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## Sensitivity of winter tourism to temperature increases over the last decades

Martin Falk<sup>a</sup>, Xiang Lin<sup>b,\*</sup><sup>a</sup> Austrian Institute of Economic Research, WIFO, Austria<sup>b</sup> Södertörn University, Alfred Nobels alle 7, SE-141 89 Huddinge, Sweden

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## ABSTRACT

This paper provides new evidence on the impact of temperatures on tourism demand in the winter season. The analysis is based on time series data spanning from 1960 to 2015 for the South Tyrolean mountains in Italy. Since 1960, winter temperatures have increased by 0.4 degrees Celsius per decade, on average. A nonlinear autoregressive distributed lag (ARDL) model is employed for the estimations. This model allows two separate coefficients to impact tourism demand, following temperature changes (decreases or increases). Results reveal that an increase in winter temperatures by one degree Celsius leads to a decline in the number of accommodation guests (arrivals) by eight per cent, while temperature decreases have no effect on the number of arrivals. However, sensitivity to temperature increases has been declining since the early 1990s, probably due to the widespread usage of snowmaking facilities. The number of these facilities has increased by almost 10 per cent per year on average over the same period. In recent years (1986–2015), and as a consequence of these measures, temperature increases no longer have an effect on winter tourism demand. Conversely, decreases in temperatures lead to small increases in arrivals (by four per cent increase due to a one degree Celsius decrease).

## 1. Introduction

As global warming is predicted to continue throughout this century, many scholars have raised concerns about potential negative consequences on the global economy. Literature demonstrates that climate change has significant negative effects on the output and productivity of outdoor work-intensive sectors such, as agriculture (Deschênes and Greenstone, 2007; Schlenker and Roberts, 2009) or construction (Heal and Park, 2016). In addition, there is research revealing that not only weather-dependent industries are affected but also that there are wider effects of climate change on aspects such areas as economic growth (Dell, Jones and Olken, 2012), economic production (Burke et al., 2015) human health, conflict, migration, and demographics (for surveys of the literature see Dell, Jones and Olken, 2014; Carleton and Hsiang, 2016; Heal and Park, 2016). However, the relationship between climate variability and tourism demand has been largely overlooked in the economics literature (see for an exception Agiormirgianakis, Serenis and Tsounis, 2017). In contrast, climate factors and weather fluctuations are well covered by recent tourism literature, often through use of dynamic time series or panel data models (Falk, 2010; Li, Song and Li, 2016; Goh, 2012; Li, Song and Li, 2016; Töglhofer, Eigner and Prettenhaler, 2011; Zhang and Kulendran, 2017).

Independent of the field, the literature mentioned above agrees to the extent that there is a symmetric long-run relationship between year-to-year fluctuations in weather indicators or climate factors and economic outcomes. Implicitly this means that the effects of weather fluctuations such as temperature increases or decreases on outcomes are assumed to be of the same magnitude independent of direction.

The aim of the study is to analyse the impact of temperatures on demand for winter tourism measured as registered guest arrivals. The analysis is based on time series data for the province of South Tyrol (Alto Adige in Italy) for the winter period 1959/1960 to 2014/2015. This time span of more than 50 years allows for testing the stability of the regression relationship between temperatures and winter tourism demand over time. We employ a nonlinear autoregressive distributed lag (ARDL) model introduced by Shin et al. (2013), which makes it possible to capture asymmetric effects in the long-run relationships. Non-symmetric reactions could well be expected in the case of winter tourism: On the one hand, temperature increases may have negative effects on winter tourism demand because it can shorten the snow season with a reduction in snow depth and also may reduce the number of optimal snowmaking days. On the other hand, unusually low temperatures may not necessarily stimulate tourism demand further even if smaller decreases are beneficial for winter sports.

\* Corresponding author.

E-mail address: [xiang.lin@sh.se](mailto:xiang.lin@sh.se) (X. Lin).<https://doi.org/10.1016/j.econmod.2017.12.011>

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This article contributes to existing tourism literature in several ways. First, it allows for asymmetric long-run elasticities of tourism demand. To our knowledge, the nonlinear ARDL model with bounds test for small samples developed by Narayan (2005) has not been applied to tourism demand studies. Second, in order to study consequences of a structural break caused by increased investment in snowmaking facilities over time, this paper provides estimations for different sub-periods to deal with possible impacts due to structural breaks. Third, we use temperatures to measure year-to-year fluctuations in weather. While the majority of tourism studies for winter destinations focus on the role of natural snow, little is known about the relationship between winter tourism demand and long term temperature changes, which, for instance, is the central variable in climate change scenarios reported by the Intergovernmental Panel on Climate Change (IPCC, 2014).

The structure of this paper is as follows. Section two outlines the conceptual background and empirical model together with the data sources, while section three presents the study area and descriptive statistics. Section four presents the empirical results, and section five provides concluding remarks.

## 2. Conceptual background and empirical model

In this study, tourism inflows are related to the year-to-year fluctuations of local weather conditions. Similar approaches are commonly used to investigate climate change impacts on agriculture (Deschênes and Greenstone, 2007; Schlenker and Roberts, 2009), electricity consumption and energy demand (Considine, 2000; Bessec and Fouquau, 2008; Do et al., 2016), and tourism demand (Falk, 2010, 2013). The underlying assumption is that weather conditions are exogenous and generally random (Deschênes and Greenstone, 2007), implying that their inter-annual variations can be used to identify the tourism impact of climate change. Commonly used measures in these cases are, for instance, growing degree days in agriculture (Schlenker and Roberts, 2009) or heating and cooling degree days in electricity consumption (Bessec and Fouquau, 2008).<sup>1</sup> Typically, these studies find a non-linear relationship between temperature or degree days and economic outcomes. In the case of winter tourism demand, often used indicators are snow conditions measured as snow depth or temperatures (Töglhofer et al., 2011). As an alternative, the number of snow-making days calculated as wet bulb temperatures can be used (Demiroglu et al., 2015).

