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Die another day: explanations based on qualitative comparative analysis (QCA) for the survival and non-survival of isolated ski lifts in Switzerland

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Abstract. In the form of an explorative empirical study, this paper deals with the reasons for the survival and demise of isolated Swiss ski lifts. For the first time, all isolated lifts documented in Switzerland have been recorded and coded according to a total of six conditions. Using a set-theoretical research method in the form of qualitative comparative analysis (QCA), the study aims to identify the necessary conditions and configurations of sufficient conditions explaining (non-)survival. It transpires that closed isolated lifts tend to be outdated and have no technical snowmaking facilities. Moreover, it has become evident that the simultaneous occurrence of the lack of lift facility replacement, lack of technical snowmaking and high ski area competition has caused the closure of most isolated lifts. Low natural snow depth and low elevation difference, conversely, have not had a measurable impact. The causes for the survival of isolated lifts, by contrast, are extremely heterogeneous.

1 Introduction

The crisis in winter skiing in Switzerland and in many other countries has been thoroughly discussed in the literature for several years. The main focus is on climatic changes and their consequences for winter sports (for a good overview on the evolution of this debate, see Steiger et al., 2019). Accordingly, a plethora of relevant studies and robust findings are available (among others, Willibald et al., 2021; Steiger et al., 2019; Schmucki et al., 2017; Clivaz et al., 2015; Scott et al., 2012; Bürki, 1998) that also cover numerous world regions, thus underlining that this is a global problem, going beyond Switzerland and the Alpine region. With regard to ski areas in New England, for example, it can be noted "that weather conditions have had a significant impact on the survival of New England ski areas in the past four decades", for instance with regard to "increasing winter temperatures and decreasing snowfall" (Beaudin and Huang, 2014:67; for climatic changes in New England ski areas, see also Hamilton et al., 2007). This finding is also shared by the study of Hamilton et al. (2003) looking at the US federal state of New Hampshire. In addition, the fact that a general decline in interest in skiing and winter sport activities can be observed is repeatedly mentioned (Bausch et al., 2019; Bürki, 1998; Vanat, 2014; Lütolf et al., 2020). Steiger et al. (2019:1343) note that "today, ski tourism in historically leading markets has matured, with … declining demand (e.g., Switzerland, Japan) in many countries." In Austria, the percentage of people who would never ski has risen from about 42 % in the 1980s to 63 % in 2018 (Zellmann and Mayrhofer, 2018:3). Switzerland, too, has been registering a decline in ski entries (skier visits) for years (Vanat, 2022a:49). There are various reasons for this. In the literature, reference is regularly made not only to the high costs associated with this sport (Zellmann and Mayrhofer, 2018) and changed travel behaviour (Jülg, 2007; Prettenthaler et al., 2021), but also to demographic change (Steiger, 2012; Vanat, 2022a; Witting and Schmude, 2019) and increasing scepticism amongst many people about the phenomenon of nature-invasive "overtourism" (Benner, 2020) in particularly ecologically vulnerable areas such as the Alps. It is therefore not surprising that Alpine winter tourism passed its peak in the early 21st century and that

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the number of children and adolescents who ski is steadily decreasing (Jülg, 2007).

Thus, while the overarching causes of the ski resort crisis have already been extensively analysed, a third aspect still requires further research: the question of why, in the face of comparable superordinate problems, some ski areas remain stable, while others have to cease operation, i.e. become so-called lost ski area projects (LSAPs). In the following, we would like to focus on a type of lift that has been widely underrepresented in the literature but which is still frequently encountered in Switzerland, other alpine countries and many low mountain ranges (see also Philipp, 1974, for the German state of Bavaria and Mayer, 2019, for Austria): the isolated ski lift, which is sometimes misleadingly referred to as a valley or village lift (*Tal-* or *Dorflift* in German). In our definition, the isolated lift is characterised by (a) the fact that it comprises only a single transport facility[1] whose slopes have no direct access to other lifts,[2] (b) its lift facility type being specifically listed in the official maps of Switzerland (magic carpets or seasonally dismountable rope lifts are thus not taken into account), (c) it exclusively including the surface lift type (T-bar lift and button lift but not chairlifts and ropeways)[3], and (d) it not having any feeder facilities such as a gondola or cable car. We base our calculations on the actual spatial situation at the end of the 2021/22 winter season.

Looking at isolated lifts is also promising from a societal perspective: isolated lifts typically provide an important service for skiing and snowboarding beginners and also perform an important social function for many municipalities (see, for example, Schuhwerk, 2023; Autonome Provinz Bozen – Südtirol, 2012); they have so far not been adequately considered in research. The very few existing studies on the survival of ski areas either are limited to larger areas with three or more lifts (Falk, 2013; Mayer and Steiger, 2013) or come to the rather general conclusion that especially small areas have a particularly hard time surviving (cf. Falk and Steiger, 2020). If one combines the assessment of Hamilton et al. (2003:68) that "the proliferation of small low-investment ski areas in the early days … was possible because winters then tended to be snowy and cold" with that of Steiger et al. (2019:1343) stating that "large capital investments and increased operating costs altered the market and forced many small ski areas to close", it becomes clear that it is worth considering why these small ski areas with isolated lifts had to cease operations. This kind of study combines superordinate sets of problems in the sense of "first-nature" factors (Krugman, 1993), such as topography or climate, with "second-nature" factors (Krugman, 1993), such as snowmaking or equipment replacement. To the best of our knowledge, there have hardly been any studies on isolated lifts so far, although they have an important function especially for the training of young skiers and thus for the future development of alpine winter sports (Jungfrau Zeitung, 2004), in short: they are making winter sports more accessible to young people (Die Neue Südtiroler Tageszeitung, 2018). At the same time, it can be assumed that due to their comparatively low average altitude (own calculation; see the Supplement[4]) as well as their limited financial and management possibilities (Steiger and Abegg, 2018), they have a particularly difficult time defying the two overriding challenges identified: climate change and declining interest in alpine skiing. The fact that numerous isolated lifts nonetheless still exist today shows that some have successfully resisted the trend towards closure, at least so far. In this paper, we aim to identify reasons why some isolated lifts have had to close, while others have survived.

With regard to research methods, an appropriate range can be observed in the scientific analysis of alpine winter sports. There are many promising new approaches and indicator developments, such as the recent work of Abegg et al. (2021). We will also follow this path in the following in order to introduce an innovative research method that has its origins in sociology but has also become increasingly widespread in neighbouring disciplines in recent years. Using a set-theoretical research method in the form of qualitative comparative analysis (QCA, originally developed in Ragin, 2014 [1987]; for the current state of the art, see Oana et al., 2021), we analyse, with a view to Switzerland, which characteristics have led to some isolated lifts surviving despite the overarching problem, while others have had to cease operations. A central aim of the QCA is to methodologically merge quantitative and qualitative elements. Buche and Siewert (2015:392) have described this as follows: even if QCA as a method is based on Boolean algebra and various formulas, algorithms and software programs are used, the researchers have to make a large number of qualitative deci-

[1] We have accordingly not included those areas that have two lifts running in parallel on the same route. These areas can carry far more passengers than those that have single lifts.

