Weather Effect on Apparel Sales in France

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Abstract: In 2012, French apparel industry suffered weak sales for the fifth consecutive year. Even if economic conditions were not favorable, trade professionals feel that the weather played a significant role. Its impact on retail sales in general has not been formally quantified. This has become an urgent issue as climate change is aggravating naturally occurring climate variability and is becoming a source of uncertainty for climate-sensitive economic sectors. In this paper we provide managers with tools to evaluate the impact of temperature anomalies on sales volumes. We present a statistical method to separate out the weather effect from the underlying real performance of apparel sales. The model has been developed for the retail economic sector but can be extended to all fast moving consumer goods both in France and abroad. These models are applicable to supply chain managers and business analysts.

1 INTRODUCTION

Weather is a powerful force affecting the economy. Abnormal weather conditions can shift the timing of purchases or result in a total loss of demand. Weather is a risk factor for business and government. Retailers often talk about how adverse weather impacts their sales and/or earnings. Witness, for example, the July 6, 2005, statement on second-quarter earnings by Peter Harris, CEO of West Marine, who said of his companys sales: “As one would expect, continuing poor weather in April and May on both coasts dampened second quarter sales, especially when compared to the great spring weather we enjoyed last year”. In the following, we present both a method for computing the impact of the weather on economic activity and an illustration using the retail sales in the apparel industry in France as recorded by the Institut Français de la Mode (IFM).

2 LITERATURE REVIEW

The impact of weather on economic activity has been acknowledged as being large in most economic sectors in all countries (Howarth and Hoffman, 1984; Ellithorpe and Putnam, 2000). In some industries such as agriculture and energy, weather is such a risk factor that it is tracked, documented and hedged through risk management instruments (Roll, 1984; Lee and Oren, 2009).

Although the impact of the weather on behavior has been explored in fields such as finance, energy consumption and psychology, it has been largely ignored in the marketing literature. (Stoltman et al., 1999) used weather conditions as one of six factors that affect behavioral reactions while shopping for clothes. (Conlin et al., 2007) found evidence of weather-related projection bias of catalogue sales. However, there is now more than anecdotal evidence that firms try to incorporate weather variables into their sales forecasting models. For example, Wal-Mart lowered its June 2006 sales forecasts due to unusually cool summer weather (Murray et al., 2010). The impact of the weather on retail sales has been recognized now for a long time (Steele, 1951). It has been studied with varying conclusions. (Linden, 1959) studied the effects on New York City department stores of rain, sunshine, temperature and snow on the ground during business hours, finding few systematic effects. (Swinyard, 1993; Babin and Darden, 1996; Groenland and Schoormans, 1994) focused on the link between consumer mood, behavior and weather. To mitigate the effects of the weather on sales in fashion retail, (Caliskan Demirag, 2013) studied the effectiveness of weather-conditional rebates applied by numerous retail and manufacturing organizations to promote a variety of products from toys to health and beauty items with cash values incentives when weather conditions are unfavorable.

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In the particular sector of garment and apparel distribution, (Bahng and Kincade, 2012) provide strong evidence that fluctuation in temperature can impact sales of seasonal garments on a daily basis. However, no evidence has been found to substantiate an impact on sales of a whole season. (Rowley, 1999) prove what retailers had long suspected, ie, that precipitation affected substantially actual clothing purchases. The classic example can be found in the northern hemisphere: the placement of Easter in the calendar affects seasonal retail sales pattern depending upon whether it is in early March or late April. Generalizing, (Starr-McCluer, 2000) estimated that the effect of weather on retail sales in the United States has a small but statistically significant role in explaining monthly retail sales.

3 DATA AND METHODS

3.1 Data

The analysis of this relationship relies on choosing the most representative set of economic output, relevant weather data, and appropriate quantitative techniques. The objective is to prove the existence of a statistically significant relationship and establish the weather-sensitivity relationship in the case of textile and clothing.

3.1.1 Defining Weather Sensitivity

Weather exposure is the amount of revenues or costs at risk, which results from changes in weather conditions (Brockett et al., 2005). Many businesses experience some form of seasonal pattern in their activity. For example, electricity consumption is higher in winter than in summer, ice cream sales are stronger in summer than in winter, and so on. Business managers can execute their plans as long as the weather patterns remain typical. Potential gains or losses arise when weather conditions unexpectedly deviate from their normal values. Meteorologists refer to these deviations as weather anomalies. Because they are unexpected, weather anomalies, or weather surprises (Roll, 1984), can potentially change the economic performance of a firm or a sector. Normal weather conditions are calculated as the average weather over 30 years (Baede, 2001; Dischel, 2002).

