Importance of early snowfall for Swedish ski resorts: Evidence based on monthly data

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Motivation

- major ski markets are reaching a point of stagnation (=> tourism life cycle, Butler 1980)

- characteristics of SE downhill skiing market
  - long tradition
  - small market: 6.5 million skier visits
  - 70 downhill ski areas
  - high share of domestic visitors
  - from 2009/2010 onwards the number of skier visits declined
  - snow making widespread Sälen 62 out of 115 slopes covered

- possible factors for skiing demand
  - costs of skiing too high
  - low income elasticities combined low income growth
  - Increase in snow poor winter seasons
  - importance of snow fall in the early season
  - significant trend decline
Motivation

• Aim
  – relationship between the inter-annual variation of lift ticket sales and snow depth using monthly data

• contribution
  – First estimates using monthly data on output of ski lift operators
  – Precise information on lift ticket prices and lift ticket sales

• model
  – seemingly unrelated regression model (SUR) estimated jointly for five months for the winter seasons 93/94 to 13/14
  – economic factors are restricted to be identical across the winter months
  – snow conditions and calendar effects (early Easter holidays) are allowed to differ
Motivation

Evolution of lift ticket sales and skier visits

- Skier visits in 1000 (Top 17)
- Lift ticket sales in million SEK

- Skier visits (left axis)
- Lift ticket sales (const prices) million SEK (right axis)
Motivation

Evolution of the price index for ski lifts and total CPI

- CPI
- Deflator Lift ticket sales
- Price index ski lifts
Theoretical background

• Recreational demand
• Indirect utility function n number of skier days, d # ski trips
  \[ V(n, d, z, p_{m}^{t}, p_{i}^{l}, z, T, \tau) = u(n, d, z) + \]
  \[ \lambda \left[ y - \sum_{i=1}^{m} n_{i}p_{m}^{t} - p_{i}^{l}d_{i} - z \right] + \mu \left[ T - \tau - nt_{i}^{t} - \sum_{i=1}^{m} d_{i} \right] \]

• Budget and time constraints, costs of travelling and costs of stay
• Demand function, first order condition:
  \[ n_{i} = n_{i}(p_{m}^{t}, p_{i}^{l}, t^{t}, y, T) \]

• effects
  \[ \partial n_{i} / \partial y > 0, \partial n_{i} / \partial p_{i}^{t} < 0, \partial n_{i} / \partial p_{i}^{l} < 0, \partial n_{i} / \partial T > 0 \]
Theoretical background and previous literature

• Cost factors are main determinants of skiing demand (Tuppen, 2000)
• Gilbert and Hudson (2000) : high costs are the major constraints for skiing participation
• Priporas et al. (2014) : financial costs and interpersonal constraints are the main factors
• However: lack of snow and congestion on the slopes play a minor role
• winter sport destinations in the mature phase: income elasticities can be expected to be low
Theoretical background and previous literature

- Skier visits strongly depend on natural snow depth (Gonseth 2013, Falk 2014; Steiger 2011).
- Despite large investments in snow making facilities.
- Distribution of snowfall during the winter is of high importance (Burroughs, 2000).
- Poor start to the winter season may have a disproportionately negative impact on output and profits.
- Choice of the time scale of the weather data (e.g. monthly, daily or for total season) is crucial when modelling the relationship between weather and tourism demand.
- Gómez Martín (2005): weather conditions can cause major variations in visitor flow on the same days or on successive days (Hamilton et al., 2007, Shih et al. 2009).
- However, studies based on daily data have not accounted for price and income effects.
Empirical model

- Recreation/tourism demand model:

$$\ln YCP_{mt} = \alpha_{0m} + \alpha_{1m} \ln PS / CPI_t + \alpha_{2m} \ln GDPcp_t$$
$$+ \alpha_{3m} SNOW_{mt} + \alpha_{4m} t_t + \varepsilon_{mt},$$

- $m=1,..,5$ months: Nov-Dec, Jan, Feb, Mar, and April-May
- $t=$seasons 1992/1993 to 2013/2014
- $YCP$: lift ticket sales (net of value added tax) in constant prices
- $PS$: price index of ski lift tickets
- $CPI$: consumer prices index
- $GDPcp$: Swedish GDP in constant prices
- prices and GDP refer to the year when the season starts (season 2013/14 uses 2013 values)
- $SNOW$: average monthly snow depth
Empirical model

- dependent and explanatory variables are both I(1) and I(0) => model in first differences (to the same month previous yr)