[2] This means that a road or a stream, for example, also counts as a dividing line to other lifts/slopes even if these lifts/slopes are located in close proximity to the isolated lift. We are aware that it is quite common for skiers to sometimes remove their skis briefly to walk a few metres (such as when using ropeways) to reach other slopes. We have nevertheless decided to do this because it is the only way to estimate a clear and uniform procedure. The same applies to the issue of whether isolated lifts are linked to other lifts by tariff associations, which cannot be reliably ascertained. "Isolated" is therefore, by our definition, to be understood spatially and not organisationally.

[3] Similarly, time-related aspects regarding the emergence or further utilisation of a (closed) isolated lift are also regarded as irrelevant. By our definition we always observe the actual situation at the end of the 2021/22 winter sport season. So, if a lift that was previously integrated into a larger ski area has now become an isolated lift (i.e. due to other lift closures), we count it as such. If an isolated lift has been closed but rebuilt elsewhere, we still count the closed lift as an LSAP.

[4] See the link to the Supplement at the end of the article.

sions in each phase of analysis, which are fed by their theoretical knowledge and their case expertise.

In the following, we will start with remarks on the data situation regarding isolated lifts and the presentation of selected aspects of descriptive statistics on the demise and survival of isolated lifts in Switzerland. Subsequently, we will give a thorough account of QCA,[5] which, to the best of our knowledge, has not yet been applied to ski area research and why we consider QCA to be particularly well suited to the object of our research. We then discuss and contextualise the findings with reference to existing studies and end with a conclusion.

2 Data

The selection of isolated lifts was primarily made using the already-existing and very extensive independent database Bergbahnen.org (Gross, 2024), whose own goal is to record, as far as possible, all ropeway and lift installations ever built in Switzerland. This database was supplemented by our own extensive research, based on historical maps of lift facilities and aerial photographs (both via the Federal Office of Topography *Karten der Schweiz – Schweizerische Eidgenossenschaft*), old maps of ski slopes, and on-site research including interviews with cable car operators and experts (see Heise and Schuck, 2020).[6] On this basis, the authors are optimistic that they have covered almost all documented isolated lifts in Switzerland. Despite all the efforts made, however, it cannot be ruled out that some lifts have not been recorded, since documentation from the very early phase of lift construction in Switzerland might be incomplete.

3 Method

Based on the research question, which aims to determine multicausal explanations for the survival and demise of isolated lifts, qualitative comparative analysis (QCA) was deliberately chosen as a method whose strength lies in the analysis of causal complexity (Oana et al., 2021:8; Schneider and Wagemann, 2012:78). Causal complexity is understood as the interaction of three phenomena: equifinality, conjunctural causation and asymmetric causation.

- *Equifinality*. This means that the same outcome can be explained by different equal and not mutually exclusive explanations (Schneider and Wagemann, 2012:78).
- *Conjunctural causation*. This refers to causal relationships that only occur when several conditions can be observed at the same time (Schneider and Wagemann, 2012:78). The detection of conjunctural causation is a particular advantage of QCA compared to classical statistical methods, where the effect of single variables is considered in isolation (Ragin, 2014 [1987]:64).
- *Asymmetric causation*. This describes the phenomenon that the occurrence of the outcome may have to be explained by conditions other than the non-occurrence of the outcome, i.e. that one cannot deduce the conditions for the non-occurrence of the outcome from the negation of the conditions for the occurrence of the outcome (Schneider and Wagemann, 2012:78).

For the analysis of empirical phenomena, QCA utilises set-theoretic relations, which must not be confused with statistical relations. Since familiarity with the basic ideas of QCA cannot be assumed, the basic concepts of set membership, necessary and sufficient condition, and INUS and SUIN condition, as well as *consistency* and *coverage,* are explained below and, where possible, distinguished from similar statistical concepts.[7]

Set membership initially describes whether a given phenomenon can be assigned to a certain subset or not, which in turn is represented by a *set membership score* (Schneider and Wagemann, 2012:3). Thus, if the set “LSAP” includes all closed isolated ski lifts, a closed isolated ski lift would have a set membership score of 1, whereas an operating one would have a score of 0. For phenomena in which binary calibration is not suitable because of empirical gradations (e.g. altitude or competitive situations), *fuzzy* set membership scores can be assigned. In this case, a threshold value has to be defined to distinguish whether an expression of the phenomenon is part of the set rather than not part of the set. If the phenomenon is closer to being part of the set, a set membership score > 0.5 is assigned; if it is closer to not being part of the set, a set membership score < 0.5 is applied. Hence, an isolated lift with a set membership score in the “high-altitude” subset of 0.3 would be higher than one with a score of 0.1, but neither would be part of the high-altitude set.[8] Fuzzy set membership scores can be assigned either manually based on theory (e.g. for competitive situations) or automatically based on thresholds (e.g. for altitude). The allocation methods used in this study are explained in the calibration section.

[5] This was also a request from one of the anonymous reviewers, as QCA has not been widely used in economic geography and tourism research. We are very happy to comply with this suggestion.

[6] Thanks go to the anonymous reviewer who drew our attention to two more isolated ski lifts that were previously missing from our database.

[7] The presentation given here is kept intentionally brief. For a detailed discussion, see Thiem et al. (2016).

[8] Set membership scores do not represent probabilities and should not be confused with them. Ragin (2008:88) illustrates this very vividly: assuming that a beverage has a set membership score in the set “deadly poisons” of 0.05, this means that the beverage is not part of the set “deadly poisons” even though it has some minimal toxic attributes (e.g. due to a minimal alcohol content). Consumption would accordingly be largely harmless in any case. If, on the other hand, the beverage had a probability of 0.05 of being a lethal poison, then from the statistically expected value every 20th consumption would cause a death (see also Thiem et al., 2016:749).

Once set memberships have been assigned to individual empirical phenomena, causal relationships between these phenomena can be described as *necessary* or *sufficient* conditions. If a condition is a necessary condition for an outcome, the outcome is a subset of the condition (Oana et al., 2021:66). For example, periodic elections are a necessary condition for the outcome democracy: if a democracy is observed, periodic elections can necessarily be observed. The reverse is not possible (*asymmetric causation*): just because regular elections are observed, it cannot automatically be assumed that there is democracy.

