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(Occasional Papers)

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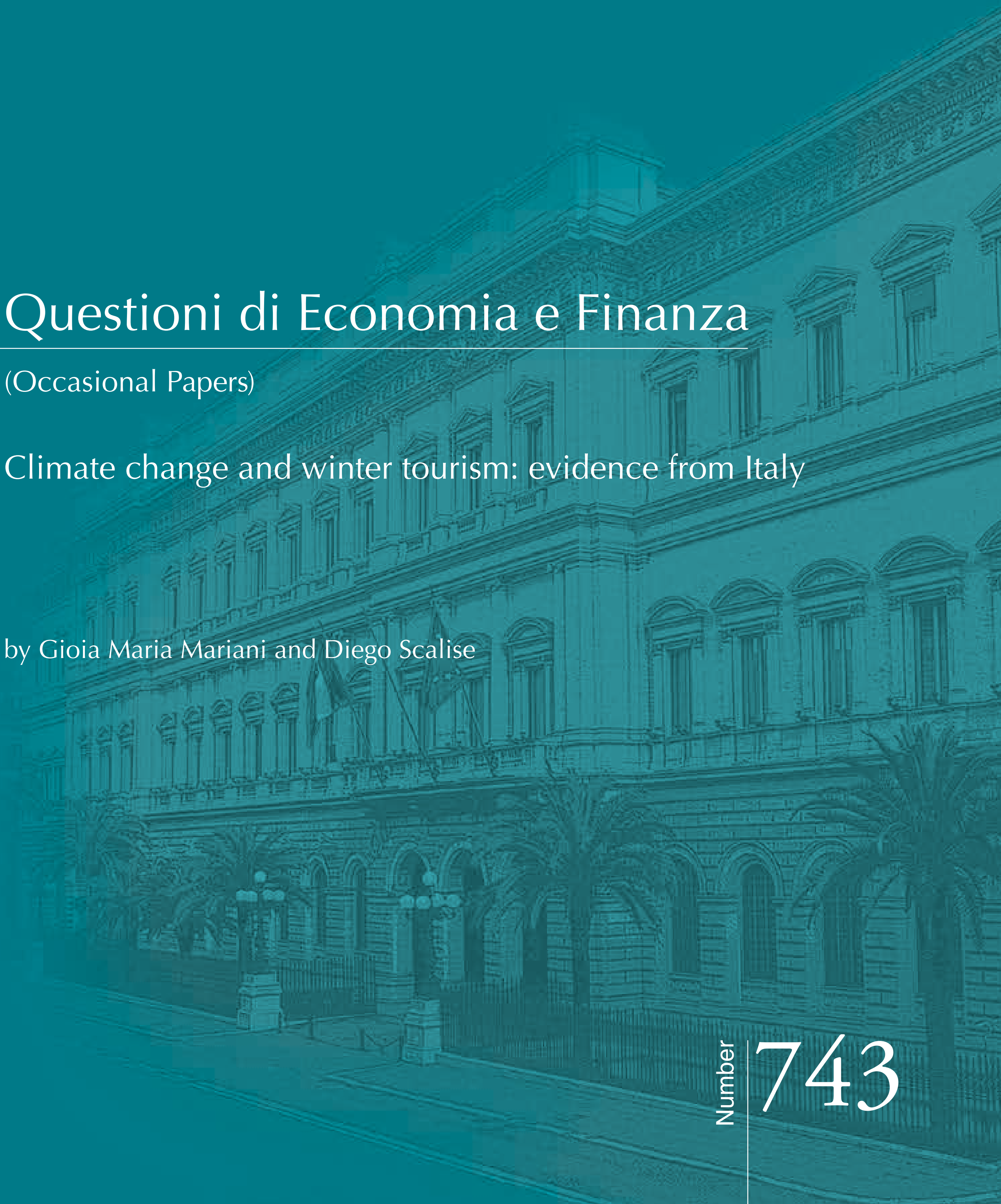

