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Returns to investments in new ski lifts: the importance of weather conditions and elevation

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Motivation

- Ski industry is under pressure
  - Saturation/end of tourism life cycle
  - Change in leisure preferences
  - increasing competition and concentration
  - global warming, environmental concerns
- Little is known about the returns to investment in new ski lifts
- Performance of ski lifts depends on a bundle of factors
- Elevation is a critical factor for performance
  - elevation is used as a criterion in risk assessment methodologies and credit ratings by banks and investors (Trawöger, 2014)
- Installations of new lifts are likely to be endogenous

Motivation

- Aim
  - Returns to investment in new ski lifts in extreme mild winter seasons =>ATE
  - Role of elevation
  - What are the main factors influencing performance of ski lifts during snow poor winter seasons?
  - Lift specific and ski area specific factors
- Empirical model: endogenous treatment regression model
- Main contribution
  - First empirical (econometric) investigation
  - New and unique database including 730 ski lifts
  - Accounting for endogeneity of new lifts
- Assumption: extreme mild winter season 2006/07 is the temperature analogue for normal winter conditions in 2050

Motivation

Impact of snow-poor winter seasons:
2006-2007

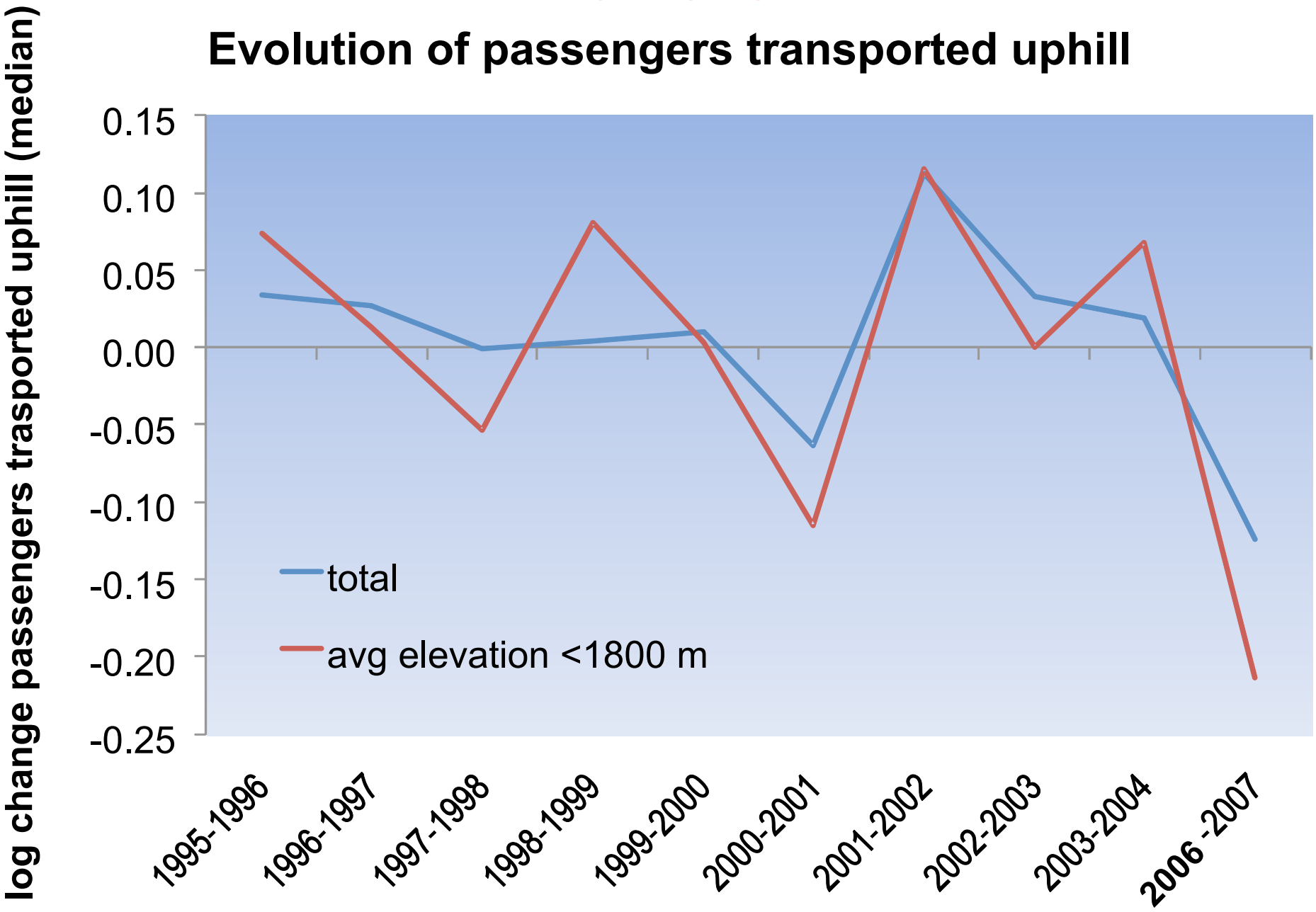
Königsleiten at
an elevation of 1750 metres

Austria
Jan 15 2007

(treeline is 1850 m)

