The Effect of Increased Fixed Costs on High-Risk Decision Making

Evidence from Mount Everest

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Motivation

What is the effect of increased fixed costs on risk levels and decision making?

Effects of price changes:

- Income/Substitution effects

Literature highlights how individuals do not discount sunk costs as rational choice theory suggests

- Kahneman and Tversky 1979, 1992
- Zeelenberg and Dijk 1997

Motivation

This context:

- Experimental → Empirical
- Professional high-risk decision makers

Prediction: Competing effects

- Higher risk to avoid potential losses

Background

Mountaineering permits:

Introduction of large-scale permit system in 1990s as commercial climbing begins on Everest to regulate market

Mandatory for undertaking climb

$5.07 million USD revenue Government of Nepal in 2019

New permit fee system 2015:

~$1000 increase

Empirical Strategy

Synthetic Control:

Weighted outcomes from other 8000m peaks used to create counterfactual

$$Y'_{EV,t} = \sum_{m \in M} W_m Y_{m,t}$$

Regression Analysis:

Ordinary Least Squares

$$R_{its} = \beta_0 + \beta_1 P_{its} + \beta_3 X_{its} + \nu_t + \psi_s + \varepsilon_i$$

Outcome Variable: Risk- Proxy: # of deaths and injuries in 24h

Variable of Interest: Permit Royalty

Empirical Strategy

Regression Analysis:

Zero-inflated Negative Binomial Regression:

$$\ln(\mu_i) = \beta_0 + \beta_1 P_{its} + \beta_3 X_{its} + \nu_t + \psi_s + \ln(t_i)$$

Outcome Variable: Conditional mean of # of deaths and injuries in 24h

Variable of Interest: Permit Royalty

Zero Prediction:

$$P(r_i = j) = \begin{cases} \pi + (1-\pi)\mathrm{P}(R = r_i) & if\ j = 0 \\ (1-\pi)P(R = r_i) & if\ j > 0 \end{cases}, \qquad \pi = \frac{\lambda}{1+\lambda}$$