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CLIMATE CHANGE AND WINTER TOURISM: EVIDENCE FROM ITALY

by Gioia Maria Mariani* and Diego Scalise§

Abstract

Increasing temperatures and snow-scarce winter seasons challenge the winter tourism industry, one of the most weather-sensitive economic sectors. In this paper we assemble a novel dataset matching weather conditions and tourism flows in a sample of 39 Italian ski resorts in the last 20 years. We study the relationship between snow conditions, ski passes and overnight stays at ski resort level by means of a panel estimator with double fixed effects to quantify the risk of tourism losses due to climate change. We estimate a positive and significant relationship between snowfall conditions and winter tourism flows in Italian Alpine resorts. According to our estimates and to consensus projections on climate variables, in the coming years the impacts of climate change on ski passes and overnight stays could be significant, especially at lower altitudes. We also find evidence that providing artificial snow only has a weak effect on winter tourism flows, pointing toward the need for a more comprehensive approach to adaptation strategies.

JEL Classification: Q51, Q54.
Keywords: climate change, winter tourism.
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Contents

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1. Introduction and literature review[1]

Mountain tourism provides a significant contribution to the economy of Alpine areas and is one of the pillars of the Italian touristic sector: according to ISTAT data, before the COVID-19 pandemic, around 13 per cent of yearly overnight stays were in mountain areas, while foreign tourists' expenditure for mountain vacations was reported to amount to almost 2 billion of euros in 2019 (Petrella et al., 2019). While summer tourism in the mountains plays an important role as well, winter sports are one of the most attractive touristic features and are strongly dependent on snow reliability. Winter tourism is, hence, one of the most weather-sensitive sectors, therefore a deep understanding of the impacts and risks that weather variability poses to this sector is important for the assessment of potential economic impacts of future climate change (Prettenthaler et al., 2016) as well as for the effective design of future economic policies and risk management strategies.

The Alpine region is going to be as far as three times more affected by global warming than the Northern hemisphere average[2]. Climate change is hence expected to have more material impacts on European Alpine tourism than in other areas of the world (Elsasser and Messerli 2001; Probstl 2006; IPCC 2007). In particular, increasing winter temperatures will result in a shorter skiing season (Scott et al, 2003) and a shift of the natural line of snow reliability to higher altitudes (Abegg et al 2007; Steiger 2011). Lack of snow (as in the winter 2010–11 in most parts of the Swiss Alps), decreasing snow cover, snow depth (Laternser and Schneebeli 2003), and snow reliability could lead to a smaller number of visitors and reduced revenues, and thus have severe economic impacts on winter tourism destinations in the Alpine region, where local communities tend to be strongly dependent on the income from such a spatially concentrated and agglomerated economic sector.

Research on the impacts of climate change on tourism has gained more and more interest in recent years. Several studies have investigated the relationship between all-season tourism demand and weather and climate factors (Amelung and Moreno, 2012, Goh, 2012, Hamilton et al., 2005, Lise and Tol, 2002, Ridderstaat et al., 2014). With respect to winter tourism, the literature is more scant: existing studies have focused on the supply side, by assessing the effect of changes in physical conditions in the mountain environment on winter sports. In particular, for Italy, a rise of 1°C would be enough to shift up the

[1] The views and the opinions expressed in this paper are those of the authors and do not necessarily represent those of the Bank of Italy. We thank Antonio Accetturo, Matteo Alpino, Luca Citino, Guido de Blasio, Giorgio Gobbi, Andrea Lamorgese, Paola Rossi and participants at the internal Workshop "Climate Change and Italian Economy" for useful comments and suggestions. All remaining errors are our own.

[2] The acute sensitiveness of Alpine Alps to climate change has been acknowledged by the Alpine Convention in 2006. The declaration of the Ministers on climate change arisen in the context of the Conference initiated the Action Plan on Climate Change in the Alps and recognized that global climate change particularly affects the Alpine space. In order to avoid a further progression of climate change, the document includes recommendations for adaptation and long-term initiatives.

natural line of snow liability and endanger all ski resorts in Friuli Venezia Giulia and around 30 per cent of the ones in Veneto, Lombardia and Trentino (Abegg et al., 2007). Another strand of research studied the elasticity of tourism demand with respect to weather changes, but while there is some limited evidence for other countries (see Falk, 2010, for a comprehensive review), less has been said about Italy. Damm et al. (2017) analyze the impact of a 2°C increase on the bed nights at regional level in the Alpine region and find that the most affected countries would be Italy and Austria. Focusing on Italy alone, Bigano et al. (2006) find that Alto Adige would be the most severely hit by climate change, while Friuli Venezia Giulia and Valle d'Aosta would suffer less, since respectively winter tourism is less relevant and ski resorts have a higher altitude there. Because of the lack of more granular data, until recently, these studies analyzed the impact of changing climate on winter tourism at regional level and focused only on bed nights. They cannot, hence, take into account ski resort specific factors such as altitude or the presence of touristic amenities.