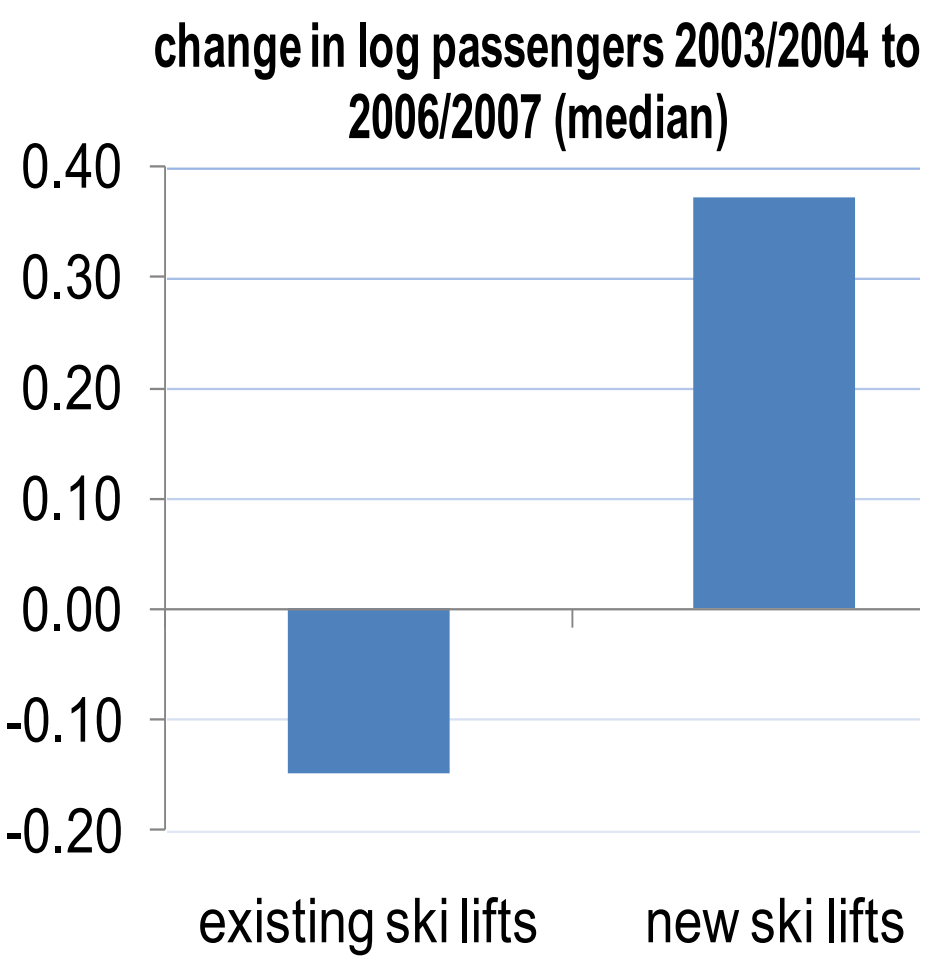
Do investments in new Ski lifts pay-off?

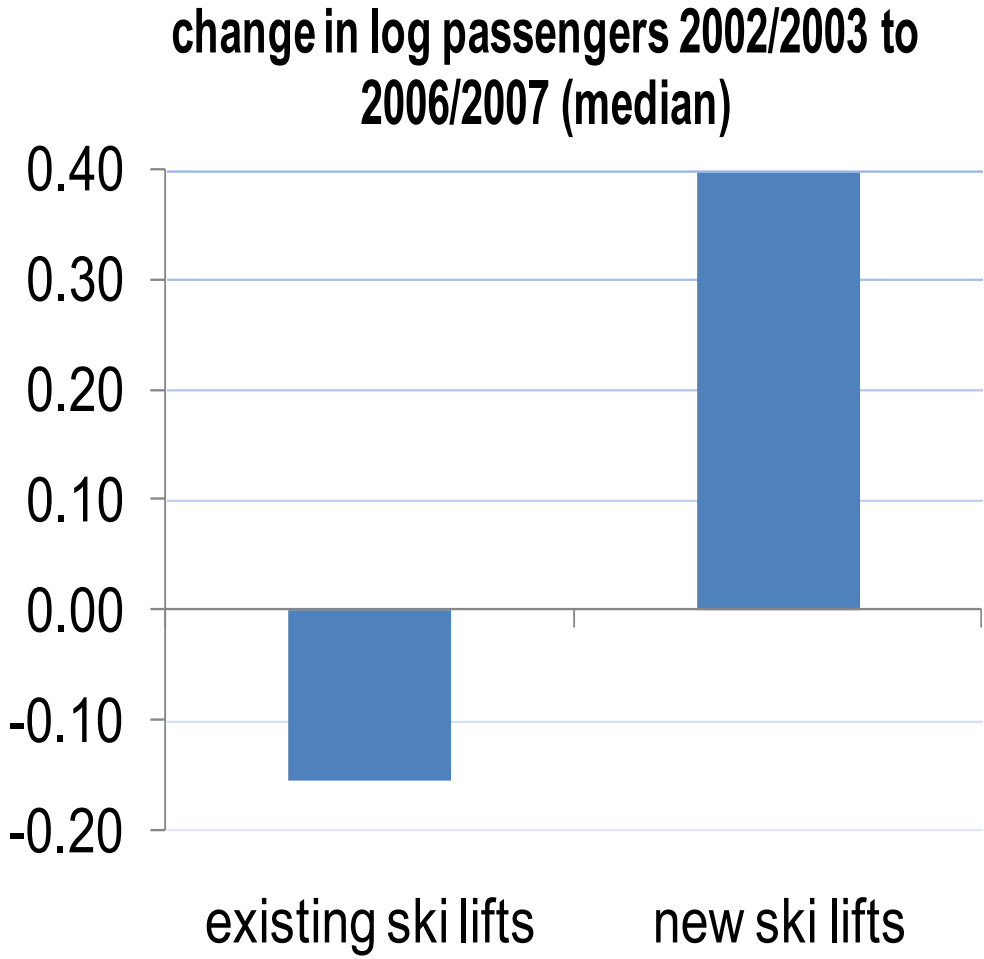
Motivation


Evolution of passengers transported uphill
log change passengers trasported uphill (median)
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
total
avg elevation <1800 m
1995-1996
1996-1997
1997-1998
1998-1999
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2006 -2007

Motivation

Evolution of transported passengers: newly installed ski lifts





Note: temperature and snow conditions winter season 2002/03 slightly below average. 2003/04 Slightly above average

Theoretical background

Ski lift specific factors

- Major innovations in the ski industry
  - (early) introduction of snowmaking facilities
  - Installations of fast ski lifts
  - Snow making and new lifts “keine neue Anlage ohne schlagkräftige Schneeanalage “ ski lift operator Kitzbuehel 2006/07 annual report
- Installations of ski lifts is likely to be endogenous
- Other output determinants: Age and past performance (Klepper 2002; Jovanovic 1982), vertical rise, size of lifts

Resort specific factors

- Geographical proximity to other ski areas
- Distance to large urban centres
- Number of hotel beds

Theoretical background

Elevation is regarded as a critical factor in extreme mild winter season

- Poor snow conditions /lower skiable days in lower sections
- Low-elevation ski areas receive more precipitation in the form of rain
- Climate change will have negative consequences for low-elevation ski

Literature:

- Bark, Colby and Dominguez, 2010; Gonseth, 2013; Hamilton et al., 2003; Pickering, 2011; Steiger, 2011
- Steiger (2011)
  - extreme winter season 2006-2007 has a strong negative impact on the number of lift transports
  - effects depend on the elevation of the ski lifts

