0.05$; *** $p < 0.01$.

Table 13. Predicting sales for product categories 17 through 20 when accounting for climate.

	Dependent Variable:			
	Sales			
	(17)	**(18)**	**(19)**	**(20)**
mesure_lineaire_cm	0.084 ***	0.422 ***	−1.349 ***	0.265 ***
	(0.015)	(0.013)	(0.039)	(0.032)
week	−0.028 ***	−0.008 ***	0.022 *	0.013 *
	(0.007)	(0.002)	(0.013)	(0.008)
qty	8.727 ***	7.568 ***	16.166 ***	3.662 ***
	(0.009)	(0.011)	(0.020)	(0.012)
temperature	−0.660 ***	−0.058 **	0.372	0.050
	(0.154)	(0.025)	(0.258)	(0.142)
promo	−0.045	12.427 ***	58.550 ***	−8.703 ***
	(1.223)	(0.268)	(2.581)	(1.486)
mdd	−31.060 ***	−14.817 ***	−32.416 ***	
	(0.724)	(0.254)	(1.925)	
surface	0.004	0.001	0.004	−0.001
	(0.003)	(0.001)	(0.005)	(0.004)
ipc	−36.891	−5.798	−9.259	6.869
	(27.857)	(11.094)	(57.952)	(48.254)
IndiceCRP				0.017
				(0.487)
Tauxdepenatration				−0.936
				(3.841)
Frequencedachat				
Constant	87.703 ***	14.780 **	−24.529	29.717
	(19.479)	(6.792)	(40.191)	(205.170)
Observations	164,401	172,466	98,252	23,594
R^2	0.865	0.765	0.889	0.837
Adjusted R^2	0.865	0.765	0.888	0.836

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 14. Predicting sales for product categories 21 through 24 when accounting for climate.

	Dependent Variable:			
	Sales			
	(21)	**(22)**	**(23)**	**(24)**
mesure_lineaire_cm	−0.002	0.098 ***	0.126 ***	0.180 *
	(0.012)	(0.020)	(0.017)	(0.103)
week	−0.016 ***	0.011 **	−0.043 ***	0.059 **
	(0.002)	(0.005)	(0.007)	(0.027)
qty	2.100 ***	2.146 ***	1.457 ***	2.576 ***
	(0.005)	(0.004)	(0.003)	(0.042)
temperature	0.193 ***	0.217 ***	−0.172	0.569
	(0.033)	(0.081)	(0.113)	(0.396)
promo	14.241 ***	−13.735 ***	12.258 ***	7.313 **
	(0.382)	(1.814)	(1.159)	(2.853)
mdd				
surface	−0.004 ***	0.0002	−0.0003	−0.006
	(0.001)	(0.002)	(0.002)	(0.005)
ipc	80.713 ***	1.105	22.391	144.353 **
	(15.454)	(19.289)	(21.087)	(59.787)
IndiceCRP	0.276 ***	−271.609 ***	−0.038	
	(0.020)	(13.760)	(0.034)	
Tauxdepenatration	−2.248 ***	267.091 ***		
	(0.046)	(14.288)		
Frequencedachat		5584.590 ***		
		(274.445)		
Constant	100.605 ***	−21,630.120 ***	78.505 ***	−250.958 ***
	(10.060)	(1094.537)	(17.403)	(77.049)
Observations	72,994	23,530	12,925	588
R^2	0.820	0.939	0.962	0.923
Adjusted R^2	0.819	0.938	0.961	0.898

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 15. Predicting sales for product categories 25 through 29 when accounting for climate.

	Dependent Variable:				
	Sales				
	(25)	**(26)**	**(27)**	**(28)**	**(29)**
mesure_lineaire_cm	0.022 ***	0.124 ***	1.631 ***	0.286 ***	−0.263 ***
	(0.004)	(0.010)	(0.027)	(0.044)	(0.029)
week	−0.006 ***	0.039 ***	−0.011	0.048	0.058 ***
	(0.001)	(0.002)	(0.025)	(0.033)	(0.014)
qty	1.225 ***	1.869 ***	2.063 ***	5.892 ***	17.997 ***
	(0.002)	(0.002)	(0.011)	(0.026)	(0.023)
temperature	0.046 *	−0.012	0.470	−1.502 ***	−0.038
	(0.024)	(0.037)	(0.511)	(0.504)	(0.289)
promo	41.435 ***	21.309 ***	325.420 ***	229.399 ***	56.784 ***
	(0.488)	(0.636)	(5.641)	(6.728)	(3.027)
mdd			−168.996 ***		−57.852 ***
			(5.002)		(1.410)
surface	0.0004	−0.001	0.008	−0.010	0.006
	(0.001)	(0.001)	(0.010)	(0.014)	(0.006)
ipc	−2.666	5.579	−41.272	60.193	−86.264
	(5.123)	(9.679)	(94.351)	(155.304)	(59.553)
IndiceCRP	−0.013	0.680 **			
	(0.015)	(0.299)			
Tauxdepenatration	0.057	−1.363 ***			
	(0.041)	(0.133)			
Frequencedachat		−14.527			
		(9.981)			
Constant	7.193 *	21.933	2.656	−115.085	−60.610
	(3.901)	(35.873)	(68.590)	(111.127)	(42.204)
Observations	298,738	144,739	74,823	13,604	44,796
R^2	0.660	0.871	0.411	0.852	0.950
Adjusted R^2	0.660	0.871	0.410	0.850	0.950

