Cost-Benefit Analysis

How it works, and when it doesn't work

Cost-Benefit Analysis

- Economists and logicians have developed a method for making "rational decisions", often called *cost-benefit analysis*.

- The basic rule is to choose the action that has the greatest "expected utility".

Utility values

- Each action under consideration has a number of possible outcomes. (In general, we cannot predict outcomes with certainty.)

- We assign a number to each possible outcome. This is called a *utility*, and it measures how good/bad that outcome is considered to be.

- Good outcomes have positive utility, bad things have negative utility.

- If an outcome has both good and bad aspects, then the negative utility is subtracted from the positive.

Example

- A company wants to build a factory in the city you're the mayor of.

- The City will earn $50,000 per year in property taxes from the factory. They will hire 400 local people, for total annual wages of $12 million.

- The factory will also reduce air quality in the area, leading to increased asthma and other diseases. There will also be an odour.

-- How do you quantify these benefits and costs?

Probabilities

- In general, we cannot predict the outcome of a given action with certainty.

- Instead, we try to assign a *probability* to each possible outcome, for a given action.

- Usually this is a subjective estimate. We use whatever knowledge we have to estimate the probability of the outcome, given the action.

Expected utility

- Consider some action A, which has possible outcomes O_1 and O_2, with probabilities P_1 and P_2. The expected (average) utility of A is then:

  $$EU(A) = O_1.P_1 + O_2.P_2$$

  We calculate the expected utility for each action, and do that action with the highest expected utility.

Difficulties with CBA

1. It is hard to assign utilities in an objective way. They reflect people's subjective preferences. Different people will assign different utilities.

2. It is hard to assign probabilities in an objective way. They are subjective assessments, and different people will assign different values.

Fallacies with CBA

1. **Omit costs and benefits that are hard to measure objectively**

   In some cases, some utilities will be objective, e.g. dollar values of costs and revenues. Other utilities are more subjective, e.g. costs and benefits to the environment, human health. The hard-to-measure costs and benefits are often left out of the analysis, effectively assigning a false value of *zero*.

2. Ignore the Costs

- If one is lobbying for an action, it is tempting to do a "benefit-benefit analysis".

- This analysis carefully counts the benefits of the action, but ignores the costs, or even claims that there are no costs.

3. Ignore the Benefits

- The exact reverse is also possible, and equally fallacious.

- If you oppose an action, then make your case with a "cost-cost analysis".

Example: Bike helmet legislation

- What are the possible costs and benefits of bike helmet legislation?

- Costs: -- Discomfort of wearing a helmet
    - Inconvenience of carrying a helmet around
    - Cost of buying a helmet
    - *Discourage cycling*, leading to increased heart disease, etc.

- Benefits: --Reduced brain injuries for cyclists
    -- Economic benefits of helmet sales

- How are these costs and benefits to be measured, *in the same units*?

- E.g. *certain* discomfort/inconvenience versus a very small reduction in chance of brain injury?

- Change in life years (hours, minutes, seconds) is a useful measure.

- E.g. in Canada, there are apparently 24 cycling deaths per billion km travelled, on average.

- If we suppose that the average cycling death shortens a person's life by 30 years, then that's a total of 720 life-years lost per billion km.

- That's 263,000 life-days, or 6.3 million life-hours, or 379 million life-minutes.

- It works out to **23 life-seconds lost per km** cycled.

- Whaaaa? I just rode 10 km this morning. Does that mean I lost 230 seconds (4 mins) of my life?

- No. If you're here, then you didn't die. The 23-second loss is an *average*, based on most people losing nothing, but the occasional person losing 10-50 years.

- Are such averages useful/ meaningful/ relevant?

Comparisons?

- According to these figures, choosing to cycle a kilometre shortens one's life expectancy by 23 seconds. (This doesn't include non-fatal injuries, of course.) Is that a lot or a little? We need something to compare it to.

- Driving a car in Canada: 8.2 deaths per billion km, means about 8 seconds lost per km.

- N.B. A car driver averages about 15,000 km per year in Canada, for a total of 120,000 seconds lost, or 33 hours per year.

- A regular cyclist rides about 5,000 km per year, for a total of 32 hours per year – about the same.

- Per *hour*, rather than per km, cycling and driving both cost a person about 5 minutes of life expectancy, in Canada.

- Walking is a little less, the cost being maybe 2-3 minutes per hour.

- But how long would it take to walk to school?

- (Per km, cycling is safer than walking.)

Discomfort vs. brain injury

- It might seem initially that the risk of dying of a brain injury will certainly outweigh costs like getting hot and sweaty, having 'helmet hair', etc.