Empirical model

Production function: Y=f(A, L,K)

- A technological level, L labour, K capital
- Short run production function:

  $\Delta \ln Y = a_1 \Delta \ln A + a_2 \Delta \ln K + a_3 \Delta \ln L + a_4 \ln E + e$

  K,L are quasi fixed ->captured by ski area effects

Outcome equation:

$$\Delta \ln Y_{ij} = \alpha_j + \alpha_1 elev + \alpha_2 newlift$$

$$+ \alpha_3 elev \times newlift + \mathrm{X}_{ij}\, \beta + Z_j\, \delta + \varepsilon_{ij}$$

- Y number of skiers/snowboarders transported uphill by ski lift i in ski resort j Δ: 2006-07 to 2003-2004

Empirical model

- elev: elevation of the lift (mean elevation or peak station)
- newlift: replacement of old lift
- **X**: lift specific characteristics
- **Z**: resort specific variables

- Hypotheses:
  - Replacement of lifts leads to a strong increase in output
  - Output effect depends on the elevation of the lift

Innovation decision

- Pr(newlift)=f(previous # passengers, age, controls)

Empirical model

- Endogenous treatment regression model (Heckman 1976, 1978, Barnow, Cain, and Goldberger (1981))

$$\Delta \ln Y_{ij} = \mathrm{x}_{ij}\,\beta + \mathrm{z}_{ij}\,\beta + \delta_1 t_{ij} + \delta_3 \ln elev_{ij}$$

$$+ \delta_2 t_{ij} \times \ln elev_{ij} + \varepsilon_j$$

$$t^*_{ij} = \mathrm{w}_j\,\gamma + u_{ij}$$

$$t_{ij} = \begin{cases} 1, & if \quad t^*_{ij} > 0 \\ 0 & , \text{otherwise} \end{cases} \qquad \begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}$$

- Estimated by ML; Identifying var: log # passengers , age of lift
- Ski resort specific effects: Mean of explanatory variables across ski areas => Mundlack (1978), Wooldridge (2002)

Data

- Austrian railway statistics: 1950 to 2006/07 no data for 2004/05 and 05/06
- Information on number of passengers, hours, operation days, elevation peak station, valley station, capacity, number of seats, year of incorporation, type of lift
- Limited information for t-bar lifts
- Replacement of lifts often occurs with change in names
- Sample is restricted to chairlifts, gondolas and t-bars replaced by chairlifts or gondolas
- Limitation: New ski lifts leading to extension of ski areas are not covered
- Other sources: Tourist beds STAT AT, GIS data, share of snowmaking various sources

Descriptive statistics

	obs	mean	st. dev	min	max
log change # passengers 03/04 to 06/07	731	-0.24	0.65	-4.41	2.34
log change # passengers 02/03 to 06/07	683	-0.20	0.61	-4.15	2.64
av. elevation of lift in m	731	1694	455	721	3155
av. elevation of valley lift in m	731	1480	482	419	3100
av. elevation of uphill lift station in m	731	1909	452	814	3440
dummy new ski lift 03/04 to 06/07	731	0.09	0.28	0	1
dummy new ski lift 02/03 to 06/07	731	0.13	0.34	0	1
mean elev. of ski area	731	1694	361	721	2665
dummy lifts with 2 seats or less	731	0.28	0.45	0	1
vertical distance in m	731	430	213	19	1750
age of lits	731	18	12	3	80
distance to nearest neighbour	731	12	8	1	57
# of beds	731	8310	6582	241	24913
number of passengers	731	471497	299369	2726	1556304
share of slopes covered by snowmaking	731	0.51	0.29	0	1

Empirical results

New lift installation exogenous

- Elevation is highly significant
- Replacement of ski lifts is highly significant
- Interaction terms significant
- Age of ski lifts and initial level of number of transports do not play a role
- Resort specific factors
  - Number of tourist beds is significantly positive
  - Geographical proximity is an advantage

New lift installations are endogenous

- LR test reject the null hypothesis of no correlation between the treatment and outcome equation errors
- New ski lifts depends on past level of passengers, age and number of seats