This paper aims at giving evidence on the relationship between snow conditions and winter tourism in the most important Italian Alpine regions in terms of flows (ski passes and overnights stays), by assembling a granular dataset at the ski-resort level: our novel database, which matches weather conditions with two measures of touristic flows – number of skipasses and bed nights for each resort – in the last 20 winter seasons allows us to add to the existing literature in many ways. Using ski-resort level data over time, we employ a double fixed effects model, in order to take care of time-invariant unobserved characteristics of the resort, such as reputation or mountain scenery. First, in order to capture the effect of snow availability on the most weather-sensitive touristic flows, we consider ski passes, which include also daily users of ski facilities, who are able to respond to changes in weather as their plans are more easily modified. Then, we complement our analysis with the study of overnight stays, also at the ski resort level: by using monthly data, we are able to estimate more precisely the relationship between touristic flows and weather conditions. In addition, we also shed light on whether resorts with more diverse amenities are able to attract tourists, even if weather conditions are not optimal for winter sports. While ski tickets are exclusively targeted at the demand of snow-related activities, hotels and other accommodation facilities do not only accommodate skiers but also visitors coming to enjoy other mountains amenities. We estimate a positive and significant relationship between snow availability and winter touristic flows in Alpine Italian resorts, robust to the inclusion of a set of controls capturing different resorts' characteristics. According to our estimates and to the Consensus projections (EURO-CORDEX[3]) on weather variables, in the next years ski passes in Alpine Italian resorts could decrease by

[3] EURO-CORDEX is the European branch of the international CORDEX initiative, which is a program sponsored by the World Climate Research Program (WRCP) to organize an internationally coordinated framework to produce improved regional climate change projections for all land regions world-wide. The CORDEX results will serve as input for climate

7 per cent on average as consequence of climate change, with much more material losses at lower altitudes. The impact on overnight stays, though less severe, would be still significant. Winter locations more specialized in tourism, with a wider cultural and hotel offer, turn out to host more visitors. We also find evidence of only a weak effect of artificial snowmaking on winter touristic flows, pointing toward the need of careful cost-benefit analysis of further investments in such an energy- and resource-intensive process.

The rest of this paper is organized as follows: Section 2 introduces data, descriptive statistics, the empirical specification and our estimates. Section 3 concludes.

2. Winter tourism and the weather: empirical evidence from Italian ski resorts

2.1 Data

Our novel dataset covers both winter season (November-April) ski passes at ski resort level for 36 resorts from 2001 to 2019 and monthly overnight stays for 39 resorts in the Italian Alpine region for the same time span. Our dependent variables are obtained from the Regional statistic offices and include resorts in Valle d'Aosta and Trentino Alto-Adige, which account for more than 2/3 of total national mountain tourism overnight stays: by comparing locations that are far enough from each other, we are able to capture enough variability in the weather conditions to identify our effect of interest. From the same source, we also retrieve data on energy spent to produce artificial snow, which we use to understand whether artificial snowmaking can play an effective role in substituting natural snow.

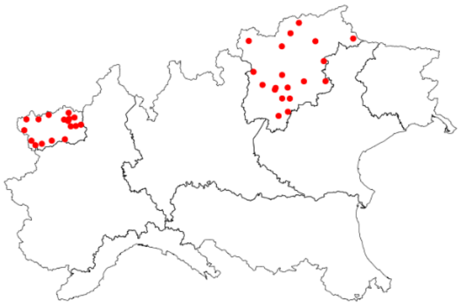
Our source for the weather variables is the Copernicus database: our variables of interest are the average surface air temperature and the average amount of snow fallen on the ground in a given period (according to the dependent variable, winter season or month). Following previous contributions, the snowfall rate is used to compute the cumulate snow depth of the period under analysis. Weather data are available on a grid of 25x25 km: we perform a spatial join to match the municipality of each ski resort to the part of the grid it falls in.