SUR model:

\[
\begin{align*}
\Delta \ln YCP_{1t} &= \alpha_1 + \alpha_1 \Delta \ln PS / CPI_t + \alpha_2 \Delta \ln GDPcp_t + \alpha_3 \Delta SNOW_{1t} + \alpha_4 D_t + \varepsilon_{1t} \\
\Delta \ln YCP_{2t} &= \alpha_2 + \alpha_1 \Delta \ln PS / CPI_t + \alpha_2 \Delta \ln GDPcp_t + \alpha_3 \Delta SNOW_{2t} + \alpha_4 D_t + \varepsilon_{2t} \\
\Delta \ln YCP_{3t} &= \alpha_3 + \alpha_1 \Delta \ln PS / CPI_t + \alpha_2 \Delta \ln GDPcp_t + \alpha_3 \Delta SNOW_{3t} + \alpha_4 D_t + \varepsilon_{3t} \\
\Delta \ln YCP_{4t} &= \alpha_4 + \alpha_1 \Delta \ln PS / CPI_t + \alpha_2 \Delta \ln GDPcp_t + \alpha_3 \Delta SNOW_{4t} + \alpha_4 D_t + \alpha_{54} EARLYEASTER_t + \varepsilon_{4t} \\
\Delta \ln YCP_{5t} &= \alpha_5 + \alpha_1 \Delta \ln PS / CPI_t + \alpha_2 \Delta \ln GDPcp_t + \alpha_3 \Delta SNOW_{5t} + \alpha_4 D_t + \alpha_{55} EARLYEASTER_t + \varepsilon_{5t}
\end{align*}
\]

\[\text{cov}(\varepsilon_{mt}, \varepsilon_{jt}) = E(\varepsilon_{mt} \varepsilon_{jt}) = \sigma_{mj} \text{ for all } t = 1, 2..T \quad \text{cov}(\varepsilon_{mt}, \varepsilon_{js}) = E(\varepsilon_{mt} \varepsilon_{ms}) = 0 \quad \text{for } t \neq s.\]
Empirical model

• Parameters are short-run elasticities
• When all regressors are the same => OLS and SUR are identical
• SUR model is estimated by two-step feasible generalized Least squares (FGLS) estimator
1. Jämtland
2. Gävleborg
3. Dalarna
Data

• monthly data on lift ticket sales (net of value added tax) in constant prices: SLAO
• GDP in constant prices and CPI: Statistics Sweden
• deflator for lift ticket sales: lift ticket sales in nominal prices/lift ticket sales in constant prices
• snow depth based on three weather stations from SMHI (Storlien-Visjövalen, Särna and Nornas)
• ski lift ticket sales for March and April-May are heavily influenced by timing of Easter holidays
• sample period starts with the 1993/1994 season
• Ski resorts in provinces (counties) of Dalarna, Gävleborg and Jämtland 80 per cent of market and of major importance for local economy
### Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Monthly data</th>
<th>Annual data:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>percentage ch. in lift ticket sales in const. prices to the same month in the previous year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov-Dec</td>
<td>2.4</td>
<td>22.1</td>
</tr>
<tr>
<td>Jan</td>
<td>1.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Feb</td>
<td>1.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Mar</td>
<td>0.4</td>
<td>17.0</td>
</tr>
<tr>
<td>Apr-May</td>
<td>-1.4</td>
<td>34.5</td>
</tr>
<tr>
<td>Change in log snow depth in percent to the same month in the previous year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov-Dec</td>
<td>-3.5</td>
<td>71.4</td>
</tr>
<tr>
<td>Jan</td>
<td>-1.8</td>
<td>37.1</td>
</tr>
<tr>
<td>Feb</td>
<td>-1.3</td>
<td>30.0</td>
</tr>
<tr>
<td>Mar</td>
<td>-4.0</td>
<td>37.2</td>
</tr>
<tr>
<td>Apr-May</td>
<td>-7.0</td>
<td>68.9</td>
</tr>
<tr>
<td>oth. determinants (percentage ch. to previous yr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>change in real GDP in percent</td>
<td>2.2</td>
<td>2.7</td>
</tr>
<tr>
<td>change in relative prices in percent</td>
<td>2.2</td>
<td>2.1</td>
</tr>
<tr>
<td>early Easter multiplied by 100</td>
<td>38.1</td>
<td></td>
</tr>
</tbody>
</table>
Empirical results

• Breusch–Pagan test of independence of the residuals: H0 is rejected => SUR more efficient than OLS
• R2 of the equations ranges between 0.10 and 0.34 with an average of 0.25
• real GDP growth significant and positive
• relative prices of ski lift tickets are significant and negative
• average snow depth is significant and positive in the early winter months of November-December and January
• snow depth is not significant for the mid-season months and for the late season
• time scale of weather data is important
• short-run elasticities of lift ticket sales with respect to snow depth are 0.14 for November to December and 0.11 for January.
### Empirical results