- Suppose, however, that you're riding to school for about 30 minutes, on a warm day. Going by bike will reduce your life expectancy by about 2-3 minutes. Wearing a helmet will, using optimistic figures, improve this by about 40 life-seconds.

- *Would you trade 40 seconds of your life for the sake of comfort, and attractive hair, on one day?*
  (It doesn't seem an unreasonable trade)

Another comparison

- It is estimated that smoking a cigarette reduces life expectancy by about 11 minutes, on average.

- N.B. Smoking is now (mostly) illegal, but this is justified on the basis of harm to others (second-hand smoke).

Health benefits

- A regular cyclist rides about 5000 km per year, in about 350 hours. This is around 7 hours per week, which is a significant amount of exercise.

- This level of activity is estimated to add about 3 years of life expectancy.

- Over 50 years, this is 17,500 hours of cycling. If the result is (on average) 3 more years of life, then the average gain is 90 life-minutes per hour of cycling.

Regular physical activity:

- Improves your chances of living longer and living healthier
- Helps protect you from developing heart disease and stroke or its precursors, high blood pressure and undesirable blood lipid patterns
- Helps protect you from developing certain cancers, including colon and breast cancer, and possibly lung and endometrial (uterine lining) cancer
- Helps prevent type 2 diabetes
- Helps prevent osteoporosis
- Reduces the risk of falling and improves cognitive function among older adults
- Relieves symptoms of depression and anxiety and improves mood
- Prevents weight gain, promotes weight loss (when combined with a lower-calorie diet), and helps keep weight off after weight loss
- Improves heart-lung and muscle fitness
- Improves sleep

Cost-benefit analysis

- A hour of cycling *adds* about 85 minutes of life expectancy. (In effect, the collision risk is negligible compared to the health benefit.)

- A hour of driving *subtracts* about 5 minutes of life expectancy (for the driver).

- What about helmets? Using the most optimistic figures, wearing a helmet can add up to 1 minute of life expectancy per hour of cycling.

Relative vs. absolute figures

- One often reads the (now refuted) claim that wearing a bike helmet reduces the risk of a serious brain injury by up to 88%. This is a *relative* measure of risk.

- Question: 88% of what? How big is the risk of brain injury to begin with?

- That's why an *absolute* measure, e.g. lost life-minutes, is more useful. It tells you whether or not it's a big deal.

Cost-benefit analysis

- Should wearing bike helmets be mandatory?

- The biggest potential cost, from the government's point of view, is discouraging cycling. Suppose, for example, that helmet legislation reduces cycling by just 1%.

- Since the benefit of cycling is 90min/h, and the benefit of helmet wearing is (optimistically) 1min/h, the costs and benefits roughly break even when the law increases helmet wearing from 0% to 100%.

Cost-benefit analysis

- In B.C., helmet wearing increased from about 45% pre-law to about 70% post-law, an increase of about 25 percentage points.

- So the health costs and benefits balance if the law reduces cycling by about 0.25%.

- In other words, a helmet law is a risky policy. The maximum possible gains are very small, and can easily be outweighed by losses.

Was Cycling Reduced in B.C.?

- We don't know for certain, since no counts were conducted.
- (Is this responsible, in view of the preceding analysis?)
- Total cyclist injuries however declined by about 30% between 1995 and 1997 (the law came in in 1996) with the proportion of head injuries remaining constant.
- It is therefore likely that cycling was reduced in BC by at least 20% between 1995 and 1997.
- On this basis, the costs of helmet legislation outweigh the benefits by a factor of 80. (Costs of helmet hair, etc. not included.)

