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Analysis

Gains from investments in snowmaking facilities

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ABSTRACT

The process of making snow requires low temperatures as well as vast quantities of water and considerable amounts of energy for the air compression. In this article the effectiveness of investment in snowmaking systems is investigated (equipment, construction works) based on data for 109 French ski resorts covering eight winter seasons (2006/2007 to 2013/2014). Both static and dynamic panel data estimations show that ski areas with large investments in snowmaking systems have a higher number of skier visits. On average a 10% higher capital stock of snowmaking infrastructure leads to an increase in the number of skier visits by 8% over the winter seasons studied. However, positive effects of snowmaking can only be observed for ski areas located at high elevations, with a magnitude deceasing by higher cumulated investments in snowmaking, indicating diminishing returns to scale. Ski areas at lower elevations, benefit effectively from snowmaking to a lower degree and only in extremely dry or snow poor winter seasons.

1. Introduction

French ski lift companies have invested heavily in snowmaking systems. Between 2006 and 2014 the 100 largest ski lift companies invested € 414 million (cumulated) or € 46 million per year on average (Source Montagne Leaders). Managers of ski lift companies argue that investment in snowmaking facilities gives a competitive advantage to the company (Trawöger, 2014). Snowmaking is commonly seen as an effective climate adaptation strategy to cope with global warming. In fact, a survey of managers of low elevation ski areas reveals that climate change is not perceived as a major challenge for the ski industry since snowmaking is the main adaptation measure (Wolfsegger et al., 2008). The goal of massive investment in snowmaking equipment is to guarantee an early start to the season and make the ski industry independent of variations in natural snowfall (Steiger and Mayer, 2008). Information on the 109 largest French ski resorts, representing 95% of the industry's total output, reveal that all but two invested in snowmaking during the period 2002 to 2014 (Source: Montagne Leaders and Table 6 in the Appendix A).

This paper presents first empirical evidence on how investments in snowmaking impact the output of French ski lift companies. Output is measured as the number of skier visits (also referred to as skier days).[1] Special attention is paid to what extent past investment in snowmaking systems leads to higher skier visits in general and how beneficial it is in winter seasons with extreme weather conditions (lack of natural snowfall or low precipitation). Since snowmaking is particularly crucial for low-altitude ski resorts we report the results for these ski areas separately. In addition to snowmaking, the model also control for new ski lift installations. Both static and dynamic panel data methods are used, where the latter makes it possible to account for the endogeneity of snowmaking investment.

This paper contributes to the growing literature on the impact of global warming on winter tourism and on possible measures to adapt (see Becken, 2013 for a review). Many studies emphasize the role of weather conditions and climate factors in the short- and long-term growth of ski lift companies. There is consensus in the literature that low-lying ski areas are considerably more affected by warm winter seasons than high-elevation areas (Bark et al., 2010; Gonseth, 2013; Hamilton et al., 2003; Pickering, 2011; Steiger, 2011). Similarly, other studies predict that climate change will have negative consequences on ski lift operations, particularly in low-elevations (Abegg et al., 2007; Dawson and Scott, 2013; Steiger and Abegg, 2013). Snowmaking is the main adaptation strategy to compensate for the lack of natural snowfall. When snowmaking is accounted for, Steiger (2012) finds that the impact of climate change on skiing demand is quite modest at least in the short and medium run. Instead, demographic changes such as stagnating and ageing population are larger threats to skiing operations.

To the best of our knowledge, this is the first study that investigates the relationship between output of ski lift companies and investment in snowmaking facilities using a longer time span and fuller data coverage (covering both warm and normal winter seasons). Previous studies investigate the link between the survival of ski lift companies and the use of snowmaking systems where snowmaking is measured as a binary variable (Falk, 2013; Beaudin and Huang, 2014), a dummy variable for a

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[1] Skier visits are defined as the number of people who buy a lift ticket or lift pass and use the ski area for one or part of the day.

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given threshold of snowmaking capacity (Gonseth, 2013) or (subjective) rating of new snowmaking systems (Tashman and Rivera, 2015). Given that almost all French ski areas in the estimation sample have been long since equipped with snowmaking systems, the amount of past investments becomes more important for output. Despite large investments in snowmaking infrastructure, little is known about their effectiveness in normal and snow poor winter seasons. Previous studies on winter tourism in the French Alps focus on winter tourism demand for ski areas belonging to the Compagnie des Alpes (CDA) group (Falk, 2015), the productivity of French ski areas (Goncalves, 2013), the productivity and greening of ski area (Goncalves et al., 2015) and the causes of stagnation (Tuppen, 2000).

A study on the returns to investment in snowmaking systems for French ski lift companies is interesting for several reasons. First, France has one of the largest ski areas in the world. Second, after a long period of increased demand and expansion the French ski market has reached a point of stagnation (Vanat, 2015; Hudson and Hudson, 2015). This holds true not only for France but for the ski industry in general. Third, the effectiveness of investment in snowmaking has been largely overlooked. Previous literature has concentrated on the relationship between winter tourism demand and weather conditions or climate variability (see Dawson et al., 2009; Holmgren and McCracken, 2014; Shih et al., 2009). An exception to this is the study by Damm et al. (2014) which investigate the costs and benefits of snowmaking under future climate change scenarios for Austrian ski areas. The authors find that costs of snowmaking will increase considerably, something that also leads to an acceleration of the increase of lift ticket prices.

Knowledge of the effectiveness of snowmaking investment is relevant for policy makers, managers, and stakeholders (e.g. investors and banks) for a number of reasons. For instance, the knowledge about the benefits of snowmaking in low elevations ski areas is important to banks and investors, since these operators pose a higher risk of failure (Trawöger, 2014).

