ABSTRACT: Incorporating concepts from behavioral economics can help improve delivery of avalanche education through a better understanding of how high-risk groups differently interpret avalanche hazards. Previous studies show that a large number of avalanche fatalities occur among a small subset of well-defined user groups. Combining what we know about the demographics of avalanche victims with the growing literature in behavioral economics on risk preference, the concentration of avalanche victims to a small number of user groups can be at least partially explained by differences in interpreting and internalizing existing hazards. Understanding how individuals internalize risk can lead to a more effective delivery of avalanche information to higher-risk groups.

KEYWORDS: Risk preference, human factors, avalanche education, behavioral economics.

1. INTRODUCTION

Over the last few decades outdoor winter recreationalists have continually defied limits and redefined the realm of possibility, skiing now what were once unskiable lines and climbing higher and steeper slopes on snowmobiles with increasing amounts of power. New technologies have aided in this quest to conquer what was once impossible, but it has also allowed people to put themselves in increasingly dangerous situations. As a result of easier access and growing popularity, yearly avalanche fatalities are rising. While some of the increase in deaths is likely due to an overall increase in backcountry users, the lack of sufficient statistics on use patterns make it impossible to calculate morbidity as a function of exposure. Nonetheless, the fact “that most avalanche victims appear to have ignored obvious signs of instability” indicates that lives can somehow be saved. (McCammon (2004), pg. 43)

This is not to imply that current avalanche prevention strategies have failed. As pointed out by Page et al. (1999), prevention methods including closures and actively triggering “fewer and less severe avalanches” near high use areas such as highways and ski areas has led to a “marked decrease in fatalities among snowplow drivers, motorists, and in-bounds skiers.” (pg. 149)

Northwest Weather and Avalanche Center (NWAC) has reported, combined number of reported fatalities in the United States for in- and out-of-bounds skiers dropped from 19 between 1990 and 2000 to 6 in between 2000 and 2010, a decrease of 68.4%.

At the same time, Page et al (1999) also note that “[i]increasing deaths are seen among out-of-bounds skiers, backcountry skiers, and snowboarders.” (pg. 147) As reported by the NWAC snowboarders and backcountry skiers have continued to experience an increasing number of deaths in their user groups from the 1990s to the 2000s (17.3% and 55.3%, respectively). Perhaps the most striking increase in fatalities among user types has occurred among snowmobilers, with deaths increasing from 62 in the 1990s to 122 in the 2000s – an increase of 96.8%. These statistics show that while the aforementioned types of preventive action have improved outcomes among user groups for which avalanches are an objective hazard, these measures may have reached a point of diminishing returns. Active initiation of avalanches in all potential use areas is infeasible, and simply closing access to backcountry areas is unacceptable to those who use them. Instead, since “[m]ost fatal accidents today in North America and [W]estern Europe are caused by people triggering the avalanche themselves,” we need to continue to develop a “better understanding of the decision process in avalanche terrain.” (McClung (2002), pg. 112, and Haegali et al. (2010), pg. 118, respectively)

Economics can lend valuable insight into this decision process. As pointed out by McClung (2002), “[s]ince avalanche forecasting ultimately contains decisions involving the chance of death or losses,
it is formally equivalent to a risk analysis.” With a more complete understanding of how people make choices when confronted with a potential avalanche hazard, avalanche educators and forecasting centers can tailor the types of information they present, as well as how they present it, to save more lives.

Economists can aid avalanche professionals by shedding light on how people make choices when travelling in avalanche prone areas. McCammon (2004) wonders how “people come to believe that a slope is safe, even when they are faced with likely evidence that it isn’t?” (pg. 42) By simply replacing ‘a slope is safe’ with ‘value is increasing’ we now have a question that has been pondered by economists for generations: How do asset bubbles form? Both of these problems stem from people having confidence when they should not, and the results from each can prove potentially catastrophic. Similar to the “systematic overvaluing of an asset,” people who choose to travel in spite of obvious signs of an increasing risk of avalanches often experience better and better returns (more tracks in fresh powder, for example) until the bubble caused by belief inertia pops. (Stanley (1997), pg. 612) Unlike asset-price bubbles, however, when the personal safety of recreating in avalanche terrain has been overestimated, the results are too often fatal.