With sufficient conditions, by contrast, the outcome can be reliably inferred from the condition (Oana et al., 2021:88). However, it is easily possible that several sufficient conditions independently lead to the same outcome (*equifinality*): for instance, belonging to the set "sports car" would be a sufficient condition for belonging to the set "vehicle with high horsepower" – however, belonging to the set "tractors" would also be a sufficient condition for the same outcome.

As a rule, though, a single condition is not sufficient for an outcome, but the simultaneous interaction of several conditions is required (*conjunctural causation*). A single condition in such a configuration is called an INUS condition (Mackie, 1965:245), because the condition is not sufficient in isolation but is a necessary component of a configuration of sufficient conditions. By analogy, there are also SUIN conditions, i.e. conditions that individually do not represent necessary conditions for an outcome but do so in logical OR combinations (Oana et al., 2021:80).

In order to finally describe the set-theoretical relationships between conditions and outcomes, QCA uses a number of mathematical parameters, so-called parameters of fit. Even if their derivation would go far beyond the limits of this paper (see instead Schneider and Wagemann, 2012:119–150), the two most important ones, consistency and coverage, will be briefly explained. Consistency describes the impact, or how well an outcome can be explained by the condition(s).[9] Coverage, meanwhile, describes the proportion of cases that can be explained by certain condition(s).[10]

Within the framework of the various sub-approaches of QCA, our study can be classified as exploratory, condition-oriented and realistic (Thomann et al., 2022:5). Since the intention is not to test an existing theory but to identify initial possible conditions in a field that has not yet been extensively researched, we deliberately refrained from formulating hypotheses in advance.

[9] $\text{Consistency}_{\text{Necessary condition}}\ (X_i \geq Y_i) = \frac{\sum_{i=1}^{I}\min(X_i,Y_i)}{\sum_{i=1}^{I}Y_i}$ / $\text{Consistency}_{\text{Sufficient condition}\,(X_i \leq Y_i)} = \frac{\sum_{i=1}^{I}\min(X_i,Y_i)}{\sum_{i=1}^{I}X_i}$.

[10] $\text{Coverage}_{\text{Necessary condition}\,(X_i \geq Y_i)} = \frac{\sum_{i=1}^{I}\min(X_i,Y_i)}{\sum_{i=1}^{I}X_i}$ / $\text{Coverage}_{\text{Sufficient condition}\,(X_i \leq Y_i)} = \frac{\sum_{i=1}^{I}\min(X_i,Y_i)}{\sum_{i=1}^{I}Y_i}$.

4 Calibration

Table 1 below explains the calibration of the six conditions[11] LOWALTOPS, LOWELEVDIFF, LOWSNOWFEB, NOREPLACEMENT, NOSNOWMAKING and HIGHCOMPETITION, three of which function as first-nature conditions and three of which function as second-nature conditions (Krugman, 1993). The first-nature conditions LOWALTOPS and LOWSNOWFEB address given climatic aspects; the condition HIGHCOMPETITION addresses the given competitive situation in the nearby radius of the isolated lift. The second-nature conditions NOSNOWMAKING, LOWELEVDIFF and NOREPLACEMENT, on the other hand, address the characteristics of the isolated lifts that can be directly influenced by the lift operators.

Conditions can be either crisp (cs) or fuzzy (fs) calibrations (Oana et al., 2021:33). In a crisp calibration, the quantity associations are assigned binarily: if an isolated lift does not have snowmaking, for example, it is given a set membership score of 1 in the condition NOSNOWMAKING; if it has snowmaking, a score of 0 is assigned. In a fuzzy calibration, continuous values between 0 and 1 are assigned, whereby the assignment is either criterion-based manually (Schneider and Wagemann, 2012:29) or calculated from the raw data based on three qualitative anchor values (full-in, full-out, crossover) as part of a so-called direct calibration (Ragin, 2008:89–94).[12]

In order to avoid misunderstandings, it must be emphasised once again that membership in a subset is assigned with the calibration. An isolated lift can therefore be part of the set "areas with low entrance altitude", for example. If, on the other hand, it is not a member, this explicitly does not mean that it has a high entrance altitude but only that it does *not* have a low entrance altitude.[13]

5 Results

5.1 Descriptive statistics

A total of 322 isolated ski lifts in Switzerland were recorded, of which 186 had ceased operations by the end of data collection (winter season 2021/22); this corresponds to 57.76 %.

[11] It is worth noting here that other conditions, in particular the presence of south-facing slopes, tariff associations and the number of inhabitants in the catchment area, were also examined as part of preliminary work for this study but were dismissed again due to distorting effects caused by low data quality. At this point, we would like to thank the anonymous reviewers once again for their helpful suggestions.

[12] Direct calibration uses a three-step algorithm to convert the raw data into a set membership score between 0 and 1 based on the data deviation from the specified crossover value using a logistic function.

[13] An analogous example is a non-tall person is not necessarily short.

Table 1. Calibration of the conditions.

Condition	Operationalisation and sources	Set and calibration
LOWALTOPS (altitude of the valley station of the isolated lift)	Altitude represents a first-nature factor (Krugman, 1993) from an economic-geography perspective. Since according to the SLF (2023) the amount of natural snow decreases significantly below 1300 m, the crossover was placed at 1300 m: full membership in the "low entrance altitude" subset for entrance altitude below 1000 m[a] and full non-membership for entrance altitude above 1600 m.	fs (direct) 0.95 = 1000 m 0.5 = 1300 m 0.05 = 1600 m
LOWELEVDIFF (elevation difference of the isolated lift)	This is the elevation difference between the lowest and highest slope point of the isolated lift. Classification is according to our own empirical values, since no reference points can be taken from the literature: we set the full-in threshold at an elevation difference of 75 m, which thus embraces lifts that are exclusively beginner oriented. The crossover is at 200 m elevation difference (at least some slope variations to be expected), and the full-out threshold is at 500 m elevation difference, since this already has the character of a ski area and promises quite high downhill variation.	fs (direct) 0.95 = exclusively beginner-oriented isolated lifts; full-in: 75 m 0.5 = elevation difference, which promises basic slope variety; crossover: 200 m 0.05 = ski area-like elevation difference; full-out: 500 m
LOWSNOWFEB (average natural snow depth in February in the long-term average)[b]	This is the area-specific average natural snow depth in February for the years 1982–2021 based on data supplied by SLF on demand. The measuring points are the entry coordinates of the isolated lifts. February is the month with most skier days for large parts of Switzerland (Vanat, 2022b:26; Vanat, 2023:28), which are very important for the operators of the isolated lifts. Moreover, February is a month that, unlike December and March/April, falls entirely within the winter season. Witmer (1986:127) has stated that, as a rule, at least 30 cm is required for ski resorts to operate (see also Abegg, 1996).	fs (direct) 0.95 = estimated minimum snow depth on average; full-in: 30 cm 0.5 = acceptable ski snow depth at isolated lifts on average; crossover: 50 cm 0.05 = full-out: 70 cm
NOREPLACEMENT (facility replacement)	If the installation of the isolated lift has never been (fully) replaced, a set membership score of 1 is assigned. If the technical installation has been replaced at least once (at the same location), 0 is assigned.	cs 1 = no replacements in the past 0 = replacements in the past
NOSNOWMAKING	If the isolated lift does not have any snowmaking facilities, 1 is assigned. Otherwise, 0 is assigned.	cs 1 = no snowmaking available 0 = snowmaking available
HIGHCOMPETITION (competitive situation with other ski areas/isolated lifts within a radius of 3 km)	This is the competitive situation due to other ski areas and isolated lifts within a radius of 3 km. Due to a lack of literature references, the estimated manual calibration is based on our professional assessment.	fs (manually) 1 = min 4× greater competition 0.8 = min one larger area OR several other isolated lifts 0.6 = exactly one other isolated lift 0 = no competition