$$\ln(\lambda) = \gamma_0 + \gamma_1 S_{its} + \gamma_2 B_{its} + \ln(t_i)$$

Data

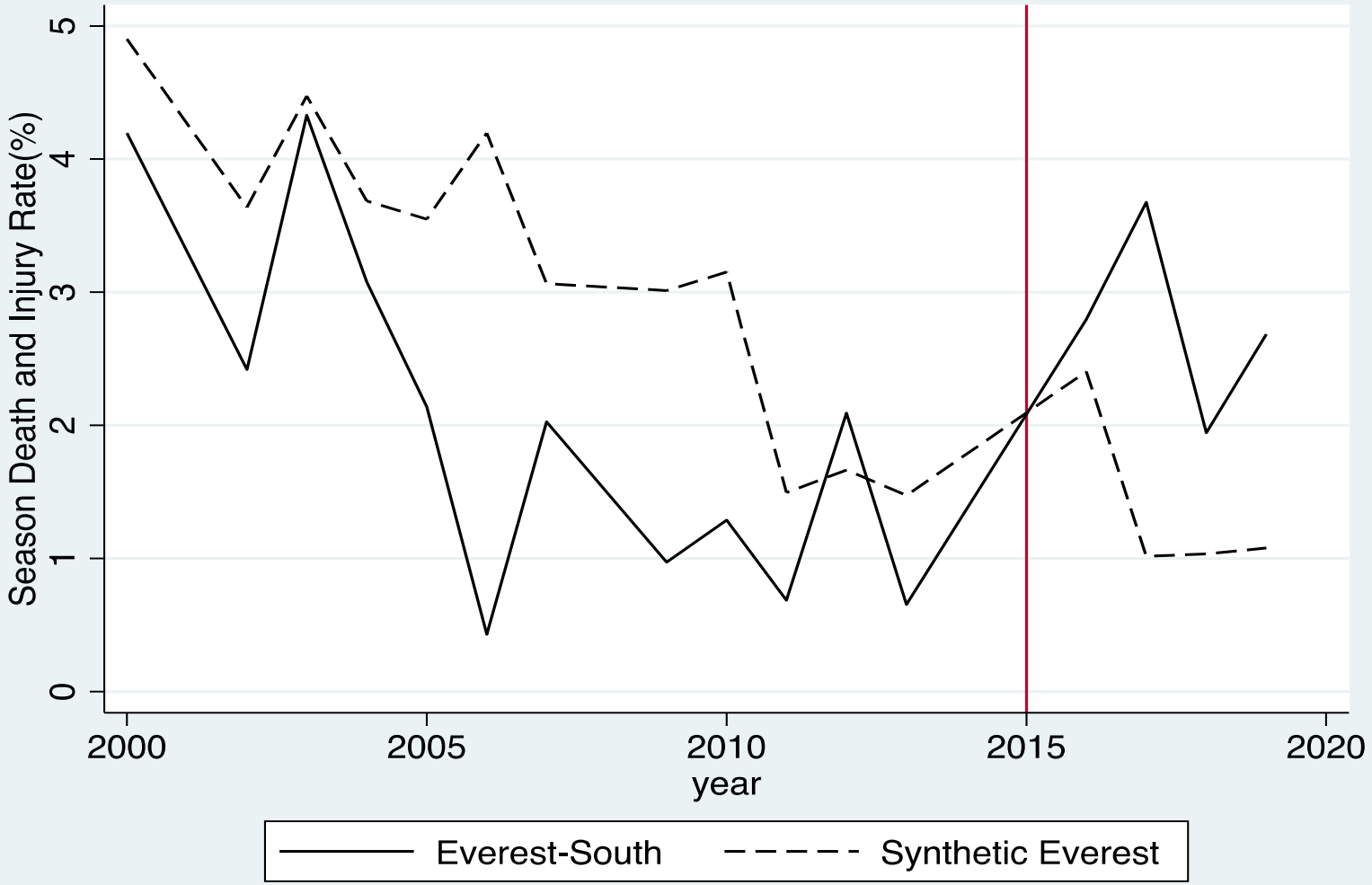
The Himalayan Database

- Eight 8000m peaks in Nepal Himalaya 2000-2019
- Focus on Nepal Side of Mount Everest

	Obs.	Mean	Std. Dev.	Min.	Max.
Deaths & Injuries in 24h	3,378	1.7614	2.2018	0	8
Deaths & Injuries in 24h >7900m	3,123	1.6555	2.0036	0	8
Permit Royalty (1000's USD)	3,796	10.0945	1.4801	0.757	15
Individual Controls					
Age	3,796	40.1457	10.4100	14	81
Oxygen Used	3,796	0.8617	0.3453	0	1
Previous 8000m Attempt	3,796	1.7640	3.4953	0	40
Previous 8000m Success	3,796	0.8172	2.1768	0	22
Previous Everest Attempt	3,796	0.9104	2.2111	0	26
Previous Everest Success	3,796	0.4049	1.5470	0	20
Expedition Composition Controls					
Climbers: Hired	3,778	1.0270	0.5211	0	4
Climbers: Hired Climbers	3,611	1.5219	1.0338	0	8.5
Summit Day Controls					
Team Size	3,796	11.4700	8.5809	1	42
Crowding	3,154	0.1237	0.3294	0	1
Same Day Climbers	3,151	84.9800	61.2169	0	240
Bad Weather	3,796	0.3256	0.4687	0	1
Bad Conditions	3,796	0.0514	0.2208	0	1