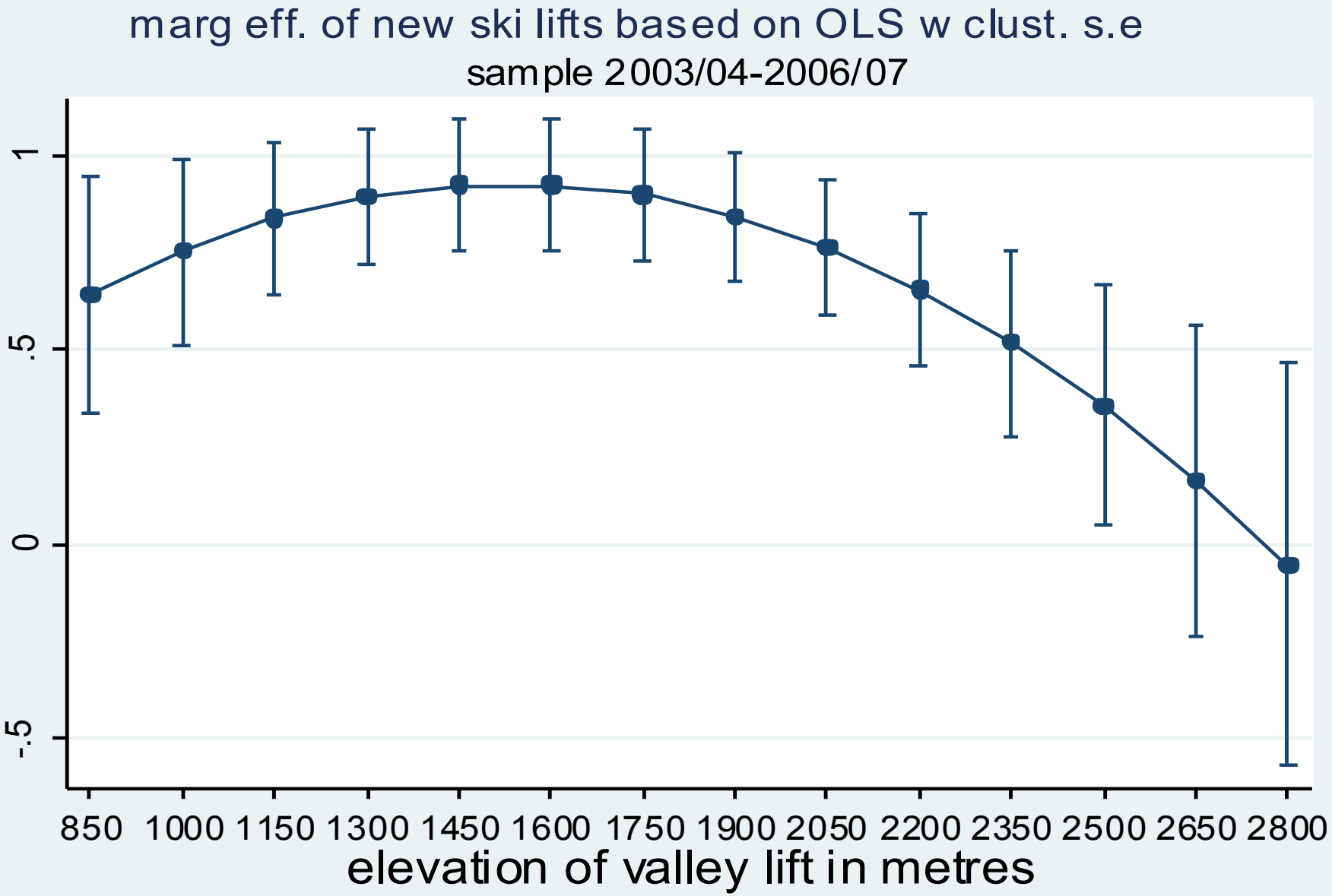
Empirical results

assumption: new ski lifts are exogenous

	OLS estimates			OLS w. interactions		
	coeff		t	coeff		t
log av. elevation of lifts	0.64	***	4.89	9.33	**	1.99
log elevation squared				-0.60	*	-1.87
new ski lift	0.78	***	9.85	-77.96	**	-2.10
new ski lifts x log elevation				21.58	**	2.14
new ski ifts x log elevation squared				-1.48	**	-2.16
dummy var. number of seats <=2	-0.24	***	-3.94	-0.23	***	-3.82
vertical metres of lift	-0.16	***	-3.93	-0.17	***	-4.09
mean elevation of ski area	0.82	***	3.14	0.97	***	3.58
log distance to the nearest neighbour	-0.12	**	-2.33	-0.10	**	-2.15
log number of accommodation beds	0.10	***	3.33	0.10	***	3.40
regional dummies	yes			yes		
constant	-10.88	***	-6.81	-43.51	**	-2.41
R squared	0.37			0.38		

Notes Standard errors are clustered by ski area

Empirical results



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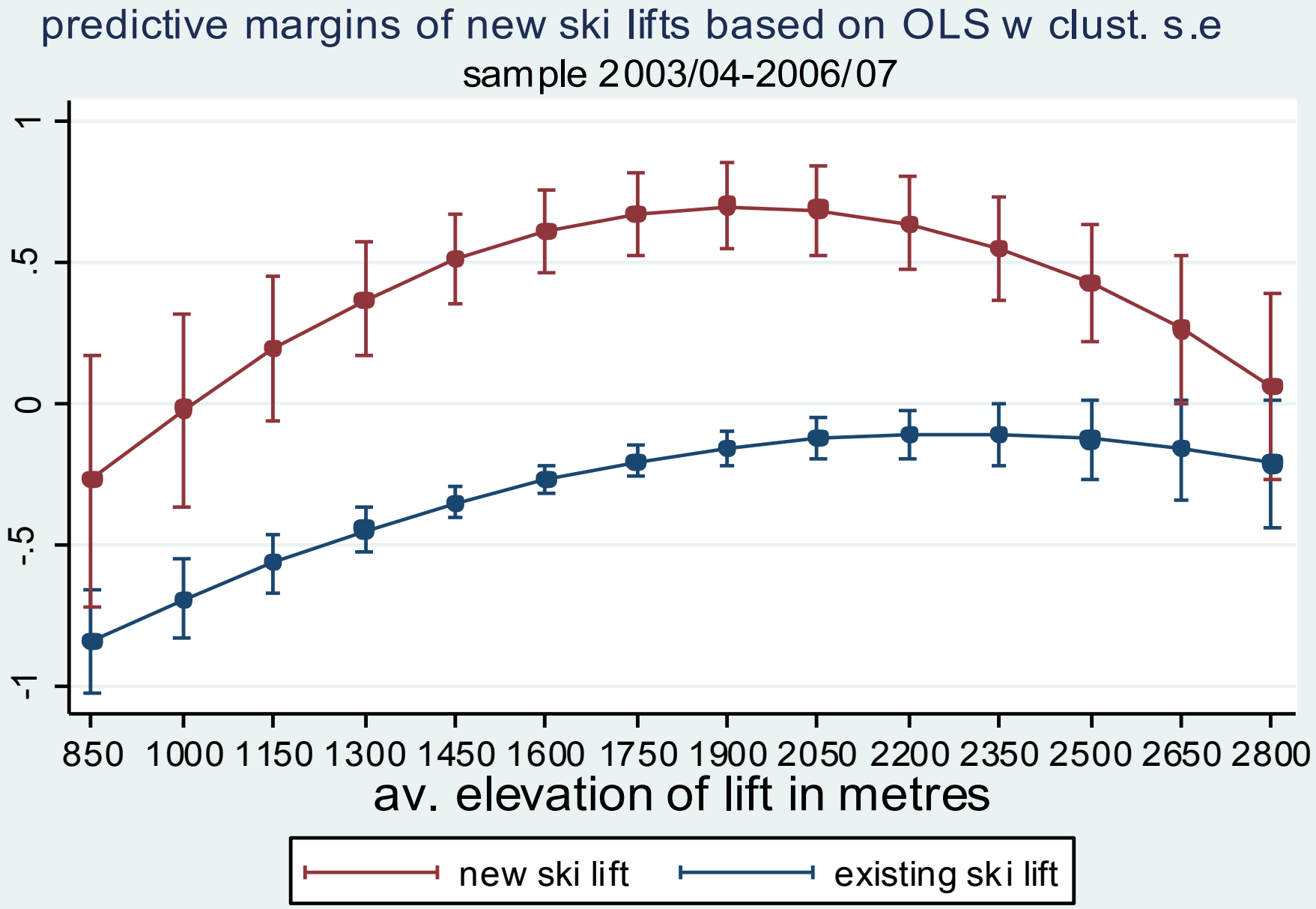