[a] According to Schöner et al., "[l]ow elevation regions (below 1000 m a.s.l.) show a high correlation with air temperature and accordingly also temperature sensitivity of snow depth, which decreases with increasing altitude" (Schöner et al., 2019:1602). [b] For a good overview of existing snow indicators, see Abegg et al. (2021). Having carried out a full survey of all isolated lifts in Switzerland, for the sake of practicability we have chosen a much less differentiated variant for our snow indicator than the possibilities shown by Abegg et al. (2021:697); taking the month of February we have also only mapped a part of the ski season. This is because the QCA is based on a sparse use of conditions, and we also wanted to capture indicators beyond the natural snow amount. We are nevertheless aware of the limitations of this condition and its calibration.

In contrast, only 21.35 % of ski areas[14] had ceased operation in the same period of time (own calculations). It is also striking that quite a number of isolated lifts were closed relatively early (the first one documented here in 1955). The median year of closure is 1995; i.e. half of all isolated lifts were closed before 1995. The percentage of closed isolated lifts varies by canton (see Table 2). In the final discussion of our survey results, we will also consider the reasons for this uneven distribution.

5.2 QCA results

The data were analysed using the QCA (Duşa, 2019) and SetMethods (Oana and Schneider, 2018) packages for the data analysis programme R in the context of an enhanced standard analysis (Oana et al., 2021:130–140). Here, separate analyses were performed for the occurrence and non-occurrence of the outcome, i.e. the demise or survival of the isolated lift. Each of these analyses is divided into the analysis of necessary conditions, sufficient condition configurations, and the robustness test. The results are presented here first and then discussed collectively. In presenting the results, the common QCA notation is used: $\sim$ stands for a logical NOT, * for a logical AND and + for a logical OR. The annotated R script and the data set for replication of the results are provided in the Supplement.

5.2.1 LSAP outcome

Necessary conditions

A necessary condition for the outcome exists if the condition tested achieves a consistency (Cons.Nec) of > 0.9 (Oana et al., 2021:74). At the same time, the so-called relevance of necessity (RoN)[15] should be above 0.5, if possible, whereby this is to be understood just as a guideline value (Oana et al., 2021:74). The coverage (Cov.Nec) shows the relation of the size of the condition set to the outcome set; i.e. a very low value would be another reason to disregard a necessary condition as trivial (Oana et al., 2021:72). The analysis of the data with regard to the presence of necessary conditions for the outcome is shown in Table 3.

Only two conditions (lack of facility replacement and lack of snowmaking) show sufficient consistency to be considered necessary conditions. However, although their coverage is within normal bounds, their relevance of necessity is below 0.5; i.e. a large number of all isolated lifts (regardless of survival) are characterised by these two conditions, making them rather trivial necessary conditions.

Sufficient conditions

To analyse the sufficient conditions for the LSAP outcome, the enhanced standard analysis first compiled the truth table with a consistency cut-off value of 0.745[16] and then all three solutions (conservative, parsimonious and intermediate). Based on the current state of methodological research (Baumgartner and Thiem, 2020; Thiem, 2022), the subsequent discussion will refer to the parsimonious solution, which is documented in Table 4.[17]

Only a single configuration of conditions, the simultaneous absence of facility replacement AND no snowmaking AND high competition, proves sufficient for the outcome LSAP.

Robustness test

Subsequently, a robustness test of the results was performed according to the current QCA robustness test protocol (Oana and Schneider, 2021). In an abbreviated description, three alternative solutions are calculated: one by varying the consistency cut-off, one by varying the calibration of conditions (here snow amount and altitude of entrance) and one by varying the minimum number of cases a row of the truth table must have to be included in the minimisation. Then a so-called robust core, i.e. an intersection of the original solution and the three alternative solutions, is calculated.

The ratio of the consistency and coverage of the original solution to the consistency and coverage of the robust core is then calculated (RFcons and RFcov). Finally, it is automatically determined whether cases are part of the original solution but not of the robust core (so-called shaky cases, i.e. potentially false positive cases) as well as whether cases are part of one of the alternative solutions but not of the robust core (so-called possible cases, i.e. potentially false negative cases).

In the summarised result, NOREPLACEMENT*NOSNOWMAKING* HIGHCOMPETITION was calculated as the robust core; i.e. the original solution and the robust core are identical (RFcons

[14] Our definition of a ski area is based on Falk's classification, which takes into account areas that have either at least three lifts or, if there are fewer lifts, at least one feeder lift, which is a non-surface lift (Falk, 2013:380–381).

[15] $\mathrm{RoN} = \frac{\sum(1-X_i,)}{\sum(1-\min(X_i,Y_i))}$.

[16] In QCA, there is no context-independent cut-off value, but 0.75 is recommended as a guideline (Ragin, 2008:136; Schneider and Wagemann, 2012:127). However, Schneider and Wagemann recommend, among other things, that a detectable drop in consistency values in the rows of the truth table be chosen as a benchmark for the cut-off value: "a gap often exists between rows with relatively high and low consistency values that can guide the decision of where to put the consistency threshold" (Schneider and Wagemann, 2012:128). Such a clear drop can be found in the present truth table (see Supplement), ordered by consistency, between the still-included line 64 with a value of 0.745 and the following line 23 with a value of 0.709. Checking the cut-off value is part of the robustness test.

[17] The truth table and the conservative and intermediate solutions are documented in the Supplement and can be replicated with the R script.

Table 2. Isolated ski lifts (survivors vs. LSAP) according to canton.