According to the tourism literature, weather conditions can have a major impact on tourism inflows (Rosselló-Nadal et al., 2011; Töglhofer et al., 2011). Gómez-Martín (2005) suggests that a season with unfavourable weather conditions may prevent tourists from travelling to that region in the following years. This implies that there is a lagged response among tourists to favourable or unfavourable weather conditions. Studies using dynamic panel data models and annual data for the total winter season show that natural snow conditions significantly affect the number of overnight stays (Damm et al., 2017; Falk, 2010, 2013; Töglhofer et al., 2011), although the magnitude of the relationship is relatively modest and varies across areas and time spans.<sup>2</sup>

In this study, temperature is the main weather variable. The reason for this is that temperature can indicate both availability of natural snow and prevalence of suitable conditions for snow-making. In contrast to the northern side, the south of the European Alps is characterised by low natural snow cover (Marty, 2008), meaning that cold temperatures that allow for snow production are particularly important in this region. In general, temperature can have direct as well as indirect effects on winter tourism demand. Higher temperatures reduce the likelihood that sufficient snow (whether natural or fabricated) will be available, can shorten the snow

season, lead to a deterioration of the snow quality, and thereby affect tourism demand. Englin and Moeltner (2004) show that lower daily temperatures lead to an increase in skier visits. Warmer weather also makes other competing outdoor activities such as hiking and biking more attractive, thereby shifting tourism demand away from the mountain destinations to other destinations. However, colder weather is not necessarily enough to stimulate tourism demand further. There is also a temperature threshold below which snow sports are no longer comfortable to perform.

Given these considerations, it is assumed that the relationship between temperature and winter tourism demand is asymmetric. Asymmetric relationships are common features of many economic relationships and are found in export demand behaviour, interest rate spreads, inflation, price dynamics, and visitors attendance to events (Katrakilidis and Trachanas, 2012; Shahzad et al., 2017; Süßmuth and Woitek, 2013; Van Hoang et al., 2016; Verheyen, 2013). In the case of tourism demand, it is likely that guest arrivals in the winter seasons react more strongly to increases than to decreases in temperature. The reaction of guest arrivals to real income might also be affected by fluctuations in the business cycle differently.

In addition, a number of factors could affect the stability of the relationship between year-to-year variations in weather and economic outcomes. Literature suggests that adaptation measures have an immense potential to reduce negative impacts of climate change (Burke et al., 2016). Among winter sport destination and ski lift companies, the most important adaptation strategies are the use of snowmaking facilities and diversification (i.e., supply of leisure activities that are not dependent on natural snow conditions or favourable temperatures). Nowadays, between 70 and 80 per cent of the ski area is covered by snowmaking facilities according to the environmental agency of South Tyrol (Agenzia provinciale per l'ambiente).<sup>3</sup> Although snowmaking is dependent on cool temperatures and temperatures have increased over time, the new generation of improved snowmaking technologies makes it possible to produce snow in a very short period of time. Thus, the massive investments in snowmaking facilities and technological progress may weaken the connection between temperature changes and tourism inflows over time. In fact, using a time span of 35 years, Töglhofer et al. (2011) find that the importance of the relationship between tourism demand and snow depth in winter sport destinations is decreasing over time. The authors attribute this occurrence to the widespread usage of snowmaking facilities. Being that in South Tyrol ski lift companies started to heavily invest in snowmaking facilities after the extremely mild and snow poor winter seasons of 1988/1989 and 1989/1990, analysis will be split into two sub-periods (before and after the period with massive investments in snowmaking).

The empirical model can be derived from the theory of tourism demand. Accordingly, quantity of tourism goods or services demanded is a function of income of consumers and its price. The tourism demand literature suggests that tourism inflows depend on real income and tourism prices of the origin and home country, exchange rates, and transportation costs (Peng et al., 2015; Song et al., 2009). Theory predicts that tourism demand increases as real income, and decreases if relative prices change in an unfavourable way (i.e. prices in the host (tourist) country increase relative to prices in other countries). According to Song et al. (2009), tourist arrivals are the most common measure of tourism demand. Other measures are tourist expenditure and overnight stays. The latter has the advantage that it accounts for both tourist arrivals and the length of stays. In principle, overnight stays can be regarded as the more accurate measure because they account for the length which generally tends to decline over time. Based on our sample, the two measures of tourism demand are highly correlated.<sup>4</sup> Therefore, we follow suit with the literature and use tourist arrivals as the dependent variable.

<sup>1</sup> Growing (heating or cooling) degree days mean the number of days in which the temperatures are above or below a given threshold.

<sup>2</sup> Studies using skier visits (or skier days or lift transports) as the dependent variable are not considered here.

<sup>3</sup> <http://ambiente.provincia.bz.it/contatti.asp>.

<sup>4</sup> The correlation coefficient between the annual percentage change in arrivals and overnight stays is 0.89 and significant at the 1 per cent level based on the full sample from 1959/1960–2014/2015.

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