The paper is structured as follows. Section 2 describes the theoretical background and introduces the empirical model, while Section 3 provides the data and descriptive statistics. Section 4 presents the empirical results, Section 5 discusses the results and Section 6 concludes.

2. Theoretical Background and Empirical Model

Snowmaking is the key adaptation measure to compensate for natural snow. The snow cannon was invented in 1950 and patented in 1954 (Pierce, 1954). Snow is produced by a process in which cold air and water are pumped through compressors and then sprayed on ski slopes (https://en.wikipedia.org/wiki/Snowmaking). Installations of additional snowmaking facilities increase the snow supply and can be regarded as a technological innovation, particularly a new process innovation. According to the OSLO manual, a process innovation is the introduction or implementation of a new or significantly improved production method that helps a firm to remain competitive (OECD/Eurostat, 2005). In tourism literature, snowmaking technology is included on the list of the 100 most important innovations (Hjalager, 2015). Snowmaking infrastructure not only consists of snowmaking equipment (snow towers, snow fans) but also requires the construction of new power lines and water pipelines. Often water reservoirs for snowmaking have to be constructed. Water can be drawn from a spring, river or lake. However, ski lift companies have to apply for water rights.

Expansion of snowmaking capacity can lead to an increase in the number of snow reliable days and thereby attract more visitors (Steiger and Mayer, 2008). Damm et al. (2014) show that snowmaking investments have a positive impact on revenues. However, the effects tend to be non-linear with a decrease in the positive effects as the levels of investments increase, indicating diminishing returns to snowmaking investments. For Switzerland, Gonseth (2013) finds that a ski operator that can ensure the presence of snow over 30% of ski runs (which is roughly the Swiss average) manages to considerably reduce sensitivity to natural snow conditions in relation to skier visits.

In the ski industry, other major new technology consists of installations of new ski lifts. These offer a higher transport capacity, faster speed, and more comfort (heated seats, bubbles, loading carpets, etc.). Replacement of an older ski lift (e.g. a t-bar lift) with a new chairlift or a gondola can be regarded as product or process innovation. It is expected that a new ski lift attracts more passengers than older less comfortable ski lifts. However, at the aggregate ski area level the expected effect of new ski lift installations is not clear-cut. New ski lifts can take passengers from the neighbouring lifts so the output effect at the aggregate ski area level might be low.

The empirical model can be motivated by a production function where output is a function of the capital stock distinguished by the capital stock of snowmaking facilities and lift infrastructure. Due to data limitations, lift infrastructure is measured by installations of new ski lifts rather than transport capacity. The resulting production function can be specified as follows:

$$\ln Y_{it} = \alpha_i + \alpha_1 \ln K_{it} + \alpha_2 NEWLIFT_{it} + \lambda_t + \varepsilon_{it}, \tag{1}$$

where i and t denote the ski area and the year, respectively. ln denotes the natural logarithm. Y denotes the number of skier visits for winter seasons 2006/2007 to 2013/2014, K denotes cumulated past investment in snowmaking infrastructure deflated by the GDP deflator, and *NEWLIFT* is a dummy variable of installation of a new ski lift (excluding carpet lifts and t-bar lifts) and zero otherwise. Note that K and *NEWLIFT* refer to the calendar year (t) (e.g. 2013) whereas skier visits refer to the subsequent ski season (e.g. 2013/2014). Further, α_i denotes the fixed effects that capture all time invariant factors such as elevation and size of the ski area, different locations (e.g. Pyrénées, Jura, Massiv Central, Alps), and distance to the neighbouring ski area or to larger agglomerations. ε_{it} is the error term with mean zero and assumed i.i.d. λ_t are time effects that capture macroeconomic factors such as business cycle effects and the effects of weather conditions that are common to all ski areas.

It would be preferable to account for the economic depreciation when calculating the capital stock of snowmaking systems. However, deprecation rates differ between snowmaking equipment and structures, and are not available. Note that the economic literature shows that capital stock estimates (in case of R&D capital) are largely independent of the use or choice of depreciation rates (Hall and Mairesse, 1995).

The output equation can be estimated by the static fixed effects model for winter seasons 2006/2007 to 2013/2014. To account for the fact that ski areas are often part of a larger ski alliance, we allow the error terms of these ski areas to be correlated. Since the effectiveness of snowmaking technology is expected to differ between low and high elevation ski areas, we provide separate estimates for the two groups. Low elevation ski areas exhibit a lower number of optimal days with appropriate weather conditions to produce snow. Therefore, in warm winter seasons marked by low snowfall, output growth is expected to be lower for low-elevation ski areas than for high elevation ski areas. Output volatility can be expected to be much higher for low-elevation ski areas than for their high elevation counterparts. For Australia, Pickering (2011) finds that low natural snow cover leads to a strong decline in visitors – ranging between 52 and 86% – for the three lowest-altitude ski resorts compared to the average number of visitors from the previous nine years. Previous empirical evidence from Austrian ski areas in the province of Tyrol shows that lower-elevation resorts experienced the largest reductions in number of passenger transports during the extraordinary warm 2006/2007 winter season (Steiger, 2011). Low elevation ski areas are defined as ski areas below the weighted average elevation of ski lifts (which is 1770 m). This is done by calculating the mean of the valley and uphill lift station and then weighting the average elevation of each lift by the share of each lift in total transport capacity adjusted by the vertical meters of each lift.

Besides separate estimations for low and high elevation ski areas, we also provide separate estimates for small and large ski areas for a given