Canton	Total	LSAP	Operating	Average altitude of the entrance valley station of surviving isolated lifts (LSAP)	Average elevation difference of surviving isolated lifts (LSAP)
Aargau	4	3 (75.00 %)	1 (25.00 %)	515 m (553 m)	61 m (93.67 m)
Appenzell Ausserrhoden	9	3 (33.33 %)	6 (66.67 %)	902.67 m (1040 m)	136 m (106.67 m)
Appenzell Innerrhoden	4	1 (25.00 %)	3 (75.00 %)	854.33 m (854 m)	249.67 m (59 m)
Basel-Landschaft	1	0 (0.00 %)	1 (100.00 %)	745 m (−)	128 m (−)
Berne	58	32 (55.17 %)	26 (44.83 %)	1069.85 m (1113.25 m)	148.85 m (143.88 m)
Fribourg	12	7 (58.33 %)	5 (41.67 %)	996 m (1014.29 m)	128.4 m (156.29 m)
Glarus	6	3 (50.00 %)	3 (50.00 %)	640.33 m (1034 m)	112.33 m (110.33 m)
Grisons	42	25 (59.52 %)	17 (40.48 %)	1421.47 m (1368 m)	157.82 m (140.04 m)
Jura	2	1 (50.00 %)	1 (50.00 %)	1052 m (781 m)	120 m (71 m)
Lucerne	13	7 (53.85 %)	6 (46.15 %)	999.33 m (813.71 m)	203.33 m (123.43 m)
Neuchâtel	5	0 (0.00 %)	5 (100.00 %)	1028.8 m (−)	122.4 m (−)
Nidwalden	3	1 (33.33 %)	2 (66.67 %)	1025 m (766 m)	118 m (88 m)
Obwalden	3	3 (100.00 %)	0 (0.00 %)	– (916.67 m)	– (79 m)
Schwyz	16	10 (62.50 %)	6 (37.50 %)	892 m (934.6 m)	174.33 m (166.1 m)
Solothurn	5	1 (20.00 %)	4 (80.00 %)	974.5 m (1254 m)	128.25 m (45 m)
St Gallen	21	9 (42.86 %)	12 (57.14 %)	935.33 m (982.78 m)	119.83 m (152.67 m)
Thurgau	2	1 (50.00 %)	1 (50.00 %)	624 m (504 m)	139 m (78 m)
Ticino	10	4 (40.00 %)	6 (60.00 %)	1155.33 m (1151.75 m)	111.83 m (101.25 m)
Uri	7	5 (71.43 %)	2 (28.57 %)	1392.5 m (1142.6 m)	132 m (118 m)
Valais	60	51 (85.00 %)	9 (15.00 %)	1438.89 m (1381.76 m)	93.78 m (126.69 m)
Vaud	28	16 (57.14 %)	12 (42.86 %)	1203 m (1151.25 m)	152.83 m (148.25 m)
Zug	2	1 (50.00 %)	1 (50.00 %)	766 m (996 m)	281 m (115 m)
Zurich	9	2 (22.22 %)	7 (77.78 %)	764.14 m (820 m)	115.29 m (73 m)
Total	322	186 (57.76 %)	136 (42.24 %)	1078.39 m (1169.07 m)	141.99 m (132.78 m)

Table 3. Results of the test for necessary conditions for LSAP outcome.

	Cons.Nec	Cov.Nec	RoN
LOWALTOPS	0.6511	0.5438	0.4942
LOWELEVDIFF	0.7703	0.5847	0.4307
LOWSNOWFEB	0.6303	0.5432	0.5184
NOREPLACEMENT	0.9301	0.6553	0.3893
NOSNOWMAKING	0.9677	0.6250	0.2394
HIGHCOMPETITION	0.5989	0.7150	0.7892
∼LOWALTOPS	0.3489	0.6536	0.8662
∼LOWELEVDIFF	0.2297	0.5551	0.8774
∼LOWSNOWFEB	0.3697	0.6477	0.8523
∼NOREPLACEMENT	0.0699	0.2241	0.8544
∼NOSNOWMAKING	0.0323	0.1765	0.9114
∼HIGHCOMPETITION	0.4011	0.4489	0.6297

and RFcov are accordingly both 1 in the result). In the case-specific test, no shaky cases but 10 possible cases were calculated. These possible cases, which are not covered by the original solution, can be represented by the condition configuration

$$\sim \text{LOWALTOPS}^{*}\text{NOREPLACEMENT}^{*}$$
$$(\sim \text{HIGHCOMPETITION} + \sim \text{NOSNOWMAKING}).$$

However, the combination of non-low altitude of entrance combined with the lack of facility replacement AND the lack of high competition OR the presence of snowmaking shows that these are 10 individually very specific areas.

Despite the presence of some potential cases, the robustness test result can therefore be considered satisfactory due to the 100 % match of the robust core with the original solution and the absence of shaky cases. The complete robustness test protocol is attached in the Supplement and can be reproduced using the R script.

5.2.2 Non-LSAP outcome

Necessary conditions

The test for necessary conditions for the non-LSAP outcome followed the same criteria as for the LSAP outcome; the results are presented in Table 5.

No condition turned out to be necessary.

Sufficient conditions

The test for sufficient conditions was also performed according to the same criteria as for the LSAP outcome; the truth table was created with a consistency cut-off value of 0.75. The parsimonious solution is shown in Table 6 and discussed

Table 4. Results of the test for sufficient conditions for LSAP outcome (parsimonious solution).

	inclS	PRI	covS	covU
NOREPLACEMENT* NOSNOWMAKING* HIGHCOMPETITION	0.818	0.818	0.524	–
Solution	0.818	0.818	0.524	–

inclS, consistency of the solution term; PRI, proportional reduction in inconsistency; covS, raw coverage of the solution term; covU, unique coverage of the solution term.

Table 5. Results of the test for necessary conditions for ∼LSAP outcome.

	Cons.Nec	Cov.Nec	RoN
LOWALTOPS	0.747	0.456	0.450
LOWELEVDIFF	0.748	0.415	0.350
LOWSNOWFEB	0.725	0.457	0.475
NOREPLACEMENT	0.669	0.345	0.251
NOSNOWMAKING	0.794	0.375	0.159
HIGHCOMPETITION	0.326	0.285	0.599
∼LOWALTOPS	0.253	0.346	0.774
∼LOWELEVDIFF	0.252	0.445	0.852
∼LOWSNOWFEB	0.275	0.352	0.758
∼NOREPLACEMENT	0.331	0.776	0.953
∼NOSNOWMAKING	0.206	0.824	0.980
∼HIGHCOMPETITION	0.674	0.551	0.676

afterwards; the other two solutions are made transparent in the Supplement.