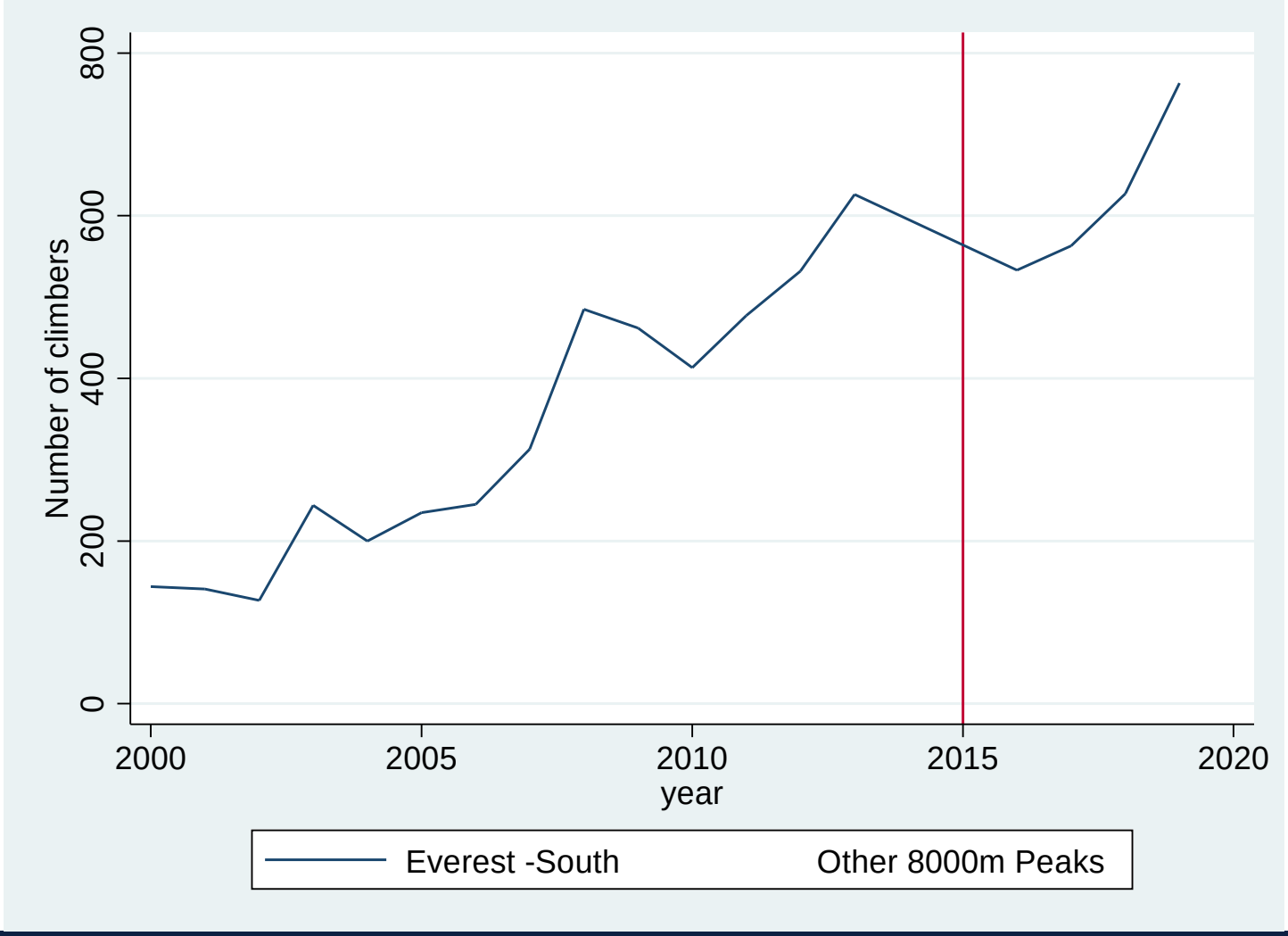
	Everest-South		Other 8000m Peaks	
	Mean	Std. Dev.	Mean	Std. Dev.
Season Death & Injury Rate (%)	2.2134	1.2206	3.9381	4.7124
Average Previous 8000m Experience	1.7833	0.2893	2.5612	1.6853
Average Hired Ratio	1.7375	0.6051	3.0100	1.6744