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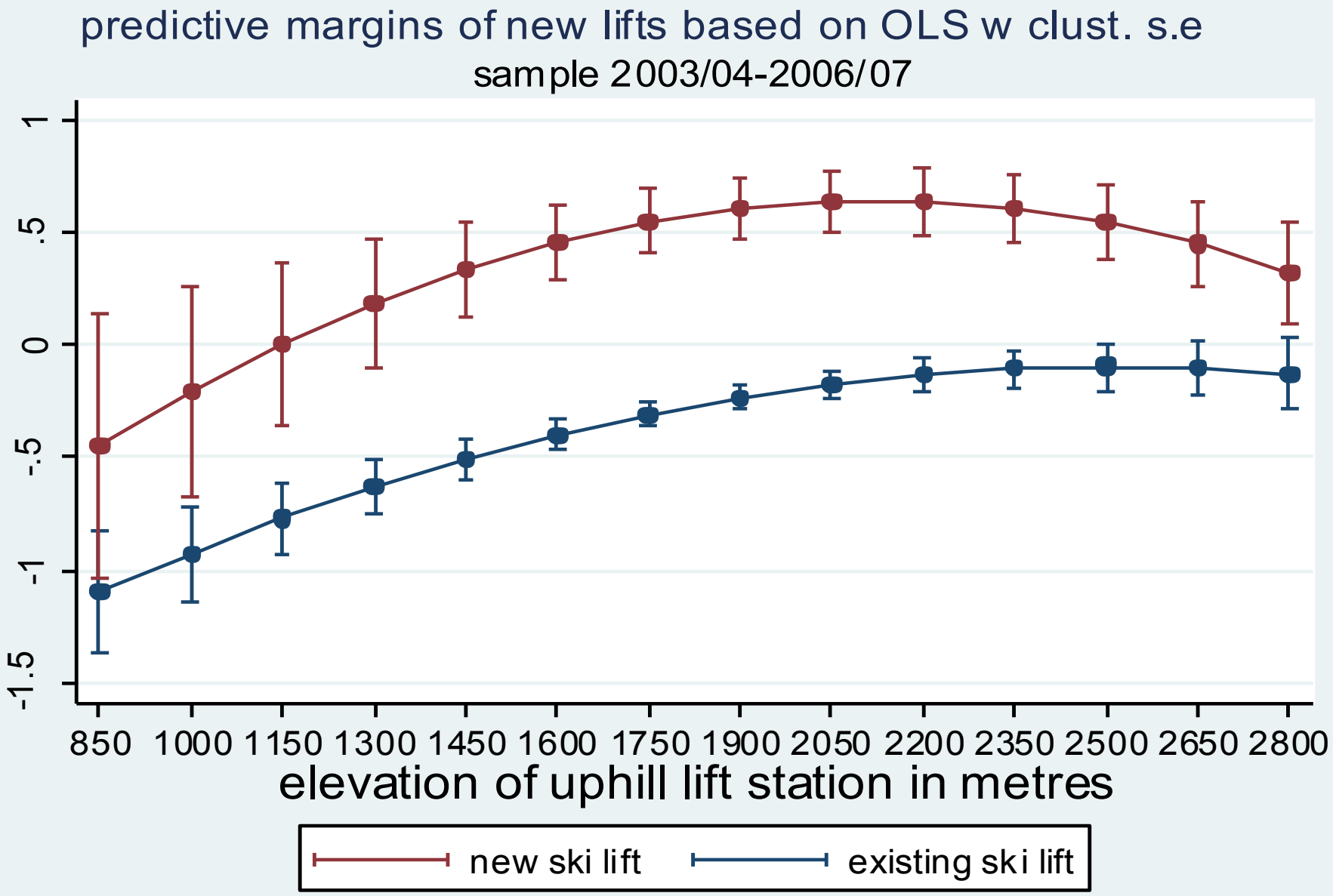

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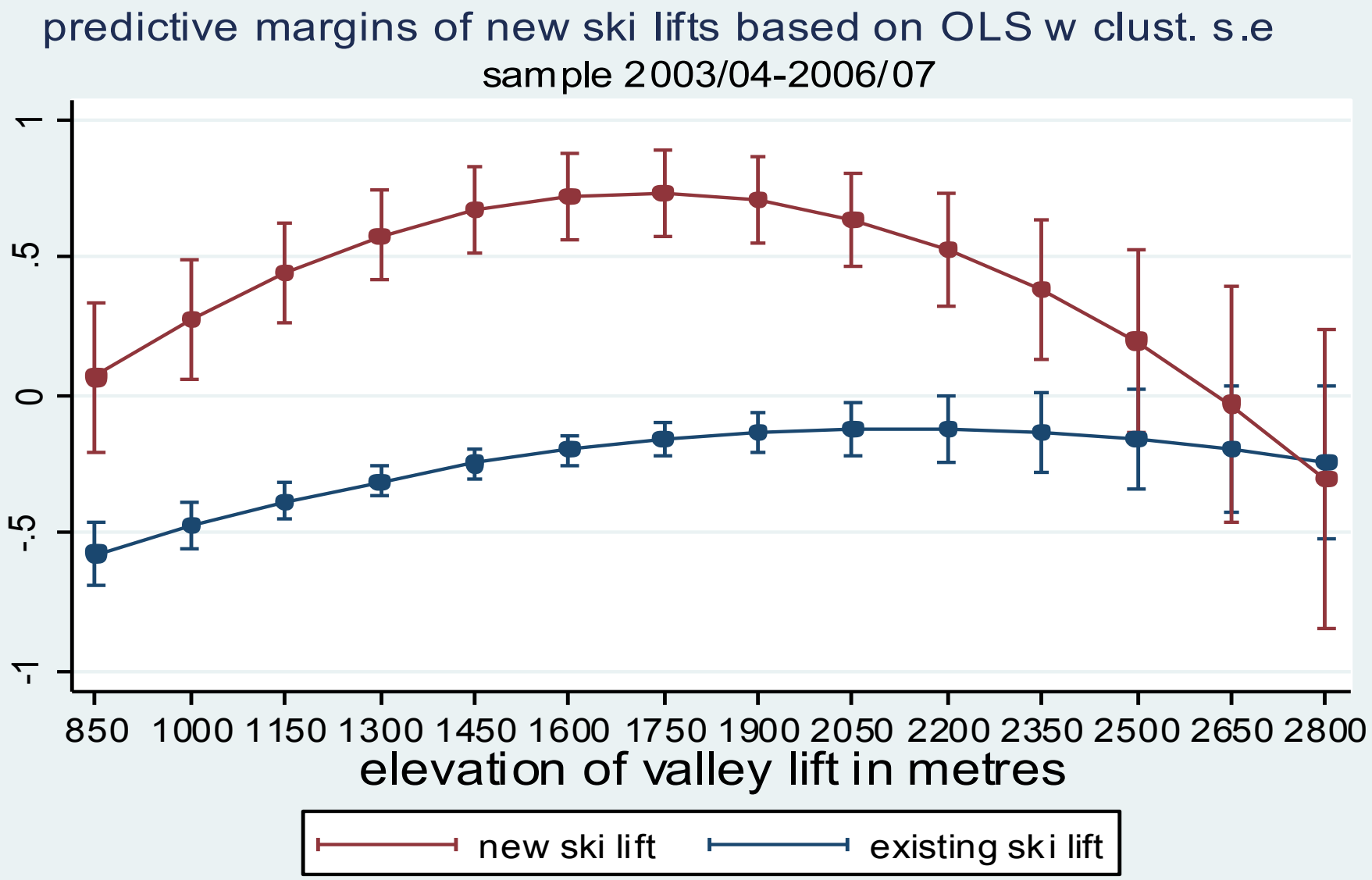