What is striking here is that a model ambiguity has arisen in the context of the Boolean minimisation of the truth table. In this case, this means that two models were calculated for sufficient condition configurations for the non-LSAP outcome, whereby it cannot be deduced from the data alone which of the two more accurately represents empirical reality. However, a closer look at the two models (M1 and M2) shows that the difference between the two is marginal: first, both models share four condition configurations (∼LOWALTOPS*∼NOSNOWMAKING, ∼NOSNOWMAKING*∼HIGHCOMPETITION, LOWELEVDIFF*∼NOREPLACEMENT* ∼NOSNOWMAKING, LOWELEVDIFF* ∼NOREPLACEMENT* ∼HIGHCOMPETITION); i.e. they differ only in one condition configuration: while model 1 (M1) lists *LOWALTOPS*∼NOREPLACEMENT* ∼HIGHCOMPETITION* as the last configuration of sufficient conditions, model 2 (M2) uses *LOWSNOWFEB*∼NOREPLACEMENT* ∼HIGHCOMPETITION*. By looking more closely at the two ambivalent configurations, we see that they also have two common conditions (*∼NOREPLACEMENT*∼HIGHCOMPETITION*) and only differ in one condition (*LOWALTOPS vs. LOWSNOWFEB*). In turn, there is likely to be a high overlap between these two conditions as areas with low altitude tend to be characterised by little natural snow (SLF, 2023). Concurrently, the differences between the two models in the consistency and coverage parameters are marginal. Due to the minimally better coverage, the discussion of results following the robustness test will refer to model 1.

Robustness test

The robustness test for the non-LSAP outcome was also performed according to the standard robustness test protocol already outlined. Again, the overall result of RFcons 0.995 and RFcov 0.97 is very satisfactory, even though one shaky typical case (Buerchen_Blatt) and two possible cases were identified.

The complete robustness test protocol is attached and can be reproduced with the R script.

6 Discussion

6.1 LSAP outcome

When looking at the results of the tests for necessary and sufficient conditions, five initial conclusions can be drawn.

1. Nearly all closed isolated lifts display a lack of facility replacement and/or lack of snowmaking; i.e. these two conditions have been found to be necessary conditions for closure. While many isolated lifts still in operation also exhibit these two conditions (hence the relatively low relevance of necessity values), the results can still be interpreted: first, both conditions indicate a lack of capital strength, thus also confirming the observation of Berard-Chenu et al. (2021:665) that small resorts in particular invest very little. At the same time, they also put themselves at a competitive disadvantage: while the lack of system replacements suggests that the lifts are outdated, prone to failure and rather underperforming in terms of their passenger transportation capacity, a lack of snowmaking systems makes it impossible to compensate for days with poor snow conditions.

2. Especially the effects of a lack of snowmaking are not surprising and concord with other research results. In the literature, climate aspects such as lack of snow have long been seen as an important factor influencing the survival or non-survival of ski resorts. Alpine skiing is to a large extent considered a "climate-sensitive

Table 6. Results of the test for sufficient conditions for ∼LSAP outcome (parsimonious solution). The values in italics denote the model ambiguity; i.e. it cannot be empirically inferred which of the two lines is correct.

	inclS	PRI	covS	covU	M1	M2
∼LOWALTOPS*∼NOSNOWMAKING	0.906	0.906	0.075	0.009	0.009	0.009
∼NOSNOWMAKING*∼HIGHCOMPETITION	0.889	0.889	0.106	0.041	0.041	0.041
LOWELEVDIFF*∼NOREPLACEMENT* ∼NOSNOWMAKING	0.988	0.988	0.090	0.030	0.030	0.030
LOWELEVDIFF*∼NOREPLACEMENT* ∼HIGHCOMPETITION	0.929	0.929	0.137	0.033	0.036	0.040
LOWALTOPS∼NOREPLACEMENT* ∼HIGHCOMPETITION*	*0.927*	*0.927*	*0.131*	*0.004*	*0.039*	–
LOWSNOWFEB∼NOREPLACEMENT* ∼HIGHCOMPETITION*	*0.949*	*0.949*	*0.120*	*0.002*	–	*0.037*
Solution M1	0.915	0.915	0.304	–	–	–
Solution M2	0.915	0.915	0.302	–	–	–

activity" (Hamilton et al., 2003:53). Berard-Chenu et al. (2021:660) point out that there is a clear "climate change vulnerability perception" among the operators of ski areas, which in many cases would lead them to invest in snowmaking systems. Unsurprisingly, there is already compelling evidence in existing research that ski areas are currently focusing more on reducing their dependence on the natural snowpack (e.g. Falk and Lin, 2018). Berard-Chenu et al. (2022c:3854) use the "path development trajectories framework" for this purpose and, with regard to French ski areas, conclude that the now widespread recourse to snowmaking represents both a "specialization strategy, since it has no other purpose than to guarantee downhill skiing", and an expansion strategy, the latter in the sense of a shift "from only ski lift operations towards the management of ski areas" (Berard-Chenu et al., 2022c:3864). Here in particular, the operators of small ski areas, who are often dependent on voluntary work (Rottmeier, 2022), are likely to be overwhelmed by the aforementioned management component, in terms of both snowmaking and complex lift technology.

3. The presence of one or both of the necessary conditions in an isolated lift area alone is not sufficient to explain its disappearance. Only the addition of another condition creates a configuration that can sufficiently explain the closure of isolated lifts. In our analysis, precisely one configuration of sufficient conditions could be identified: NOREPLACEMENT*NOSNOWMAKING* HIGHCOMPETITION. Although this configuration is not surprising as such, it illustrates that only strong competition needs to be added for an isolated lift, which already exhibits the two necessary conditions, to be forced to close. Beaudin and Huang (2014:67) rightly point out that "larger ski areas have significantly higher probabilities to own snowmaking equipment, which reinforces the chances of survival" (see also Mayer and Steiger, 2013:193), since it is precisely here that not only some independence from meteorological conditions but also greater comfort on the slopes (Steiger and Mayer, 2008:295) can be achieved. As small ski areas in particular can invest very little, isolated lifts, which are also often located at lower altitudes, suffer particularly from climate change and investment pressure and are driven out if they have to compete with better-equipped areas. This assessment is also supported by descriptive statistics (see Table 2) showing that the closure rate of isolated lifts in cantons with a very high number of large areas (especially Valais) is above average. This is also plausible because the large areas in particular have now integrated extensive trainer lift facilities into their areas, which reduces the need for isolated lifts as typical first contact facilities for beginners in their direct vicinity. Another argument could be that isolated lifts have been built on unsuitable slopes in the first place,[18] for example those highly exposed to avalanches.

