

# Booking in the Rain. Testing the impact of public information on prices

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## Objectives

The understanding of prices and of their dynamics is a key issue in economic analysis, as in market economies the price has the paramount role of allocating resources and conveying information (Hayek, 1945). When information is private, the price system uses dispersed knowledge, leading to different degrees of efficiency (Grossman and Stiglitz, 1980; Vives, 2014). Prices also reflect public information, when it concerns external factors affecting demand or supply conditions (Bernhardt and Taub, 2015). At the business level, strategies of price discrimination and dynamic pricing are nowadays very popular to capture idiosyncratic variations in demand and to provide suppliers with complex but effective tools of revenue management optimization (Nocke and Peitz, 2007; Moller and Watanabe, 2010; Gershkov and Moldovanu, 2012; Moller and Watanabe, 2016).

Within this general framework, this article aims at assessing the impact of public information on prices, identifying factors that affect the magnitude of the effect. We do this in an environment where not only information is highly relevant for the exchange, but it is also completely exogenous: the one of weather forecasts and hotel prices. The quality of the stay at the destination (particularly when considering leisure activities linked to summer holidays) is expected to depend on weather conditions (Scott and Lemieux, 2011; Gomez-Martin, 2005; Zirulia, 2016), and so is demand. Weather forecasts play an informative role for economic agents in markets characterized by information uncertainty and when purchasing decisions need to be anticipated through advance booking, like hospitality and travel. Weather forecasts are continuously produced by private and public providers to predict real weather conditions. A peculiarity of weather forecasts is that they are known (or at least accessible) to both sides of the market, which rules out, or significantly weakens, issues of information asymmetry.

In this setting, predictions hinging upon the “traditional view” of consumers’ and suppliers’ rationality are straightforward, in that forecast of good (bad) weather should be associated with relatively high (low) prices, because of the impact that information has on demand, and consequently on supply (pricing) behaviour. However, such a conclusion is less uncontroversial if one looks at the expanding literature in behavioral industrial organization

(for a review, see Heidhues and Kőszegi, 2018), specifically, the one focusing on “behavioral firms”, i.e., firms deviating from the typical benchmark of profit maximization. In fact, while in principle prices should reflect all relevant and available information regarding a certain good or service, there may be behavioural mechanisms that prevent firms from implementing optimal pricing policies. This is the case for instance of managerial inertia, advocated by DellaVigna and Gentzkow (2019) as the main explanation for uniform prices across most U.S. food drugstores and mass-merchandise chains. Ellison et al. (2018) also document pricing inertia and managerial frictions, by studying pricing decisions of a set of rival firms selling computer components in an online marketplace. In this context, managers seem to be rationally bounded and to change prices according to rules of thumb based on a subset of state variables, rather than setting the optimal price given the information available at each moment.

## Methodology

Our contribution is both theoretical and empirical. On the theoretical side, we formalize the “traditional view” and develop a simple model adopting a Bayesian rational choice approach, where the value of actions stemming from individual decisions depends on realized weather conditions (Katz and Murphy, 1997; Tena and Gómez, 2011; Zirulia, 2016; Raymond and Taylor, 2020). The model is built to resemble the distinctive features of our setting. A firm faces consumers whose willingness to pay for a product depends, among other things, on external factors such as weather conditions. Consumers take their purchasing decisions before the weather state is realized, but after having observed an informative signal, i.e., the weather forecast. The signal is observed by the firm as well, which then fixes the price contingent on the weather forecast. It follows that consumers take their choices observing the weather forecast and the posted price.

Our model predicts that bad weather forecasts have a negative effect on prices, via the impact they exert on demand. In addition, the impact is expected to be larger the more valuable for consumers information is, i.e., the higher the forecast’s level of accuracy and the higher the *ex-ante* level of uncertainty in weather.

The theoretical predictions concerning the impact of public information on prices are then brought to the data for our empirical contribution. To assess the impact of weather forecasts on hotel prices, we estimate a hedonic price model augmented with characteristics related to dynamic pricing strategies and to weather forecasts. This approach allows us to tackle the complexity of markets in which price adjustments can be almost instantaneous. We collect data through a web scraper and analyze daily prices for the population of hotels in Rimini (Italy), a typical sea & sun summer destination, highly dependent on weather conditions. Data are then merged with weather forecasts available at the moment when prices are posted.

## Results

The hypotheses deriving from the model are supported by the data. We find that weather forecasts are important and independent determinants of the price: *ceteris paribus*, the worse the weather forecast, the lower the price. As predicted by the model, the impact is larger the higher the forecast's level of accuracy, i.e., when the forecast day is closer to the arrival date, and in those months in which weather is more uncertain, i.e., the higher the *ex-ante* level of uncertainty in weather. In short, our results tend to support the traditional view in which pricing reacts significantly to public (weather) information. Nevertheless, in an additional exercise, we estimate the hedonic pricing model separately for upper-scale hotels (4- and 5-star hotels, and low- and mid-scale hotels (1-, 2- and 3-star hotels). We find that the response of prices to weather forecasts is larger for upper-scale hotels than for low- and mid-scale hotels, a result we link to the superior managerial competences that characterize the former compared to the latter.

## Implications

Our analysis concerns the impact of public information on prices, and more generally on economic outcomes and behavior. For this reason, it provides a contribution to several related streams of literature.

First, there is a vast empirical literature investigating the role of public information and media in various economic settings. In particular, a few studies have analyzed the impact of public information on the stock market (Cutler et al, 1989; Mitchell and Mulherin, 1994; Engelberg and Parsons, 2011) and in future markets such as those related to crops and livestock (Dorfman and Karali, 2015). Information by media companies has been shown to affect corporate governance (Dyck et al., 2008) and political behavior (DellaVigna and Kaplan, 2007). Our novel setting presents a few advantages with respect to most of the existing literature: i) the channel through which the information impacts on the economy is easy to identify; ii) the accuracy of information can be measured precisely; iii) information is less biased than in situations where political ideology (Gentzkow and Shapiro, 2010) or conflicts of interest (Gurun and Butler, 2012) are relevant, as suggested by Gentzkow and Shapiro (2006) (although Silver (2012) and Raymond and Taylor (2020) do find some degree of media bias for weather forecasts as well). On the theory side, our model is related to the literature analyzing the use of information in contexts where strategically interacting agents have access to public and private information (Morris and Shin, 2002; Angeletos and Pavan, 2007; Myatt and Wallace, 2015).

Our work also contributes to the growing literature on the impact of weather on the economy (a recent, comprehensive survey is provided by Dell et al., 2014). Weather can affect the economy in several ways. It can be an exogenous trigger of economic shocks, leading to shortage of goods and then to price increases (Heinen et al., 2018). It can affect

the psychological dimension of decision making, in choices ranging from financial investment (Saunders, 1993; Hirshleifer and Shumway, 2003) to college enrollment (Simonsohn, 2009). It can affect demand indirectly, as it is the case for energy (Mu, 2007). Finally, it can directly influence the quality of the good or service, and therefore demand, as it is the case for tourism (Shih et al., 2009; Day et al. 2013; Ridderstaat et al. 2014) or wine production (Ashenfelter, 2008). More closely related to our article, there is also a (mostly interdisciplinary) literature on the role of weather forecasts in the economy, which studies its overall impact (Katz and Murphy, 1997a) or in specific sectors, such as agriculture (Mjelde and Penson, 2000), energy (Considine et al., 2004) and fishery (Costello et al., 1998). To the best of our knowledge, this study is the first one looking at the impact of weather forecasts on hotel prices.