Figure 1 shows the location of the municipalities where the ski resorts are found.

change impact and adaptation studies within the timeline of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). See EURO CORDEX (2014),

Figure 1

Ski resorts location



From the National statistic office (Istat) we retrieve the set of variables that we are going to use as controls in one of the specifications: they include the economic structure of the municipality where the resort is set, the touristic and cultural offer and some geographic features.

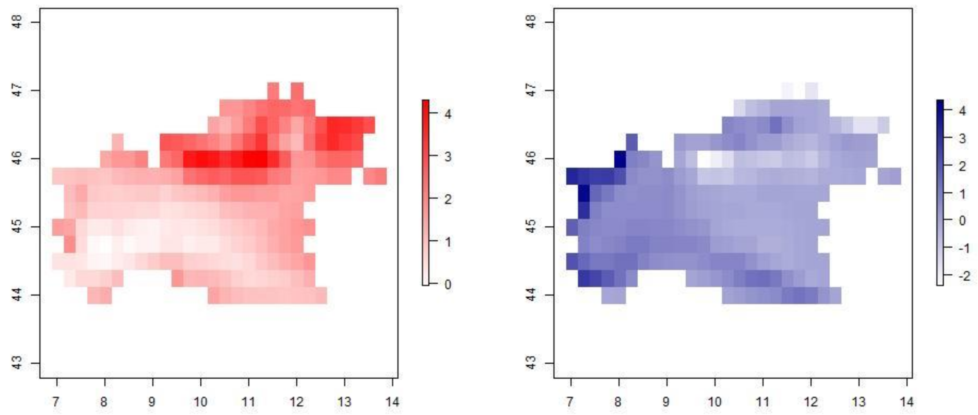
Table 1 reports the definition and source of variables covered in our database, while Table 2 shows the main descriptive statistics: our dataset includes ski-resorts whose dimensions varies significantly, according to both ski-passes and overnight stays. The same heterogeneity is observed for the weather variables, where we also find a substantial variation over the time span considered. To give some insight on this variation, Figure 2 shows the difference in temperature and cumulate snow depth in the years between 2001 and 2019 for Northern Italy.

Figure 2

Weather variables variation (2001-2019)

(a) temperature
(°C)

(b) cumulate snow depth
(meters)



Source: own elaboration on Copernicus data

In the period analyzed there was a widespread increase in temperature, which in most cases was accompanied by a decrease in the meters of fallen snow. Resorts in Trentino Alto Adige have been more severely hit than those in Valle d'Aosta both because of lower altitude and because this part of the Alps has experienced the effects of climate change more intensely. It is possible to note that the municipalities where the resorts are found are widely heterogeneous also in terms of other geographic or economic features: the ones in Valle d'Aosta have higher altitude and are smaller in terms of population. When looking at data on touristic offer, such as the number of hotels and the number of hotel beds, municipalities in Valle d'Aosta turn out to offer a more limited choice. This evidence is confirmed observing the spatial distribution among resorts of cultural amenities such as museums: as in Valle d'Aosta municipalities tend to be smaller, cultural institutions are more limited as well. A significant heterogeneity is found also in terms of local economic structure: the share of local employment in commerce related activities varies from less than 10 per cent, in more diversified municipalities to around a half in those more dependent on touristic flows.

The bivariate correlations in Table 3 indicate that ski passes tend to correlate positively with snow depth and, to a lesser extent, negatively to temperature. As expected the main factors which determine snow availability for winter sports co-move with ski passes sales. The correlations with overnight stays are weaker. Artificial snow seems to correlate only weakly with touristic flows.