4. The configuration of sufficient conditions identified has a coverage of 0.531; i.e. 53.1 % of all closed isolated lifts can be explained by this configuration of sufficient conditions alone. For the remaining 46.9 % of all closed isolated lifts, no further condition configuration could be found, but this is also due to the sparse data situation already mentioned. For a large part of all isolated lifts, neither annual reports nor balance sheets could be found, which partly reflects the small-scale company structure. Especially in the case of isolated lifts, it is possible that they are not profit-oriented at all but pursue secondary goals. It can be seen that lifts are often kept alive by donations or subsidies (see, for example, Landesrechnungshof Steiermark, 2019:41). Furthermore, several isolated lifts had to close for neither skiing-related nor economic reasons, e.g. to make way for the enlargement of a village, i.e. in the form of second homes (Sonderegger and Bätzing, 2013). This, too, cannot be surveyed due to limited data availability, which is why we have refrained from integrating such conditions in the interests of scientific seriousness. But

[18] We would like to thank an anonymous reviewer for this idea.

the knowledge of such circumstances provides a plausible explanation as to why the coverage remains relatively low with regard to the conditions we use.

5. It is also noticeable that only three of the six conditions appear in the solutions: lack of snowmaking, lack of facility replacement and high competition. The other three conditions, low amount of snow in February, low altitude at the entrance to the isolated lift and low elevation difference, on the other hand, turned out not to be sufficiently explanatory. Remarkably, the average altitude at the entrance of closed isolated lifts in the past was even slightly higher than the average entrance altitude of isolated lifts still in operation (see Table 2). The comparatively low relevance of a low amount of natural snow reinforces the finding of Falk (2013), among others, with regard to Austrian ski resorts: that the presence of snowmaking is more relevant than the natural snow depth. However, it must be emphasised here that our findings are primarily retrospective; i.e. in the past, isolated lifts were not driven out of the market because of low amounts of snow. However, this finding says nothing about how future developments will turn out, especially since it is already foreseeable that the amount of natural snow below 1300 m will decrease significantly with continued climate change (SLF, 2023; see also Matiu et al., 2021). Accordingly, it would also be presumptuous not to attribute any significance to a low amount of snow since the lack of snowmaking facilities has turned out to be the strongest necessary condition. Accordingly, it can be stated that the lack of options to compensate for below-average snow days with artificial snow was more decisive for the closure of the isolated lift than a below-average total snow amount itself, but this does not mean that the total snow amount as a starting point for artificial snow would be completely negligible. Irrespective of this, not only can it be assumed that, especially for isolated lifts, the investment in snowmaking is a cost factor that can often hardly be afforded in terms of acquisition and maintenance (Berard-Chenu et al., 2021:665), but also it requires specialists who are knowledgeable in both technical and management areas (Berard-Chenu et al., 2022c:3860). It can therefore be assumed that many operators of isolated lifts are overwhelmed by this, both financially and in terms of personnel, and are not able to invest in snowmaking facilities despite the obvious climatic necessity and the stabilising effects of artificial snow (Falk, 2013; Gonseth, 2013).

6.2 Non-LSAP outcome

The results of the tests for necessary and sufficient conditions for the survival of isolated lifts turn out to be much more diffuse. Nevertheless, three conclusions can be derived that should be discussed as well.

1. No necessary conditions for the survival of isolated lifts could be identified; i.e. surviving isolated lifts have none of the conditions investigated here in common. This already shows how heterogeneously different surviving isolated lifts can be. Berard-Chenu et al. (2022b:877) have rightly warned against underestimating the heterogeneity of ski areas, which of course also applies to isolated lifts. For example, some are subsidised by the public sector and others belong to ski schools or have tariff associations with neighbouring ski areas. But the first-nature factors also vary considerably, for example with regard to topographical aspects.

2. Still, no fewer than five configurations of sufficient conditions could be identified to explain the survival of isolated lifts (please note again that the + stands for the logical OR, the * for the logical AND the ∼ for the absence of the condition):

   $$\begin{aligned}&\sim \text{LOWALTOPS}^{*}\sim \text{NOSNOWMAKING}+\\&\sim \text{NOSNOWMAKING}^{*}\sim \text{HIGHCOMPETITION}+\\&\text{LOWELEVDIFF}^{*}\sim \text{NOREPLACEMENT}^{*}\sim \text{NOSNOWMAKING}+\\&\text{LOWELEVDIFF}^{*}\sim \text{NOREPLACEMENT}^{*}\sim \text{HIGHCOMPETITION}+\\&\text{LOWALTOPS}^{*}\sim \text{NOREPLACEMENT}^{*}\sim \text{HIGHCOMPETITION}.\end{aligned}$$

   But by factoring them out, they can be combined into two configurations that are easier to interpret:

   $$\begin{aligned}&\sim \text{NOSNOWMAKING}^{*}(\sim \text{LOWALTOPS}+\sim \text{HIGHCOMPETITION}\\&+\text{LOWELEVDIFF}^{*}\sim \text{NOREPLACEMENT})\\&+\\&\sim \text{NOREPLACEMENT}^{*}\sim \text{HIGHCOMPETITION}^{*}(\text{LOWELEVDIFF}\\&+\text{LOWALTOPS}).\end{aligned}$$

   The first configuration is characterised by the presence of snowmaking AND one of three other conditions or combinations of conditions: either a non-low entrance altitude OR no major competition OR a low elevation difference in combination with facility replacement. What is striking here is that the presence of snowmaking alone is not sufficient for the survival of the isolated lift. Instead, artificial snow complements other favourable conditions: either a sufficiently high entrance altitude makes the use of expensive snowmaking less necessary; the lack of high competition gives the isolated lift a better position; or the isolated lift is additionally characterised by (expensive) facility replacements and a low elevation difference, indicating its use as a practice and beginner lift close to larger areas. Thus, our study also supports the thesis that although snowmaking is an important component of a survival strategy (Falk, 2013), it is not sufficient on its own, at least with regard to isolated ski lifts. Cognard et al. (2023:14) have also stated that "snowmaking cannot cancel the key role played by elevation for the sustainability of mountain snow tourism in the context of climate change, as it provides better natural snow conditions and increases the ability of ski resorts to capitalise on their previous investment." Accordingly, it is also unlikely that already-struggling operators can increase the survival prospects of their lifts by simply adding snowmaking equipment. This point is also supported by the study on the "marginal utility of increasing snowmaking" by Cognard et al. (2023:2). Referring to French ski resorts, they conclude that "snowmaking growth has reached the futility limit ... [and] that investment no longer improves profitability even in the worst snow season" (Cognard et al., 2023:12). Especially when considering the ambivalence of snowmaking as an insurance policy against advancing climate change on the one hand and as a business and ecological problem on the other (especially with regard to the high consumption of water and energy; see Knowles et al., 2023), the finding of Berard-Chenu et al. (2022a) that political influence also plays a major role when it comes to the acquisition of snowmaking – with regard to both permits and loan awards – comes as no surprise.