Synthetic Control



Predictor	Year	Treated	Synthetic
Average Hired Ratio	2005	1.876475	2.033437
Average Hired Ratio	2009	1.480435	1.540164
Average Hired Ratio	2011	1.185471	1.800944
Average Hired Ratio	2012	1.349298	2.698744
Average Hired Ratio	2013	1.294335	1.39057
Average Previous 8000m Experience	2005	1.452555	1.651099
Average Previous 8000m Experience	2009	1.787645	1.443867
Average Previous 8000m Experience	2011	1.966387	1.709093
Average Previous 8000m Experience	2012	1.673333	2.637846
Average Previous 8000m Experience	2013	1.759259	2.088824
Death & Injury Rate	2000	4.195804	4.901789
Death & Injury Rate	2002	2.419355	3.637751
Death & Injury Rate	2003	4.329004	4.474459
Death & Injury Rate	2005	2.139037	4.471751
Death & Injury Rate	2006	0.4310345	4.196029
Death & Injury Rate	2007	2.027027	3.06433
Death & Injury Rate	2009	0.973236	3.012651
Death & Injury Rate	2010	1.28866	3.1518671
Death & Injury Rate	2011	0.6864989	1.495696
Death & Injury Rate	2012	2.09205	1.664377
Death & Injury Rate	2013	0.6557377	1.474096
Root Mean Squared Prediction Error		1.547861	

Increasing Numbers



Regression Results

Dependent Variable Deaths & Injuries in 24h	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: OLS						
Permit Royalty	-0.0292	-0.0193	-0.0180	-0.0150	-0.0157	-0.0166
	(0.0255)	(0.0237)	(0.0238)	(0.0238)	(0.0207)	(0.0236)
Crowding		3.985***	3.992***	3.944***	3.207***	3.998***
		(0.143)	(0.143)	(0.145)	(0.130)	(0.143)
R-Squared	0.427	0.622	0.623	0.626	0.603	0.626
Panel B: Zero-Inflated N.B.						
Permit Royalty	-0.00779	-0.0109**	-0.0113**	-0.00990*	-0.00916**	-0.00992*
	(0.00609)	(0.00533)	(0.00533)	(0.00514)	(0.00422)	(0.00514)
Crowding		0.529***	0.533***	0.527***	0.354***	0.528***
		(0.0427)	(0.0428)	(0.0430)	(0.0367)	(0.0430)
Zero-Predictor:						
Same day Summitters	-0.0540***	-0.0541***	-0.0541***	-0.0597***	-0.0558***	-0.0594***
	(0.00282)	(0.00285)	(0.00285)	(0.00312)	(0.00305)	(0.00310)
χ^2	18196.8	18607.8	17416.7	16475.0	26885.5	16467.1
Degrees of Freedom	20	21	24	26	26	27
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Weather & Conditions Controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	No	No	Yes	Yes	Yes	Yes
Expedition Controls	No	No	No	Yes	Yes	Yes
Season FE	No	No	No	No	No	Yes
Observations	3378	3123	3123	3055	3055	3083

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Discussion: Possible Mechanisms

Changes in climber characteristics

- Higher average age, but experience levels remained unchanged

Changes in team characteristics

- Significant decrease in the number of climbers to hired climber
- Expedition size unchanged

Changes in decision-making

- More oxygen use
- Less climbing in adverse conditions/bad weather

Discussion: Externalities

Dependent Variable Deaths & Injuries in 24h	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: OLS						
Everest Permit	1.030***	1.005***	0.934***	1.085***	0.915***	1.029***
	(0.118)	(0.125)	(0.116)	(0.174)	(0.123)	(0.176)
R-Squared	0.152	0.172	0.157	0.172	0.178	0.196
Observations	5243	4644	5243	4337	4644	3943
Panel B: Zero-Inflated NB						
Everest Permit	0.563***	0.670***	0.505***	0.545***	0.581***	0.572***
	(0.0937)	(0.106)	(0.0989)	(0.129)	(0.110)	(0.140)
χ^2	1158.2	1150.8	1178.5	1320.0	1187.1	1314.7
Degrees of Freedom	27	29	30	28	32	33
Observations	4337	3943	4337	4337	3943	3943
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Peak FE	Yes	Yes	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes	Yes	Yes
Weather/Conditions Controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	No	No	Yes	No	Yes	Yes
Expedition Controls	No	Yes	No	No	Yes	Yes
Crowding Controls	No	No	No	Yes	No	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusion

Increases in permit royalties lower risk→ More support for climbers, less climbing in bad conditions, and large negative externalities

Confounders:

- 2014 Khumbu Avalanche, 2015 Earthquake
- Small increase relative to overall cost of expedition

Further Research: Behavioural Context

Policy Suggestion: Limit number of permits issued per season