2.2 Empirical framework and estimates

Our empirical approach is based on a panel regression framework. Our basic specification is the following:

$$y_{it} = \beta_1 \times Snow_{it} + \sum_{i=2}^{N} \beta_i \times X_{it} + \delta_i + \mu_t + \varepsilon_{it}$$

where y_{it} is the of the number of ski passes, measured at ski resort i and season t, or overnight stays, measured at resort i and month t, $Snow_{it}$ is the average meters of snow fallen in a given unit of time t , X_{it} is a matrix of control variables; δ_i is a set of ski resort fixed-effects, μ_t is the set of time fixed-effects (year or month), and ε_{it} is an error term, corrected for spatial autocorrelation. In the set of controls we include the intensity of use of artificial snow making, the number of the number of hotel beds in order to take into account the different capability to accommodate tourists, the presence of cultural amenities (number of museums), as they might help explain if visitors can have viable alternatives to winter sports in case of snow-scarce seasons, the share of workers in services and in commerce, as a proxy to catch how much the municipality is dependent on tourism. As an additional control, we compute the mean distance from cities with more than 100.000 inhabitants in a radius of 300 km, in order to take into account that for some locations there might be more tourism demand as they attract visitors from close big cities. β_1 is the coefficient we are most interested in because it gives us, on average in the observed period and across the ski resorts included in the sample, the direction and the magnitude of the relationship between climate variables, such as snow and temperature. The identification of the effect of our variable of interest on the outcome variable relies mainly on the scheme of fixed effects, able to control for the variables we are not including in the analysis or we cannot observe[4] (fixed at resort level over time or symmetric time effects such as the global financial crisis in 2009 or a particularly snow scarce year across the entire Alpine arc).

2.2.1 Ski passes

The outcome variable in Table 4 is the number of ski passes. A double fixed effects (ski resort-season) estimation (column (1)) confirms the positive and significant correlation between the number of ski passes and snowfalls. In column (2) we regress the logarithm of the number of ski passes on the logarithm of snow fallen, to take into account likely non normality of residuals and to obtain a direct measure of the elasticity of touristic flows to snowfalls. According to these estimates, on average in the period considered and for all the ski resorts included in the sample, a reduction of 1 meter in the snow fallen during the season is associated to a decrease of 1,3 per cent in ski passes. Projections of future snowfalls, elaborated through EURO-CORDEX regional climate models, provide robust signals of

[4] As shown in Chaisemartin and D'Haultfœuille (2021), the coefficient in a two-way fixed effects regression with group and period fixed effects capture an average treatment effect in a Diff-in-Diff setting only under some conditions.

decreasing snowfall amounts over most parts of the Alps for any emission scenario considered: average decreases in mean September–May snowfall by the end of the century range from 30 to up to 45 per cent, while snowfall in low-lying areas in the Alpine forelands could be reduced by more than 80 per cent. These decreases are driven by the projected warming and are strongly connected to an important decrease in snowfall frequency and snowfall intensity. According to our estimated coefficients, a decrease of 40 per cent in snowfalls (the central projected estimate for European Alps) would lead, all else equal, to a reduction of almost 7 per cent in ski passes. The impact is likely to be much stronger in lower altitude ski resorts (prevalently in Trentino Alto Adige), as the snow reliability line is likely to shift higher, making in many cases ski lifts working unfeasible or not economically convenient.

In column (3) we investigate the potential role of a commonly implemented adaptation strategy, such as artificial snowmaking. In order to do so we introduce as controls the intensity in the use of artificial snowmaking facilities[5] and its interaction with the quantity of snow fallen: the coefficient for natural snow is virtually unchanged, while the effect of artificial snow making on ski passes does not appear to be significant. This result is consistent with previous literature according to which found the effects of artificial snow making on the number of visitors are only marginal (Damm et al., 2014): for this reason a thoughtful cost-benefit analysis on investments in snow making facilities appears fundamental, also in light of the increasing operating cost induced by increasing temperatures and energy prices (Albegg. et al., 2007).