The average weather is the climate. Climate variability is the extent to which actual weather differs from this climate. Climate variability causes potential disruption in economic conditions (Dischel, 2002). How much less will the ice-cream producer sell if the temperature is cooler than normal? How much more will the motorway operator spend to clear roads if snowfall is higher than in a typical winter? An economic sector is considered to be weather sensitive if weather anomalies can explain a percentage of the performance of the sector. In other words, a sector is weather sensitive if it is possible to establish a statistically significant relationship between weather anomalies and change in revenues: The stronger the relationship, the higher the sensitivity to weather.

3.1.2 Time Series from the Institut Français de la Mode

The first weather-sensitivity research papers focused on U.S. economic output. Gross Domestic Product (GDP) or gross state product data for the 11 non-governmental sectors were used as a measure of economic activity principally because time-series were sufficiently long to apply statistical analysis (Dutton, 2002; Larsen, 2006; Lazo et al., 2011).

Similarly, one important data source which could have been used are monthly turnover indices published by the French National Bureau of Statistics (INSEE). These indices aggregate turnover figures of firms falling within the scope of value-added tax payment. They are available at the most detailed level of the European classification of activities. More important, turnover indices are volume-based, which make them particularly relevant as a base for testing the impact of weather anomalies, as weather risk is a volume risk (Brockett et al., 2005; Barrieu, 2003; Dischel, 2002). Though data starts in January 1995, only two sectors could have been used for our analysis (textile retail sales in specialized stores and retail sale via stalls and markets of textiles, clothing and footwear). Moreover, the level of detail is insufficient.

We used data provided by IFM, the French Institute of Fashion. Researchers from the Economic Observatory of IFM have been gathering sales figures in volume from a panel of thousands of textile and clothing retailers across France since January 2000. Panel members range from independent multi-brand clothing stores to specialized single brand chain stores and department stores. Data is available by garment type for women, men and children. Sales figures are compiled and analyzed by IFM in a survey (Distribilan) to highlight major trends and changes by product category and distribution channel year on year on a monthly basis (see table 1).

Table 1: Apparel categories and distribution channels as used by the Institut Français de la Mode.

Category	Product	Distribution Channels
Women	Ready-To-Wear	Independent Stores
	Small Garments	Department Stores
	Underwear	Mass Merchant, Factory Outlets
Men	Ready-To-Wear	Online
	Small Garments	Hypermarkets
	Underwear	Large Distribution Chains
Children	Children's Clothes	Specialty Chain Stores
Other	Haberdashery - Knitting Wool	Multi-Brand Independent Stores
	Fabric By Meter	
	Household Linen	

3.1.3 Weather Data

The choice of weather variables is a key step of the process. IFM sales figures are produced at national level, whereas weather is a local risk. On a given day at a given time, weather conditions are different in Paris, in Brest in western France, and in Marseille in southern France (Barrieu, 2003). IFM indices add revenues from all regions at a national level. Therefore, weather variables must be constructed in such a way that they not only are a valid representation of national weather conditions but also can capture potential weather signals at a national level. In 2002, Météo France and Powernext developed a range of national temperature indices (NextWeather), initially aimed at the financial community to serve as a base for derivative instruments. They constructed the temperature index to fit the geographical distribution of economic activity. Météo France selected 22 representative weather stations (figure 1) and weighted daily data from each station by the population in each region to construct national temperature indices (Bertrand, 2010).