SUR estimates of the determinants of growth of lift ticket sales

<table>
<thead>
<tr>
<th>dep. var.: year to year change in lift ticket sales</th>
<th>compared to the same month in the previous year</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Nov-Dec</th>
<th>January</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>coeff.</td>
<td>t</td>
</tr>
<tr>
<td>change in log av. snow depth</td>
<td>0.14</td>
<td>**</td>
</tr>
<tr>
<td>change in log GDP in constant prices</td>
<td>0.88</td>
<td>***</td>
</tr>
<tr>
<td>change in (deflator lift ticket sales/CPI)</td>
<td>-0.68</td>
<td>**</td>
</tr>
<tr>
<td>dummy time period 2010-11 to 2013-14</td>
<td>-0.08</td>
<td>***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.04</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>February</th>
<th>coeff.</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>change in log av. snow depth</td>
<td>0.05</td>
<td>1.07</td>
</tr>
<tr>
<td>change in log GDP in constant prices</td>
<td>0.88</td>
<td>***</td>
</tr>
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<td>-0.08</td>
<td>***</td>
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<tr>
<td>Constant</td>
<td>0.03</td>
<td>1.29</td>
</tr>
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</table>
Empirical results

SUR estimates of the determinants of growth of lift ticket sales
dep. var.: year to year change in lift ticket sales (compared to the same month in the previous year

<table>
<thead>
<tr>
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<th>March</th>
<th></th>
<th></th>
<th>April-May</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>coeff.</td>
<td>t</td>
<td>coeff.</td>
<td>t</td>
<td></td>
</tr>
<tr>
<td>change in log av. snow depth</td>
<td>-0.03</td>
<td>-0.76</td>
<td>-0.04</td>
<td>-0.69</td>
<td></td>
</tr>
<tr>
<td>change in log GDP in constant prices</td>
<td>0.88</td>
<td>***</td>
<td>3.37</td>
<td>0.88</td>
<td>***</td>
</tr>
<tr>
<td>change in (deflator lift ticket sales/CPI)</td>
<td>-0.68</td>
<td>**</td>
<td>-2.03</td>
<td>-0.68</td>
<td>**</td>
</tr>
<tr>
<td>dummy time period 2010-11 to 2013-14</td>
<td>-0.08</td>
<td>***</td>
<td>-4.28</td>
<td>-0.08</td>
<td>***</td>
</tr>
<tr>
<td>early Easter</td>
<td>0.33</td>
<td>***</td>
<td>12.10</td>
<td>-0.49</td>
<td>***</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.11</td>
<td>***</td>
<td>-4.60</td>
<td>0.18</td>
<td>***</td>
</tr>
</tbody>
</table>
Empirical results

- Effects are calculated in standard deviation units.
- Year-to-year variations in natural snow depth in the early winter season are much more important than economic factors.

Effects of a change in one standard deviation of the main explanatory variables on the percentage change in lift ticket sales

<table>
<thead>
<tr>
<th>explanatory variables</th>
<th>one standard deviation change X 100</th>
<th>elasticity</th>
<th>effect of a one standard deviation increase, percentage p.</th>
</tr>
</thead>
<tbody>
<tr>
<td>change in log snow depth Nov-Dec</td>
<td>68.6</td>
<td>0.14</td>
<td>9.3</td>
</tr>
<tr>
<td>change in log snow depth Jan</td>
<td>40.3</td>
<td>0.11</td>
<td>4.6</td>
</tr>
<tr>
<td>change in log GDP const. prices</td>
<td>2.7</td>
<td>0.88</td>
<td>2.3</td>
</tr>
<tr>
<td>change in log relative prices</td>
<td>2.3</td>
<td>-0.68</td>
<td>-1.5</td>
</tr>
</tbody>
</table>
Conclusions and implications

• lift ticket sales depend negatively on lift ticket prices and positively on real GDP
• income and price elasticities are quite low in absolute terms
• decline in snow depth in the early season has a strong negative impact on lift ticket sales
• effect is much more pronounced than the impact of economic factors
• strong trend decline in lift ticket sales from the season 2010/2011 onwards
• future prospects for Swedish ski lift operators are poor given
  – moderate growth in real domestic income
  – further price increases in lift tickets following huge investments in snow making and new lifts
  – expected increase in green early winter seasons
Conclusions and implications

• implications for stake holders and policy makers
  – attracting a larger group of international skiers
  – More direct flights

• Limitations
  – aggregate time series data

• Future work
  – Similar analysis at the individual ski area level
  – applying the same methodology to other countries
  – accounting for other factors