2.2.2 Overnight stays

The outcome variable in Table 5 is the number of overnight stays measured monthly at ski resort level. There are different reasons for considering overnight stays. First, the effect of snow on ski passes can be quite mechanically determined by the dynamics in supply factors, since scarcity of snow is likely to correspond to a larger number of closed ski resorts in a time unit. Secondly, the availability of monthly data allows for an analysis on a wider spatial and temporal scale. Finally, it allows us to introduce month fixed effects: in this way, we can control for seasonally fixed factors and resort-year fixed effects which capture location specific yearly events or factors (such as Winter Olympics). In column (1) we introduce the full battery of controls without resort fixed effects to study the impact of slow moving or resort fixed factors on touristic flows (such as the presence of cultural amenities, such as museums). The regression confirms the significant and positive relationship between overnights stays and snowfalls. Winter locations more specialized in tourism, with a wider cultural and hotel offer, tend to host more overnight stays, while the distance from a metropolitan area does not seem to exert any significant effect on bed nights. In column (2) we introduce resort fixed effects and in column (3) resort-year fixed effects: our

[5] This variable is likely to be a bad control since is likely to be itself outcome of the treatment variable. Indeed, as expected, artificial snow making is more frequent when natural snow is more scarce (Table 3). Hence results of this specification should be considered just as a robustness check.

results remain virtually unchanged. In columns (4) we estimate the log-log model. Again, our results hold robust.

3. Conclusions

In this paper, we studied the relationship between winter tourism flows and weather conditions in a sample of Italian Alpine ski resorts, by employing a panel fixed effects estimation strategy on a newly assembled dataset matching ski passes, bed nights and climatic variables at granular level. Our results, robust to a number of robustness checks, indicate a significantly positive relationship between ski passes and snow coverage. Better snow conditions tend to correspond to more bed nights as well. Artificial snowmaking does not appear, instead, crucial to sustain significantly touristic flows.

The Alps are particularly sensitive to climate change, and recent warming has been roughly three times the global average. Climate models project even greater changes in the coming decades, including a reduction in snow cover, especially at lower altitudes. Our results suggest that the impacts of climate change on winter tourism could be material and particularly severe for lower altitude ski resorts. The viability of measures to adapt to the impacts of climate change is therefore of critical importance for Alpine countries. This has been recognized by the Alpine Convention, which in late 2006 invited member countries to develop adaptation strategies promptly. While artificial snowmaking remains the dominant adaptation strategy, our results confirm previous studies indicating that it does not appear to be crucial in sustaining touristic flows. Furthermore, snowmaking costs will increase non-linearly as temperatures increase and, if temperatures increase beyond a certain threshold, snowmaking will simply not be viable, especially at lower altitudes, the most affected by climate change. As pointed out by OECD (2007), even if artificial snow can reduce the financial losses from occasional instances of snow-deficient winters, it cannot protect against systemic long-term trends towards warmer winters. In this context adaptation strategies based on diversification of mountain activities and revenues are crucial. Considering the potential of a wider set of amenities to sustain touristic flows, investments could be made to reduce the dependence of mountain economy on snow conditions: for example, by enhancing engagement in year-round tourism, stimulating and promoting summer tourism, but also activities and winter weather independent entertainments such as winter trail running races, congress, educational and health events. At the same time summer tourism in the Alps is often considered as a potential "winner" of global climate change as the Mediterranean will become too hot and lose its climatic attractiveness. In more temperate European regions, including the Alps, where the climatic suitability for summer tourism may improve as a result of climate change (warmer and maybe also drier conditions), the tourism industry could benefit from the adverse future climatic conditions in the Mediterranean. At the same time, however, glacier retreat, permafrost melting, changes in hydrology, flora and fauna and increased geomorphic processes will all impact tourism to varying degrees and are thought to be largely negative. The limited empirical evidence is mixed and our data confirm that summer touristic flows and temperature are only weakly correlated[6]. A more nuanced analysis of the relationships between climate change and summer tourism in the Alps, taking into account direct and indirect effects, is part of our future research agenda.

One limitation of our work is the limited time span covered[7], which does not allow us to capture the effects of longer run changes in snow conditions; also spatial coverage of our data constrained our analysis to resorts in two, albeit important, Italian Alpine regions. The extension of the dataset to estimate more precisely the impacts of climate change, also considering possible substitution effects between resorts, exploiting a wider heterogeneity in snow conditions is part of the future agenda, as well as a wider analysis of the impacts of climate change on the local economy.

[6] The correlation between overnight stays in summer months and average temperature in the municipalities covered in our analysis is weak and not statistically significant.
[7] For example we cannot cover the time span from 1980 to 2000, in which, according to most data sources (OECD, 2007) the Alpine arc experienced a particularly strong process of warming and decreased snow cover, associated with structural changes in the winter tourism industry: by not including this period, it is likely that we underestimate the effect of changing snow conditions.