2. DIFFERENT RISK PREFERENCES

What leads some individuals to accept higher levels of risk? Answering this question is one of the keys to further reductions in avalanche deaths. As Kristensen et al. (2012) point out, avalanche professionals need to incorporate “a higher level of understanding on how low-probability / high-consequence events” are internalized by individuals. (pg. 501) Clearly not everyone makes the same decision given the same information. Sitkin and Pablo (1992) claim “that decision makers who have been risk averse in the past will tend to continue in their cautious ways, whereas previously risk-seeking decision makers will continue to be more adventurous,” but what factors underpin these preferences? (pg. 17) In a user survey conducted by Haegali et al. (2010), different user groups were found to have “significantly different decision preferences depending on their relevant training, experience, and recreation preferences.” (pg. 206) These preferences are revealed in the demographics of avalanche victims.

Most avalanche victims are young and male. In a review of Canadian avalanche incidents, Boyd et al. (2009) find that 88% of fatalities were male, with “victims most commonly being in their twenties.” This corresponds with Page et al. (1999), who studied American avalanche reports and found a mean age of victims of 27.6 years, with males accounting for 87.3% of victims. While the exact numbers vary slightly between nations, these trends hold for both North America and Western Europe.¹

One explanation of why avalanche victims are typically males in their mid- to late-twenties could be that these individuals simply use the backcountry more. If this is the case, the higher reported rates of death among these users would simply reflect their increased exposure to the hazard. Even if this were true, the suggestions that follow in section 3 would be no less valid, as these user groups could still benefit from improvements in avalanche education. Nonetheless, the findings of Sole et al. (2010) illustrate that this is not the case. In a controlled survey of winter recreationalists, they found that “people aged 25 to 29 may be more likely to experience an avalanche incident” and that women were “less likely to experience an avalanche incident.” (pg. 447) This follows the finding of McCammon (2004) that “women appeared to avoid participating in parties where they had the highest probability of being caught.” (pg. 46)

These demographics are not surprising in light of the economics literature on risk. Women are generally more risk averse than men, as shown by studies including Eckel and Grossman (2002, 2008), Fellner and Maciejovsky (2007), and Croson and Gneezy (2009). This is not to say women are always more risk averse, as studies employing “contextual frames show less consistent results” than studies using general gamble choices. (Eckel and Grossman (2008), pg.1061) In an avalanche setting this may mean that in familiar instances such as traveling in known terrain with regular companions, women may exhibit risk aversion similar to men. This specific effect is not well-studied, however, and the economics literature generally agrees that “[w]omen are less willing to take risks than men.” (Dohmen et al. (2011), pg. 530) While age-impacts on risk perception has received considerably less attention than gender-

¹ Haegeli et al. (2011) find “no statistically significant differences between the Canadian and Swiss samples” when looking at individual characteristics from reports of fatalities in those countries. (pg. 790)
impacts, studies such as Dohmen et al. (2011) find that "[i]ncreasing age reduces willingness to take risks… but has a particularly large impact in the domain of sports and leisure." (pg. 535)

The uneven distribution of fatalities among user types, however, is tougher to explain. As the figures previously cited from NWAC illustrate, snowmobilers represent not only the user group with the most fatalities, but one with a growing proportion of overall deaths. Snowmobilers accounted for 26.5% (62/234) of US fatalities in the 1990s, which increased to 41.6% (122/293) of US fatalities in the 2000s. The trend of increasing deaths among snowmobilers also exists in Canada. Boyd et al. (2009) found that in the period between April 1, 1984 and April 5, 2005, snowmobilers accounted for 22% of Canadian avalanche fatalities. Looking at the past decade, Haegeli et al. (2012) report that in "the last five winters, mountain snowmobilers accounted for 53% (41 of 77) of all recreational avalanche fatalities in Canada, which is a significant increase from the 28% (18 of 64) during the previous five winters." (pg. 800) The increases in the absolute and relative numbers of fatalities among snowmobilers could come either from a marked increase in users of this type, or from underlying differences in how they interpret and internalize risk, or some combination thereof.

As noted by Boyd et al. (2009), snowmobilers are "the fastest growing and probably the largest activity group exposed to avalanches in North America." Some of this increased exposure can be attributed to the ability to cover many more miles in a day than human-powered activities. Because they travel faster, snowmobilers are potentially exposed to more potential hazard areas than skiers are in a given number of hours. While the growing popularity of snowmobiling in North America no doubt accounts for some of the increase in avalanche fatalities among this group, there is reason to believe that other factors are also influential. When comparing mortality rates of individuals caught in avalanches reported to the Canadian Avalanche Centre, Haegeli et al. (2011) found that backcountry and out-of-bounds skiers caught in avalanches had 45.1% and 41.7% mortality rates, respectively, while snowmobilers had a 72.3% mortality rate. While this could stem from systematic reporting biases, user surveys also support the idea that snowmobilers have a different underlying interpretation – and internalization – of risk.