The second configuration, consisting of facility replacements AND the absence of competition combined with a low elevation difference OR a low entrance altitude, indicates an isolated lift with a fundamentally solid capital situation and little competition nearby. Correspondingly, however, it is not certain whether this configuration really constitutes a reliable survival strategy for the future or whether what have been captured here are only the last temporary survivors of progressive cut-throat competition. Especially since the path dependencies described by Berard-Chenu et al. (2022c:2) also exist for isolated lifts, it is not certain whether these isolated lifts can respond to crises caused by climate change or fewer skiers and, if they can, how.

3. The heterogeneity of the surviving isolated lifts is reflected not only in the absence of necessary conditions, but also in the low coverage for sufficient conditions: 0.304. This means that just under one-third of all surviving isolated lift areas can be explained by the two configurations discussed above. In addition to the already-mentioned disadvantageous data situation as far as annual (financial) reports are concerned, this initially seemingly low explanatory value can, however, also be explained by the fact that isolated lifts often cease operation only when their technical operating permit expires. If one takes into account the often important social role that isolated lifts play in many villages (Anker, 2022), for example as a recreational place for children or meeting place for adults, the political dimension is also likely to play an important role in this type of lift in particular. In other words, despite often negative operating results and unfortunate initial conditions, isolated lifts and small skiing areas have often continued operating thanks to local interests through subsidies or support associations, as long as this was still possible within the framework of concessions and/or technical operating permits (Beuter and Dumin, 2020:185; Heise, 2020:59; König and Schuck, 2020:35; Rucktäschel, 2020:135; Schlegel, 2020:100).

7 Limitations

We have so far presented the strengths of this study, such as the full survey of the Swiss isolated-lift situation and the choice of methods, which proved very appropriate for addressing the initial question and were inspired by interdisciplinary research. In the interests of good scientific practice, however, we should also draw attention to certain general limitations in the study.

1. First of all, it has not been possible to collect operating balance sheets within the scope of the full survey because of a lack of information. On the one hand, this is explained by the fact that numerous ski lifts do not have a publicly accessible accounting obligation for their balance sheets due to their legal form. On the other hand, data are no longer available for the ski lifts that were closed several decades ago. Therefore, one obvious reason for the closure of ski lifts – financial deficits – had to be measured indirectly by means of proxy conditions, in particular via the condition of capital-intensive technical snowmaking: "Regardless of the resort size, over the past decades, ski lift operators dedicated around 20 % of their investments for snowmaking. Snowmaking is an essential investment in this capital-intensive sector, for all ski resort sizes" (Berard-Chenu et al., 2021:669).

2. Particularly in the case of isolated ski lifts, it is noticeable that some of them are kept alive on the basis of donations or by means of very differently constituted support associations and/or ski schools. Due to the lack of available data, we were not able to record this factor directly.

3. Finally, it cannot be completely ruled out that, despite very extensive research work, isolated ski lifts have been overlooked and accordingly not recorded. In our estimation, however, this point should hardly have any impact on the results.

8 Conclusions

We addressed the question of why, under the given challenging conditions of advancing climate change and declining interest in winter skiing, some of Switzerland's isolated ski lifts have had to cease operations while others have survived, at least so far. Especially because the isolated ski lifts are very heterogeneous, we decided to use QCA as a research method that allows us to identify equifinalities. Based on our full survey, it can be assumed that about 58 % of all documented isolated ski lifts in Switzerland by now had to cease operations. Half of the closures occurred before 1995, a time when the effects of climate change were less visible than today. Furthermore, the descriptive statistics of LSAPs and non-LSAPs hardly differ in terms of entry altitude and elevation difference.

With consistency values > 0.9, the common features of the closed isolated ski lifts are the lack of snowmaking facilities and the fact that the ski lifts have never been replaced. The four other conditions tested, on the other hand, show no effects (low altitude, low elevation difference, low average snow depth in February, high competition with other ski areas in the vicinity). Considering the conditions that have led to the demise of isolated lifts so far, only one condition configuration with a consistency value of 0.818 proves to offer a strong explanation, namely when a lack of snowmaking occurs in conjunction with a failure to replace facilities and in conjunction with high competition. It seems likely that both cost-intensive snowmaking and facility replacement, which is expensive as well, can be seen as proxies for financial strength. The latter is a condition which is hard to capture directly due to a lack of available data.

If one looks at what the isolated ski lifts currently still in operation have in common, no similarities can be found, which once again illustrates their strong heterogeneity regarding topography, financing, operating models, etc. However, if the question is asked as to which conditions have contributed to survival so far, two configurations of conditions can be identified: the presence of snowmaking in combination with one of three other conditions or combinations of conditions, namely, either a non-low entrance altitude, no major competition or a low elevation difference in combination with facility replacement. The second condition configuration that has contributed to the survival of isolated ski lifts links facility replacement to the absence of competition and combines these two conditions with either a low elevation difference or a low entrance altitude.

Will the death knell soon be rung for the isolated Swiss ski lifts as Mayer and Steiger (2013:166) report with reference to the predictions of many environmental associations in the low-lying Bavarian ski resorts? First of all, it can be assumed that a considerable number of the isolated ski lifts currently still in operation are already operating at a loss in a business sense and their continued existence must be classified as at least unstable. Given the expected worsening of climatic conditions and the possible further decline in interest in alpine winter sports, it remains to be seen whether operating companies, volunteers and the public sector will still be willing to support isolated ski lifts in their fight for survival in the future. An aggravating factor for isolated ski lifts in particular is that they have a very difficult time diversifying their product portfolio, which is now common in many larger ski resorts (Rouch, 2022). One option is to open the lifts for summer operation as well. Even here, isolated ski lifts are at a disadvantage because classic summer activities such as downhill biking or convenient transportation for hikers at high altitudes are not viable. They are thus mostly forced to generate their revenues exclusively during the winter season. Therefore, especially in the absence of subsidies, the future prognosis for isolated ski lifts can be described quite accurately by borrowing the title of a James Bond film: *Die Another Day*.

In a follow-up project, we will address the question of whether the results of the isolated ski lifts also apply to (larger) ski resorts. Other possible areas of follow-up research include a comparison of the situation in the Swiss cantons. It would also be worth investigating whether Switzerland's findings are identical to those of other Alpine states. Furthermore, it seems to be promising to transfer the findings of this paper to the more application-oriented area of tourism research. Last but not least, for the maintenance costs of snowmaking increasing with rising temperatures (Cognard et al., 2023:2), the so-far stabilising effect of snowmaking can be crosschecked in the future. This, too, could be reexamined in follow-up studies in a few years' time.

Data availability. Our database is mainly based on the online database https://Bergbahnen.org (Gross, 2024) and the Federal Office of Topography.

The R script and raw data for transparency and replication can be found in the Supplement.

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