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

5. Discussion

The results of our analysis highlight the importance of accounting for climate when determining the impact of weather on retail sales. When not accounting for climate, we found that a significant number of product categories (20 out of 29) were sensitive to weather. However, when we accounted for climate using the *week*52*Index* variable, we found that only 11 product categories were sensitive to weather.

This indicates that some product categories may be misidentified as dependent on weather when climate is not taken into consideration. In other words, weather may have a temporary influence on certain product categories, but when climate is accounted for, the effect of weather becomes less significant.

These findings have important implications for both research and practice. From a research perspective, our study contributes to the understanding of the relationship between weather, climate, and retail sales. By highlighting the importance of accounting for climate, we offer a more accurate and nuanced understanding of how weather impacts sales in different product categories. This can inform future research on the subject and guide researchers in designing more robust studies.

From a practical standpoint, our findings suggest that retailers should take climate into consideration when analyzing weather's impact on sales. By understanding how climate affects consumer behavior, retailers can make more informed decisions regarding product assortment, marketing strategies, and inventory management. For example, if a product category is found to be sensitive to weather only in certain climates, retailers can tailor their strategies accordingly for stores in those regions with the identified climates. This can lead to more effective marketing campaigns, better inventory planning, and ultimately, improved sales performance.

It is worth noting that while our study focused on a specific set of product categories, the methodology and framework we developed can be applied to other industries and contexts. The inclusion of climate variables can provide valuable insights into the relationship

between weather and sales in various sectors, allowing for more accurate predictions and informed decision making.

In terms of limitations, our study is based on a dataset from a single retailer and a single country and may not be representative of the entire global retail industry. Additionally, we only considered temperature as a weather variable, and other weather factors, such as precipitation and humidity, may also have an impact on sales. Future research could explore the influence of these other weather variables and investigate the interactive effects of weather and climate on sales in more depth.

In conclusion, our study highlights the importance of accounting for climate when determining the impact of weather on retail sales. By incorporating climate variables into our analysis, we found that the influence of weather on sales varied depending on the climate conditions. This underscores the need for retailers to consider climate factors when analyzing the effects of weather on sales in different product categories. Our findings contribute to the existing literature on weather and sales, and have implications for both research and practice in the retail industry.

6. Conclusions

In this paper, we explored the importance of accounting for climate when determining the impact of weather on product sales in the retail industry. Our study is motivated by the need to differentiate between weather and climate in order to accurately assess the effects of weather on retail sales. We used a France-wide scanner panel dataset provided by our industry partner, which includes information on sales, temperature, promotional activities, and other relevant variables.

Our analysis revealed that if climate is not accounted for, product categories may be misclassified as being weather sensitive when they are not, and vice versa. This finding highlights the need for retailers to consider climate factors when making decisions about marketing and sales strategies. It also emphasizes the importance of accurately determining the impact of weather on retail sales, as flawed conclusions can be drawn if climate is not taken into account.

Furthermore, we showed that a simple week index can serve as a proxy for climate, eliminating the need for additional data collection and approximation efforts. By accounting for the time of the year, we were able to capture climate factors in our analysis. This approach is practical and scalable, making it a useful tool for retailers and practitioners.

Our findings have implications for both research and practice. From a research perspective, our study contributes to the literature by highlighting the importance of accounting for climate when determining the impact of weather on retail sales. It also provides insights into the use of a week index as a proxy for climate, which can guide future research in this area.

For practitioners in the retail industry, our results offer practical implications for decision making. By considering climate factors, retailers can make more accurate assessments of the impact of weather on product sales, leading to more informed marketing and sales strategies. This can ultimately result in improved business performance and customer satisfaction.

In conclusion, our study underscores the importance of accounting for climate when determining the impact of weather on retail sales. By doing so, retailers can avoid misclassifications and make more accurate assessments of weather-related effects. Our findings also highlight the practicality and scalability of using a week index as a proxy for climate, providing a valuable tool for retailers and practitioners. We hope that our study contributes to a better understanding of the relationship between weather, climate, and retail sales, and inspires further research in this area.

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