Appendix A

Table 1- Variables

Variable	Definition
Ski passes (dependent variable)	Number of first passes at ski resort per season (Regional Statistical Offices); 2001-2019.
Overnight stays (dependent variable)	Number of monthly overnight stays at ski resort (Regional Statistical Offices); 2001-2019
Snow	Cumulate meters of snow fallen in the season (month): Copernicus database
Temperature	Mean temperature on the ground (month or season): Copernicus database
Artificial snow	KW of used energy to produce artificial snow at ski resort (Regional Statistical Offices)
Hotel beds	Number of hotel beds in municipality (Istat)
Hotels	Number of hotels in municipality (Istat)
Visitors in museums	Number of visitors at local museums (Istat)
Museums	Number of museums and cultural institutions (Istat)
Share of workers in services	Share of local employment in services (excluding commerce; Istat)
Share of workers in commerce	Share of local employment in commerce (Istat)
Population	Resident population (Istat)
Altitude	Geographical altitude over level sea
Mean distance	Mean distance in km from a city with more than 100.000 inhabitants in a 300 km radius

Table 2- Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Ski-passes (season)	576	871783.04	1660819.8	177	7034869
Overnight stays (season)	412	790494.7	965972.8	2472	4900455
Snow (cumulate meters; season)	576	11.712	4.631	2.509	26.263
Average temperature (°C)	576	-5.196	2.681	-11.111	1.816
Artificial snow (KW)	576	91705.149	120207.27	-279843.13	481907
Hotel beds	557	3027.42	2269.488	155	9079
Hotels	557	101.355	98.476	8	474
Visitors in museums	432	36282.481	89796.599	50	411426
Museums	432	1.972	1.45	1	7
Share of workers in services (commerce excluded)	557	41.119	9.701	25.4	75.8
Share of workers in commerce	557	29.239	8.152	9.6	49.1
Population	557	3977.291	7052.703	94	37368
Altitude	557	1263.943	369.324	325	1816
Mean distance	557	201.031	13.04	177.938	225.644

Table 3- Correlations

	Ski passes	Overnight stays	Snow	Temperature	Artificial snow
Ski passes	1				
Overnight stays	0.82	1			
Snow	0.39	0.22	1		
Temperature	-0.18	-0.05	-0.56	1	
Artificial snow	0.043	0.046	-0.27	-0.05	1

Table 4 - Panel estimates. Dependent variable: ski passes

	[1] Ski passes	[2] Log (Ski passes)	[3] ski passes
Snow.	11200**	1.26**	10900**
	[5700]	[0.03]	[5700]
Artificial snow			-0.16
			[0.10]
Artificial snow*Snow			0.019
			[0.018]
Constant	Yes	Yes	Yes
Ski resort fixed effects	Yes	Yes	Yes
Year (season) fixed effects	Yes	Yes	Yes
obs	576	576	576
groups	39	39	39
Wald statistic	6690	7000	7000

* Significant at the 10% level; ** 5% Level; *** 1% level. Robust standard errors in parenthesis corrected for spatial autocorrelaztion.

Table 5 - Panel estimates.
Dependent variable: overnight stays and Δ overnight stays

	[1] Overnight stays	[2] Overnight stays	[3] Overnight stays	[4] log (Overnight stays)
Snow.	365***	340**	320**	1.1**
	[134.9]	[122]	[112]	[0.04]
Museums	54.9*			
	[1100]			
Hotel beds	61.6*			
	[43.1]			
Share of workers in services	21.6*			
	[3.1]			
Distance from main city	-21.4			
	[3.1]			
Altitude	11.1			
Constant	Yes	Yes	Yes	Yes
Ski resort fixed effects	No	Yes	Yes	Yes
Year (season) fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes
Resort*year fixed effects	No	No	Yes	No
obs	1980	1980	1980	304
groups	26	26	26	26
F test	6690	7000	7800	8000

* Significant at the 10% level; ** 5% Level; *** 1% level. Robust standard errors in parenthesis corrected for spatial autocorrelaztion.

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