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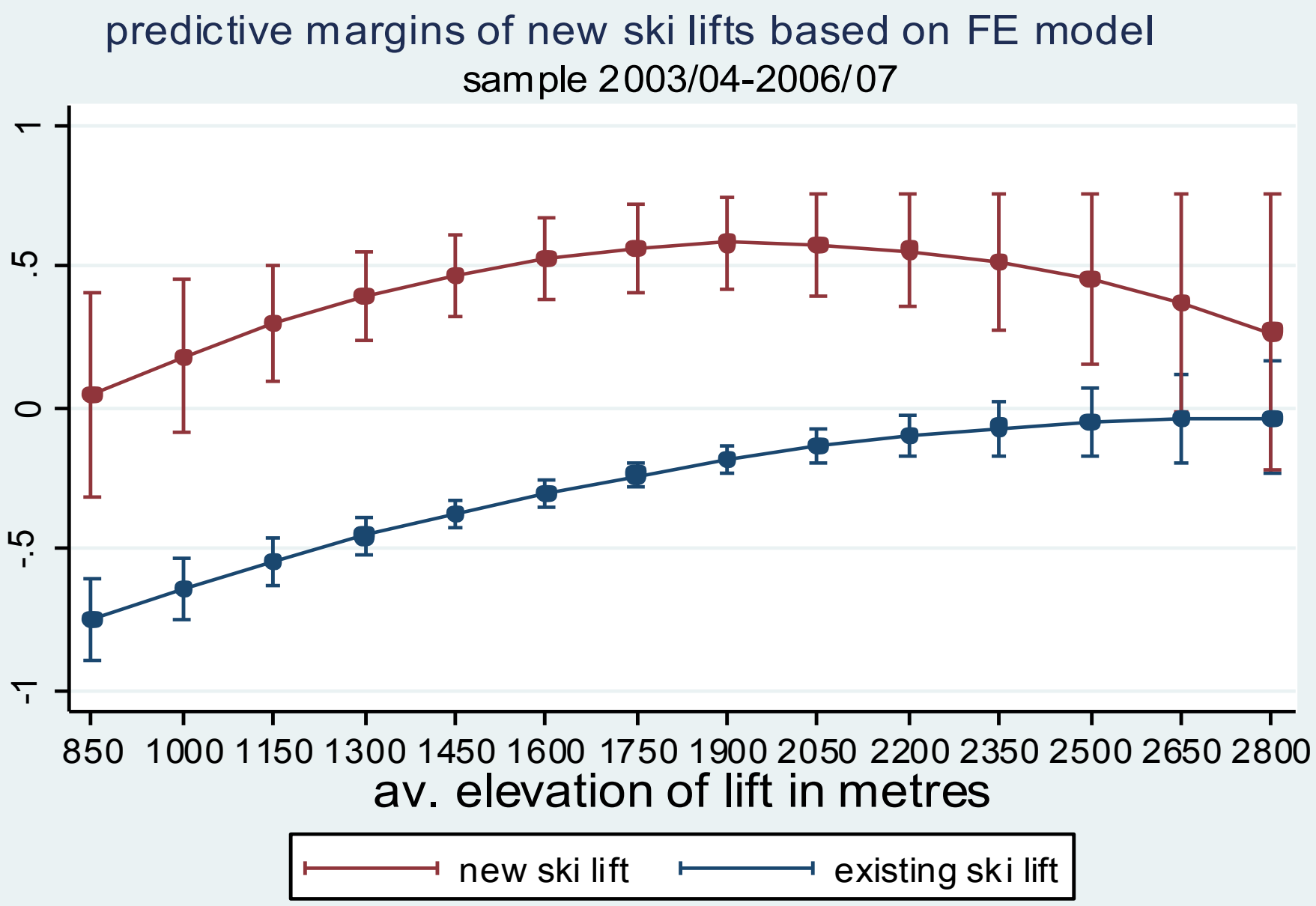