Counts in Victoria, Australia

Figure 1. Counts of cyclists with and without helmets in Victoria, pre- (May 1990) and post- (May 1991) helmet law (source: MUARC surveys 7).
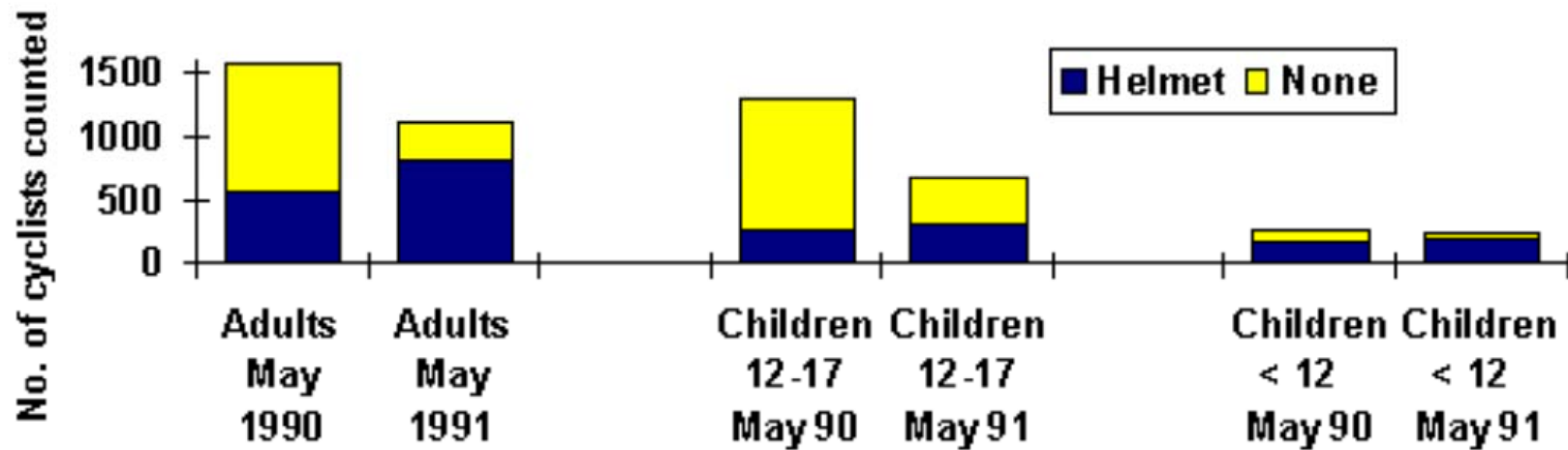
Lives lost/gained

- Annually in BC I estimate there are about 30 million cycling hours. (Based on 10 deaths per year.)
- So life-years gained through helmet legislation is (optimistically) about 7.5 million life-minutes, or 14 life-years, per year.
- Assuming a 20% drop in cycling following legislation, 6 million cycling hours have been lost each year. Each cycling hour gains 90 life-minutes, so the life-loss is 9 million hours per year, or 1027 life-years lost per year.
- Since the law passed in 1996, about 7 lives have been saved, and 500 lost, as a result of the legislation.

Cost-benefit analysis and justice

- Cost-benefit analysis assumes the moral theory known as *consequentialism*, which say that the morally right action is the one with the best (estimated) consequences.

- Consequentialism is often criticised for ignoring justice, and indeed for finding unjust actions to be morally right.

Cost-benefit analysis and justice

- E.g. suppose in the American South, in 1890, a white woman has been raped. A lynch mob of white men has captured a black youth and dragged him to the sheriff, claiming that he is the rapist, and demanding that he be hanged.

- The sheriff knows that it would be unjust to hang the youth without a fair trial. But he does a quick cost-benefit analysis, predicting riots and mayhem if he refuses to hang the boy. So he does the "right" thing and hangs him.

Helmet laws and justice

- Aside from consequences (life-years lost and gained) is it *just* to fine bare-headed cyclists?

- In general, illegal actions ought to be immoral as well. (Not vice-versa, in general.) And just punishment is in proportion to the harm done by the criminal.

- If bare-headed cycling is morally wrong, then this is due to its being excessively risky. But it is much safer than driving a car. So it's not morally wrong.

- If people are to be punished for taking risks, then justice surely requires that bigger risks are punished more than smaller risks.

'Helmet hair' fears put women off cycling - survey

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Women are three times less likely to cycle than men because they are put off by "helmet hair" and getting sweaty, a survey said today.

Despite the golden heroics in Beijing by the British female cycling team, 64% of women said they never cycle, according to an online survey commissioned by Cycling England.

Citing the reasons for avoiding cycling, 58% said they would not want to arrive at work sweaty, and one in four (27 per cent) were too worried about helmets ruining their hair to risk a ride in the saddle.

Almost one in five (19%) of women even said they could not risk colleagues catching them without their make-up on.

Other Communities stories

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Why more parents need to let their kids get hurt

Posted by Amy Dickinson on October 19, 2011

in Parent Perspective   Playful Learning   play outdoors   providence children's museum   risk

"Calculate the medical damage, and let them fall. How else are they going to learn balance?"

So asserted Julia Steiny, a columnist for *Education News*, at a recent community discussion on "Kids, Play, and Risk" at the Providence Children's Museum. Though some parents might bristle at Julia's suggestion, she's right.

When we don't allow children to take acceptable risks in their play, we take away crucial learning opportunities. Risk teaches them how to fail and try again, test their limits and boundaries, become resilient and acquire coping skills, interact in groups, and negotiate rules amongst themselves.

Would you let your child do this?