We applied the methodology developed by Météo France to construct our set of weather data. We used certified temperature and precipitation data from the National Oceanic and Atmospheric Administration (NOAA). To facilitate the replication of our work, it is important to detail the calculation process using one example. For each month m of year y, we calculated the national temperature index $T_{m,y}$ as follows:

$$T_{m,y} = \sum_{s=1}^{22} \sum_{d=1}^{l_m} \frac{1}{l_m} \frac{p_v}{p_{total}} \cdot t_{d,s,m}, \quad (1)$$

where $t_{d,v,m}$ is the average temperature of day d of year y in the weather station s of the 22 representative cities, l_m is the number of days within the month m, p_v the regional population and finally p_{total} the total population for all regions. Since we defined weather sensitivity as the exposure to weather anomalies, we calculated weather anomalies as the difference between the observed value and its "normal" value. For the current studys purposes, the normal value is the average observation over 30 years (19832012) as defined by the World Meteorological Office. For each month m of year y, the national temperature index anomaly $T'_{m,y}$ is given by the difference between the monthly national temperature index $T_{m,y}$ and the average of the same index over 30 years:

$$T'_{m,y} = T_{m,y} - \frac{1}{30} \sum_{y=1983}^{2012} T_{m,y} \quad (2)$$

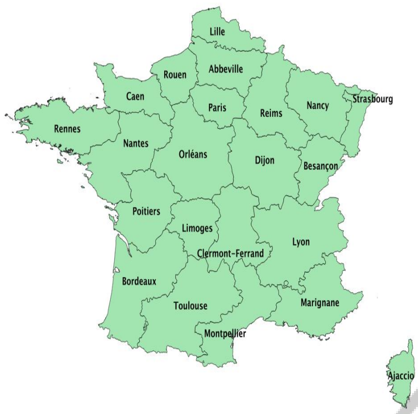
4 MODEL SELECTION

4.1 Times Series: Stationarity and Lags

A common assumption in time series analysis is that the data are stationary. Stationary series follow an accurate mathematical definition, which, for the purposes of the current study, is summarized by taking to mean that a stationary process has the property that the mean, variance, and autocorrelation structures are constant over time. This property means that stationary series are trendless with no seasonal fluctuations. There are several precise statistical tests on stationarity, of which the DickeyFuller one (Greene, 2011). This test applied to our data confirmed our assumption that all series are stationary. To test whether textile sales anomalies can be explained by temperature anomalies, we built the following linear models:

$$\alpha_{m,y} = \alpha + \beta T'_{m,y} + \varepsilon, \quad (3)$$

where $\alpha_{m,y}$ is the apparel sales anomaly of month m and year y, $T'_{m,y}$ the national temperature index



Town	Region	National population portion (%)
Strasbourg-Entzheim	Alsace	2.96
Bordeaux-Merignac	Aquitaine	5.04
Clermont-Ferrand	Auvergne	2.2
Dijon-Longvic	Bourgogne	2.69
Rennes-St Jacques	Bretagne	5.01
Orleans	Centre	4.13
Reims-Courcy	Champagne-Ardenne	2.22
Ajaccio	Corse	0.47
Besancon	Franche-Comté	1.89
Paris-Montsouris	Ile-de-France	18.77
Montpellier	Languedoc-Roussillon	4.05
Limoges-Bellegarde	Limousin	1.2
Nancy-Essey	Lorraine	3.86
Toulouse-Blagnac	Midi-Pyrénées	4.46
Lille-Lesquin	Nord-pas-de-calais	6.65
Caen-Carpiquet	Basse-Normandie	2.39
Rouen-Boos	Haute-Normandie	2.98
Nantes-Bouguenais	Pays de la Loire	5.58
Abbeville	Picardie	3.12
Poitiers-Biard	Poitou-Charentes	2.8
Marignane	Provence-Alpes-Côte-d'Azur	7.79
Lyon-Bron	Rhône-Alpes	9.75
Total	100	

Figure 1: Regions of France and share of total population.

anomaly, ε a random variable following a normed and centered distribution, and α and β the coefficients which we need to estimate. The textile industry is season-driven so we assumed that the sensitivity to weather for each month does not change within the same season. We therefore tested each model, for each of the four seasons to build each model. The models use the unexpected change in sales volumes which may be explained by unexpected changes in weather conditions as represented by temperatures. For each model, we tested the significance and the fit of the linear regression.