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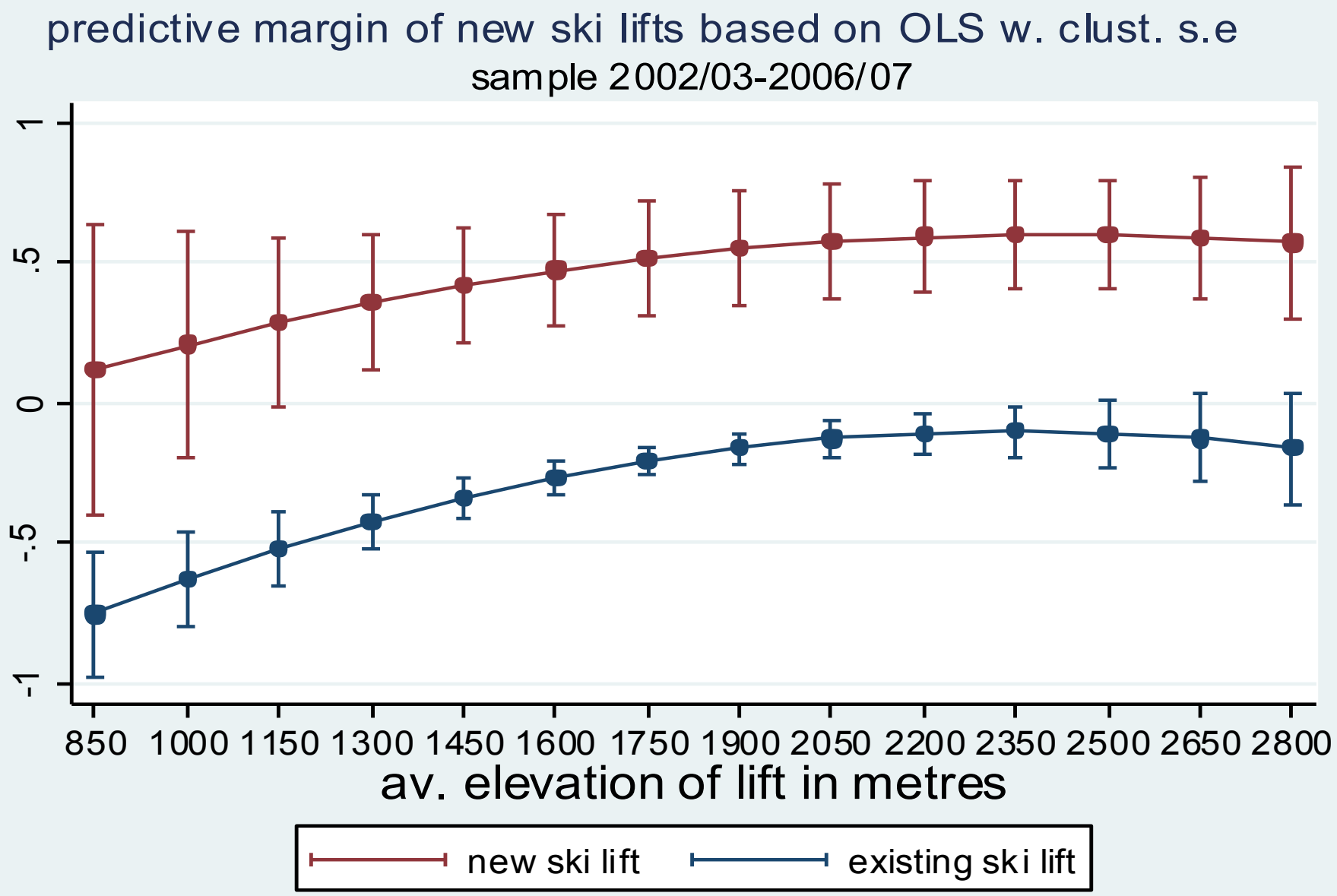
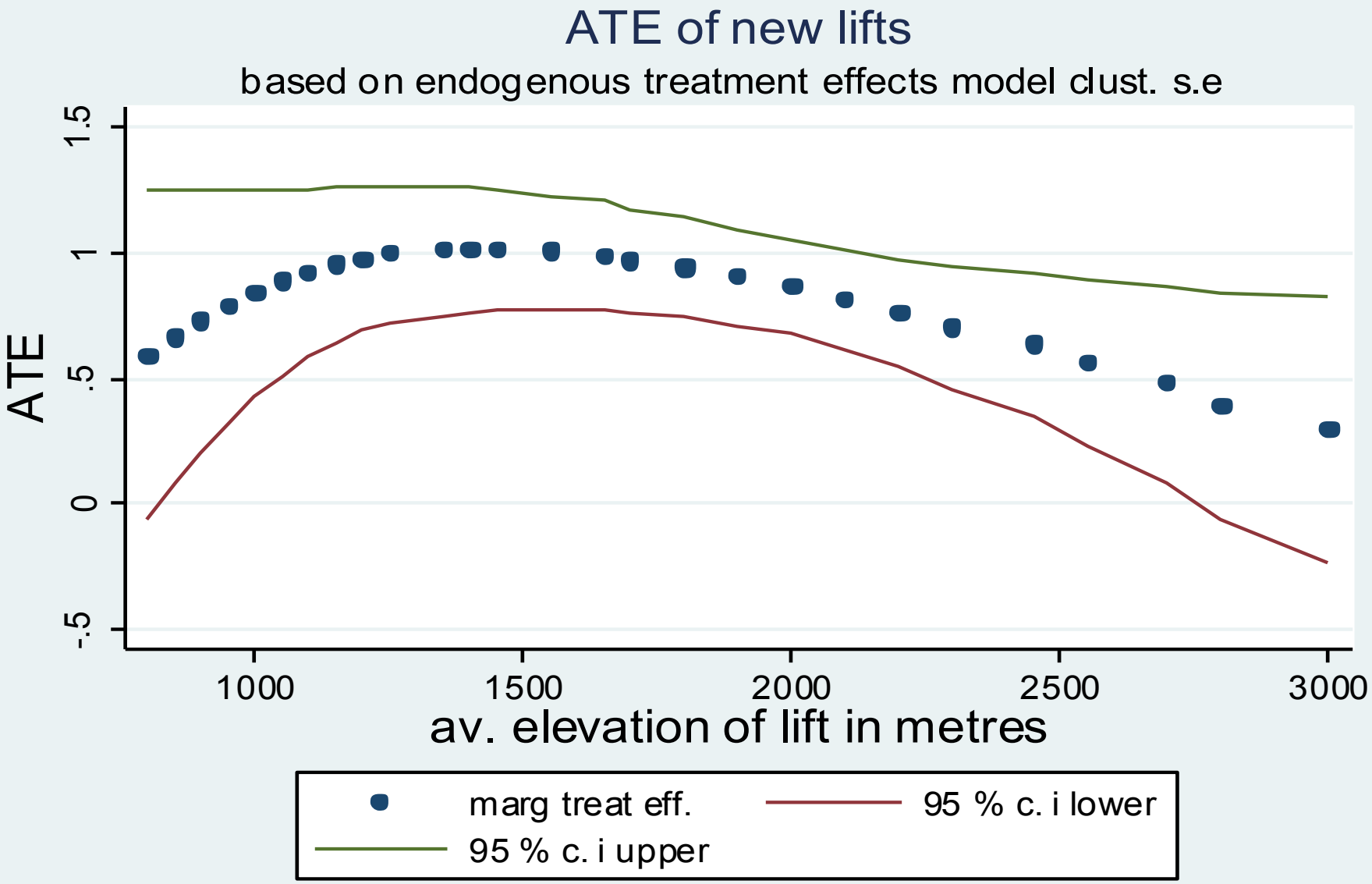