Two possible economic explanations exist for the difference in risk preferences, and both are alluded to by Kristensen et al. (2012). The first possibility is that individuals in these user groups are willing to accept higher levels of risk. Kristensen et al. (2012) suggest that we may be observing "a conscious choice" which may "actually reflect the risk…considered acceptable by these people." (pg. 501-502)

That snowmobilers in particular have an increased willingness to accept risk has some empirical support. Haegeli et al (2010) find that professionals and backcountry skiers "prefer to avoid terrain that is rated as complex because of its potential for avalanches, whereas [snowmobilers] show preferences for complex terrain…" (pg. 204)

The second possibility, however, is that users in high-risk groups differ in their perception of how much risk a given decision entails. As Kristensen et al. (2012) point out, the "problem with the perception of risks seems to be the ability to translate the abstract probabilities into person life consequences." (pg. 502)

Sole et al. (2010) find that "although traditional risk factors like age and sex” matter when individuals make decisions regarding travel and recreation in avalanche prone areas, “motivation to participate may be at least as important.” (pg. 450) Indeed, the motivations of snowmobilers seem to lead to different perceptions of the risk they undertake. Silverton et al. (2009) find that "snowmobilers often underestimate the avalanche danger when traveling in the backcountry." (pg. 272) This is also reflected in the findings of Haegeli et al. (2012), who find that “snowmobilers interpret danger ratings on a linear scale and that the presence of a persistent avalanche problem does not affect their riding choices.” (pg. 800) These beliefs contrast starkly with the earlier findings by Haegeli et al. (2010) that “avalanche experts” generally agree “avalanche hazard increases exponentially on the avalanche danger scale,” and that experts exhibit “increasing sensitivity toward higher levels of avalanche hazard.” (pg. 203)

The reason for increased fatalities in snowmobilers and young males is most likely a combination of these two factors – both an increased willingness to accept risk and an underevaluation of the risk itself – though which factor dominates remains an open question. With these two factors in

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2 This activity is not popular in Europe, so while the demographics of victims is similar between North America and Western Europe, the activities that victims were involved in differ by continent.
mind, three potential improvements to avalanche education are offered below.

3. POTENTIAL EDUCATION IMPROVEMENTS

3.1 Compensate for Lack of Experience

Perhaps the biggest way to help at-risk user groups is by helping them compensate for a lack of experience. After all, “perceived risk is shaped not only by [how] individuals see themselves being able to handle uncertainty, but also by how individuals interpret the impact of possible negative outcomes.” (Cho and Lee (2006), pg. 118-119) Individuals with high confidence in their ability to avoid avalanches or in their abilities to rescue other party members in the event of an avalanche may systematically underestimate the avalanche hazard and their ability to deal with it. One commonly observed overconfidence in snowmobilers is that they can ‘outrun’ an avalanche. While the occasional exception occurs, avalanches typically run faster and longer than anticipated, making such overconfidence too often deadly. Kwan and Lee (2009) show that “the self-perception of possession of knowledge, especially when that perception reflects one’s over-confidence, may negatively affect objective and rational information processing.” (pg. 724)

One solution to the overconfidence problem is simple: give students in avalanche courses more practice integrating terrain, snowpack, and weather information in a controlled environment. Sitkin and Pablo (1992) cite the “U-shaped relationship between experience and choice behavior,” implying that some experience may make individuals overconfident, while even more experience makes expectations and insights more realistic. Taylor et al. (1996) find that “outcome feedback affected subjects’ decisions as evidenced by performance levels and improvements over time.” (pg. 309) Avalanche courses need to not only teach the skills necessary to evaluate safety in avalanche terrain, but to have the students apply those skills in as many realistic case studies as possible. As shown by Stanley (1997) with respect to bubbles, while experience does not prevent the formation of irrational beliefs, it can help reduce their occurrence. In their survey of individuals who had experienced an avalanche event, Sole et al. (2010) find that nearly “two-thirds of those reporting an avalanche incident indicated that it resulted in his/her being more cautious … with respect to avalanche risk.” (pg. 449) Practical case studies can also get students in the habit of justifying their choices, which Vieder (2009) finds “to enhance rationality and the quality of decisions.” (pg. 98) Simulating the choices made in avalanche terrain, and taking time to discuss the potential consequences of these decisions, can help build the necessary experience that aids people in making safe choices when actually traveling in avalanche terrain.