5 MANAGERIAL IMPLICATIONS

The present study is the first research work which analyzes the impact of temperature anomalies on sales in the entire apparel sector at regional level for a whole country. We calculate the sensitivity to weather of each product category, for each distribution channel, for men, women and children. As a result, we show how to remove the impact of weather on the historical apparel sector performance to display the true organic performance. We show how to specifically identify periods of the year which exhibit the highest exposure to changes in weather conditions. And finally, we provide "sales at risk" results thanks to a deep weather database to determine the average and the maximum potential losses which can be caused by extreme weather conditions by product category, by distribution channel. The fact that weather has an impact on apparel sales is not new to retailers. For the first time however, our findings formalize the relationship between weather and apparel sales and provide retailers with invaluable information about their performance excluding weather effect and about their exposure to weather. Such modeling also allows for risk management instruments such as weather derivatives or weather insurance to be implemented to protect retailers from losses caused by unfavorable weather.

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REFERENCES

Babin, B. J. and Darden, R. (1996). Good and bad shopping vibes: spending and patronage satisfaction. *Journal of Business Research*, 35(3):201–206.

Baede, A. P. M. (2001). Climate change 2001: Working group i: The scientific basis. appendix i - glossary. Technical report, Intergovernmental Panel on Climate Change (IPCC).

Bahng, Y. and Kincade, D. (2012). The relationship between temperature and sales. *International Journal of Retail and Distribution Management*, 40(6):410–426.

Barrieu, P. (2003). Introduction aux produits dérivés climatiques. *Journal de la Société Française de Statistique*, 144(3):53–68.

Bertrand, J.-L. (2010). *La gestion du risque météorologique en entreprise*. PhD thesis, Université Paris Ouest Nanterre La Défense.

Brockett, P., Wang, M., and Yang, C. (2005). Weather derivatives and weather risk management. *Risk Management and Insurance Review*, 8(1):127–140.

Caliskan Demirag, O. (2013). Performance of weather-conditional rebates under different risk preferences. *Omega*, 41:1053–1067.

Conlin, M., O'Donoghue, T., and Vogelsang, T. J. (2007). Projection bias in catalogue orders. *The American Economic Review*, 97(4):1217–1249.

Dischel, R. (2002). *Climate Risk and the Weather Market: Financial Risk Management with Weather Hedges*, chapter Introduction to the weather market: Dawn to mid-morning, pages 25–41. Risk Books, London.

Dutton, J. (2002). Opportunities and priorities in a new era for weather and climate services. *Bulletin of American Meteorological Society*, 83(9):1303–1311.

Ellithorpe, D. and Putnam, S. (2000). Weather derivatives and their implications for power markets. *The Journal of Risk Finance*, 1(2):19–28.

Greene, W. (2011). *Econometric Analysis*. Prentice Hall, Upper Saddle river, NJ, USA, 7th edition edition.

Groenland, E. A. and Schoormans, J. P. L. (1994). Comparing mood-inducion and affective conditioning as mechanisms influencing product evaluation and product choice. 11:183–197.

Howarth, E. and Hoffman, M. S. (1984). Amulti dimensional approach to the relationship between mood and weather. *British Journal of Psychology*, 75(1):05–23.

Larsen, P. H. (2006). Estimating the sensitivity of u.s. economic sectors to weather. Working Paper, Cornell University.

Lazo, J. K., Lawson, M., Larsen, P. H., and Waidmann, D. M. (2011). U.s. economic sensitivity to weather variability. *Bulletin of American Meteorological Society*, 92:709–720.

Lee, Y. and Oren, S. (2009). An equilibrium pricing model for weather derivatives in a multi-commodity setting. *Energy Economics*, 31:702–713.

Linden, F. (1959). The business of department stores. Technical report.

Murray, K., Di Muro, F., Finn, A., and Popkowski Leszcyc, P. (2010). The effect of weather on consumer spending. *Journal of Retailing and Consumer Services*, 17:512–520.

Roll, R. (1984). Orange juice and weather. *The American Economic Review*, 74(5):861–880.

Rowley, J. (1999). Loyalty, the internet and the weather; the changing nature of the marketing information systems. *Management Decision*, 37:514–518.

Starr-McCluer, M. (2000). The effect of weather on retail sales. Technical report.

Steele, A. T. (1951). Weather's effect on sales of a department store. *Journal of Marketing*, 15:436–443.

Stoltman, J. J., Morgan, W. F., and Anglin, K. L. (1999). An investigation of retail shopping situations. *International Journal of Retail and Distribution Management*, 27(4):145–153.

Swinyard, W. R. (1993). The effects of mood, involvement and quality of store experience on shopping intentions. *Journal of Consumer Research*, 20(2):271–293.