Endogenous treatment regression model

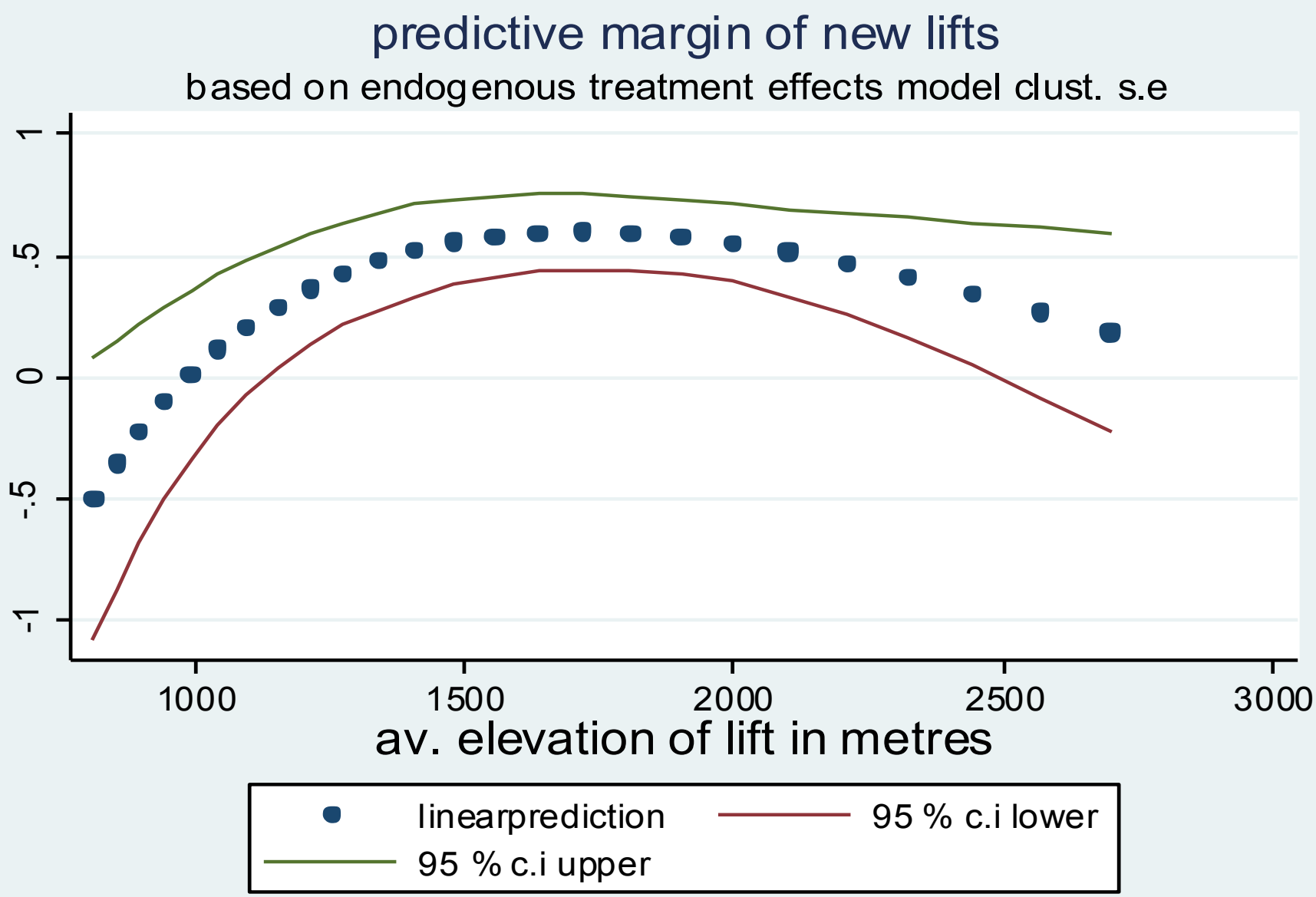
	Linear part: Δ log pass 04-07		probit model new ski lift		
lift specific factors:	coeff	t	coeff	t	marg eff.
log elevation	10.27**	2.37			
log elevation squared	-0.66**	-2.23			
new ski lift	-69.2*	-1.95			
new ski lifts x log elevation	19.3**	2.01			
new ski ifts x log elev. squared	-1.33**	-2.04			
log # of passengers 2004	-0.01	-0.20	7.28***	3.01	0.52
log # of passengers 2004 squared			-0.29***	-3.00	-0.02
log age of ski lift	0.05	1.16	1.09***	3.96	0.08
dummy var. number of seats <=2	-0.23***	-3.75	0.46***	3.10	0.04
vertical metres of lift	-0.17***	-3.92			
ski area specific factors (averages)					
mean elevation of lifts	0.93***	3.53			
mean number of seats <=2	-0.40**	-2.08			
ski resort specific factors:					
log distance nearest neighbour	-0.12**	-2.23			
log # tourist beds	0.08***	2.82			
snowmaking in 2002			0.74***	3.92	0.05
regional dummies	yes				
constant	-46.4***	-2.77	-50.3***	-3.28	
rho	-0.17**	-2.22	N: St. err are clustered		

ATE of new lifts:0.89
exp(0.89)-1 =1.43

Endogenous treatment regression model



Endogenous treatment regression model



Conclusions and implications

- Return to investment (ATE) in ski lifts is large even extreme mild winter seasons
- ATE depends significantly positively on elevation
- Threshold of about 1150 metres for average elevation of lift and 1400 metres for the peak station
- Proximity and plenty of accommodation matters for growth
- Results are robust with respect to estimation method and accounting for endogeneity
- Limitations: gross effects
- Policy implications: investments plans for ski lifts below 1200 metres should be carefully evaluated
- Future work:
  - Multi-level models
  - Output effects of linked ski areas
  - Sensitivity of ski lift performance to weather conditions 1950-2007