3.2 Reframe the Problem

Kahneman and Tversky (1979) famously found that the way a problem is presented will influence the decisions made. Sitkin and Pablo (1992) define framing effects as differences observed in decisions “whether the situation is presented to the decision maker in a positive or negative light, as an opportunity or a problem, or in terms of gains or losses.” (pg. 14) More recently, Charness and Levin (2009) demonstrate that “framing is critical, since people do better when helped to overcome [a] contingent-reasoning problem.” (pg. 210) People tend to be more loss averse than risk averse, as shown by Köbberling and Wakker (2005), among others. Reframing the avalanche hazard as a potential loss of life, friends, or future recreational opportunities rather than as a risk taken to enjoy a recreational activity may go a long way in helping to reduce avalanche fatalities. Reframing the problem can also mean changing the menu of options that an individual chooses between. Having a better defined — and potentially more palatable — alternative should facilitate better decision choices. Rather than teaching students in avalanche classes to evaluate the snowpack for a “Go/No Go” decision, the choice can be framed as one of “Go Here vs. Go Elsewhere.” If the snowpack, terrain, or weather indicate a certain route may be risky, having a predetermined, safer, yet still attractive alternative (low-angle trees, for example) makes it easier to not proceed with the initial riskier plan. Many avalanche courses have already begun to incorporate this kind of thinking into their syllabi. When coupled with increased practice making decisions by integrating information, as outlined above, reframed options can help recreationalists of all types safely enjoy their time in avalanche terrain.

3.3 Continue to Simplify

Avalanche professionals have long been concerned with ways to simplify the integration of complex information to aid in decision making. Behavioral Economists Charness and Levin (2009) point out that “complexity is a hurdle for
many people," and find that "simplifying [the] environment makes the decision problem more approachable." (pg. 223 and pg. 222, respectively) Many tools have been suggested and tested over the past couple of decades, with the overall goal of these “decision aids … to make appropriate choices more accessible and more likely for their users by reducing the complexity of decision situations.” (Haegeli et al. (2010), pg. 190) In fatal avalanche incidents, McCammon (2004) finds that the “problem was not that these victims didn’t have enough knowledge to make good decisions; the problem was that they didn’t know how to apply the knowledge that they did have.” (pg. 50) Introducing students to a variety of current avalanche tools will help them find a system they can practice with and use in the field, be it the ALP TRUTH acronym, the Canadian Avalanche Centre’s ‘Avaluator,’ the counting of ‘Lemons’, or the Stability Wheel proposed by Rodriguez et al. (2014). Each helps the outdoor recreationalist by collapsing a complex decision into a handful of tractable, yes/no questions, which in turn leads to relatively straight-forward travel advice.

4. CONCLUSION

In spite of many differences between their fields, economists and avalanche professionals can gain useful insights by working together. The applied nature of work in avalanche prevention coupled with the findings of economics from theory and laboratory experiments makes a functional and practical marriage for all involved.

Existing economic literature is shown above as useful to avalanche professionals in two ways. First, by helping to explain why avalanche fatalities are concentrated in a small subset of user groups. Second, by giving practical suggestions on how to improve choices made involving risk and uncertainty. Avalanche education can continue to improve by incorporating more practice in integrating information. Practice becomes even more useful when the choices are reframed so that alternative options are seen positively, and when the choices made are seen as choices of “potential loss” rather than "potential risk." Finally, this practice should utilize tools that simplify the decision making process.

Some avalanche courses may already incorporate some or all of the suggestions above. Instructors conducting avalanche education courses that include these components should take heart in knowing that the information they have been providing to their students has strong theoretical basis. For those educators who conduct courses without one or more of these components, consider including them the next time around.

The interdisciplinary benefit between economists and avalanche professionals is not a one-way street. More studies completed by avalanche professionals regarding backcountry user preferences in the vein of Haegeli et al. (2012) will not only further improve the manner in which avalanche education and forecast products are presented, but also provide economists with generalizable information about how individuals make real-world choices with potentially serious consequences under uncertainty. After all, travelling in avalanche terrain involves observable real-world choices that deal with high-consequence/low-probability events. The improved understanding of behaviors and biases that can be gained from analysis of decisions made in the avalanche context could result in myriad applications.

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